ENGINEERING CHANGE NOTICE

Page 2 of 2

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

ECN-635592

16. Design Verification Required

☐ Yes

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17. Cost Impact

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

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

Document Number/Revision

Document Number/Revision

Document Number Revision

N/A

21. Approvals

Signature	Date	Signature	Date
Design Authority		Design Agent	
Cog. Eng. D.J. McCain <i>D.J. McCain</i>	<u>2/25/98</u>	PE	
Cog. Mgr. K.M. Hall <i>Kathleen M. Hall</i>	<u>2/25/98</u>	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other R.J. Cash <i>R.J. Cash</i>	<u>2/25/98</u>	Other	
N.W. Kirch <i>N.W. Kirch</i>	<u>2/25/98</u>		
J.G. Kristofzski <i>J.G. Kristofzski</i>	<u>2/25/98</u>		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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

Dennis J. McCain
Lockheed Martin Hanford Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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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-110. This report supports the requirements of the Tri-Party Agreement Milestone M-44-15B.

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

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CONTENTS

1.0 INTRODUCTION	1-1
1.1 SCOPE	1-1
1.2 TANK BACKGROUND	1-2
2.0 RESPONSE TO TECHNICAL ISSUES	2-1
2.1 SAFETY SCREENING	2-1
2.1.1 Exothermic Conditions (Energetics)	2-2
2.1.2 Flammable Gas	2-2
2.1.3 Criticality	2-2
2.2 ORGANIC COMPLEXANTS	2-3
2.3 HAZARDOUS VAPOR SAFETY SCREENING	2-3
2.3.1 Flammable Gas	2-3
2.3.2 Toxicity	2-3
2.4 ORGANIC SOLVENTS SCREENING	2-4
2.5 COMPATIBILITY	2-4
2.6 OTHER TECHNICAL ISSUES	2-5
2.7 SUMMARY	2-6
3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE	3-1
4.0 RECOMMENDATIONS	4-1
5.0 REFERENCES	5-1
APPENDICES	
APPENDIX A: HISTORICAL TANK INFORMATION	A-1
A1.0 CURRENT TANK STATUS	A-3
A2.0 TANK DESIGN AND BACKGROUND	A-4
A3.0 PROCESS KNOWLEDGE	A-8
A3.1 WASTE TRANSFER HISTORY	A-8
A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS	A-9

CONTENTS (Continued)

A4.0	SURVEILLANCE DATA	A-15
A4.1	SURFACE LEVEL READINGS	A-15
A4.2	DRY WELL READINGS	A-15
A4.3	INTERNAL TANK TEMPERATURES	A-15
A4.4	TANK 241-T-110 PHOTOGRAPHS	A-16
A5.0	APPENDIX A REFERENCES	A-19
	APPENDIX B: SAMPLING OF TANK 241-T-110	B-1
B1.0	TANK SAMPLING OVERVIEW	B-3
B2.0	SAMPLING EVENTS	B-3
B2.1	1997 GRAB SAMPLING EVENT	B-5
	B2.1.1 Sample Handling and Analysis	B-5
B2.2	1997 PUSH-MODE CORE SAMPLING EVENT	B-5
	B2.2.1 Sample Handling	B-6
B2.3	ANALYTICAL RESULTS, NONVAPOR SAMPLING EVENTS	B-8
	B2.3.1 Total Alpha Activity	B-10
	B2.3.2 Thermogravimetric Analysis	B-10
	B2.3.3 Differential Scanning Calorimetry	B-10
	B2.3.4 Inductively Coupled Plasma	B-10
	B2.3.5 Specific Gravity/Bulk Density	B-10
	B2.3.6 Ion Chromatography	B-11
	B2.3.7 Total Organic Carbon	B-11
	B2.3.8 pH Measurements	B-11
	B2.3.9 Gamma Energy Analysis	B-11
	B2.3.10 Beta and Strontium Analyses	B-11
B2.4	VAPOR PHASE MEASUREMENT	B-12
B2.5	DESCRIPTION OF HISTORICAL SAMPLING EVENT	B-12
B3.0	ASSESSMENT OF CHARACTERIZATION RESULTS	B-30
B3.1	FIELD OBSERVATIONS	B-31
B3.2	QUALITY CONTROL ASSESSMENT	B-31
B3.3	DATA CONSISTENCY CHECKS	B-32
B3.4	MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS	B-32
	B3.4.1 Solid Segment and Liquid Grab Sample Means	B-33
	B3.4.2 Analysis of Variance Models	B-36
B4.0	APPENDIX B REFERENCES	B-39

CONTENTS (Continued)

APPENDIX C: STATISTICAL ANALYSIS FOR ISSUE RESOLUTION	C-1
C1.0 STATISTICS FOR THE SAFETY SCREENING DATA QUALITY OBJECTIVE	C-3
C2.0 APPENDIX C REFERENCES	C-5
APPENDIX D: EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR TANK 241-T-110	D-1
D1.0 CHEMICAL INFORMATION SOURCES	D-3
D2.0 COMPARISON OF COMPONENT INVENTORY VALUES	D-3
D3.0 COMPONENT INVENTORY EVALUATION	D-5
D3.1 CONTRIBUTING WASTE TYPES	D-5
D3.1.1 Waste Transaction History	D-5
D3.1.2 Predicted Current Waste Types	D-6
D3.2 BASIS FOR ASSESSING 2C AND 224 WASTE COMPOSITION IN TANK 241-T-110	D-6
D3.3 ESTIMATED INVENTORY FOR TANK 241-T-110	D-9
D4.0 DEFINE THE BEST BASIS AND ESTABLISH COMPONENT INVENTORIES	D-12
D5.0 APPENDIX D REFERENCES	D-17
APPENDIX E: BIBLIOGRAPHY FOR TANK 241-T-110	E-1

LIST OF FIGURES

A2-1 Riser Configuration for Tank 241-T-110	A-6
A2-2 Tank 241-T-110 Cross Section and Schematic	A-7
A3-1 Tank Layer Model	A-11
A4-1 Tank 241-T-110 Level History	A-17
A4-2 Tank 241-T-110 Weekly High Temperature Plot	A-18

LIST OF TABLES

1-1 Summary of Recent Sampling	1-2
1-2 Description of Tank 241-T-110	1-4
2-1 Summary of Technical Issues	2-6
3-1 Best Basis Standard Inventory Estimate for Tank 241-T-110 (Nonradioactive Chemical Species)	3-3
3-2 Best Basis Inventory Estimate for Radioactive Components in Tank 241-T-110 Decayed to January 1, 1994	3-4
4-1 Acceptance of Tank 241-T-110 Sampling and Analysis	4-1
4-2 Acceptance of Evaluation of Characterization Data and Information for Tank 241-T-110	4-2
A1-1 Tank Contents Status Summary	A-4
A2-1 Tank 241-T-110 Risers	A-5
A3-1 Tank 241-T-110 Major Transfers	A-9
A3-2 Historical Tank Inventory Estimate Analytes	A-11
A3-3 Historical Tank Inventory Estimate Radionuclides	A-13

LIST OF TABLES (Continued)

B2-1 Integrated Data Quality Objective Requirements for Tank 241-T-110	B-4
B2-2 Analytical Procedures	B-7
B2-3 Tank 241-T-110 Subsampling Scheme and Sample Description	B-7
B2-4 Analytical Tables	B-9
B2-5 Results of Headspace "Sniff" Measurements of Tank 241-T-110	B-12
B2-6 Historical Analytical Information	B-13
B2-7 Tank 241-T-110 Analytical Results: Aluminum (ICP)	B-13
B2-8 Tank 241-T-110 Analytical Results: Antimony (ICP)	B-14
B2-9 Tank 241-T-110 Analytical Results: Arsenic (ICP)	B-14
B2-10 Tank 241-T-110 Analytical Results: Barium (ICP)	B-14
B2-11 Tank 241-T-110 Analytical Results: Beryllium (ICP)	B-14
B2-12 Tank 241-T-110 Analytical Results: Bismuth (ICP)	B-14
B2-13 Tank 241-T-110 Analytical Results: Boron (ICP)	B-15
B2-14 Tank 241-T-110 Analytical Results: Cadmium (ICP)	B-15
B2-15 Tank 241-T-110 Analytical Results: Calcium (ICP)	B-15
B2-16 Tank 241-T-110 Analytical Results: Cerium (ICP)	B-15
B2-17 Tank 241-T-110 Analytical Results: Chromium (ICP)	B-15
B2-18 Tank 241-T-110 Analytical Results: Cobalt (ICP)	B-16
B2-19 Tank 241-T-110 Analytical Results: Copper (ICP)	B-16
B2-20 Tank 241-T-110 Analytical Results: Iron (ICP)	B-16
B2-21 Tank 241-T-110 Analytical Results: Lanthanum (ICP)	B-16

LIST OF TABLES (Continued)

B2-22	Tank 241-T-110 Analytical Results: Lead (ICP)	B-16
B2-23	Tank 241-T-110 Analytical Results: Lithium (ICP)	B-17
B2-24	Tank 241-T-110 Analytical Results: Magnesium (ICP)	B-17
B2-25	Tank 241-T-110 Analytical Results: Manganese (ICP)	B-17
B2-26	Tank 241-T-110 Analytical Results: Molybdenum (ICP)	B-17
B2-27	Tank 241-T-110 Analytical Results: Neodymium (ICP)	B-17
B2-28	Tank 241-T-110 Analytical Results: Nickel (ICP)	B-18
B2-29	Tank 241-T-110 Analytical Results: Phosphorus (ICP)	B-18
B2-30	Tank 241-T-110 Analytical Results: Potassium (ICP)	B-18
B2-31	Tank 241-T-110 Analytical Results: Samarium (ICP)	B-18
B2-32	Tank 241-T-110 Analytical Results: Selenium (ICP)	B-18
B2-33	Tank 241-T-110 Analytical Results: Silicon (ICP)	B-19
B2-34	Tank 241-T-110 Analytical Results: Silver (ICP)	B-19
B2-35	Tank 241-T-110 Analytical Results: Sodium (ICP)	B-19
B2-36	Tank 241-T-110 Analytical Results: Strontium (ICP)	B-19
B2-37	Tank 241-T-110 Analytical Results: Sulfur (ICP)	B-19
B2-38	Tank 241-T-110 Analytical Results: Thallium (ICP)	B-20
B2-39	Tank 241-T-110 Analytical Results: Titanium (ICP)	B-20
B2-40	Tank 241-T-110 Analytical Results: Total Uranium (ICP)	B-20
B2-41	Tank 241-T-110 Analytical Results: Vanadium (ICP)	B-20
B2-42	Tank 241-T-110 Analytical Results: Zinc (ICP)	B-20

LIST OF TABLES (Continued)

B2-43	Tank 241-T-110 Analytical Results: Zirconium (IC)	B-21
B2-44	Tank 241-T-110 Analytical Results: Bromide (IC)	B-21
B2-45	Tank 241-T-110 Analytical Results: Fluoride (IC)	B-21
B2-46	Tank 241-T-110 Analytical Results: Nitrate (IC)	B-21
B2-47	Tank 241-T-110 Analytical Results: Nitrite (IC)	B-21
B2-48	Tank 241-T-110 Analytical Results: Phosphate (IC)	B-22
B2-49	Tank 241-T-110 Analytical Results: Sulfate (IC)	B-22
B2-50	Tank 241-T-110 Analytical Results: Oxalate (IC)	B-22
B2-51	Tank 241-T-110 Analytical Results: Bulk Density	B-22
B2-52	Tank 241-T-110 Analytical Results: Exotherm - Transition 1 (DSC)	B-23
B2-53	Tank 241-T-110 Analytical Results: Percent Water (TGA)	B-23
B2-54	Tank 241-T-110 Analytical Results: Acidity Measurement (pH)	B-25
B2-55	Tank 241-T-110 Analytical Results: Specific Gravity	B-25
B2-56	Tank 241-T-110 Analytical Results: Americium-241 (AEA)	B-25
B2-57	Tank 241-T-110 Analytical Results: Plutonium-238 (AEA)	B-25
B2-58	Tank 241-T-110 Analytical Results: Plutonium-239/40 (AEA)	B-26
B2-59	Tank 241-T-110 Analytical Results: Total Beta (Alpha Rad)	B-26
B2-60	Tank 241-T-110 Analytical Results: Total Alpha (Alpha)	B-26
B2-61	Tank 241-T-110 Analytical Results: Antimony-125 (GEA)	B-27
B2-62	Tank 241-T-110 Analytical Results: Ce/Pr-144 (GEA)	B-27
B2-63	Tank 241-T-110 Analytical Results: Cesium-134 (GEA)	B-27

LIST OF TABLES (Continued)

B2-64	Tank 241-T-110 Analytical Results: Cesium-137 (GEA)	B-27
B2-65	Tank 241-T-110 Analytical Results: Cobalt-60 (GEA)	B-27
B2-66	Tank 241-T-110 Analytical Results: Europium-152 (GEA)	B-28
B2-67	Tank 241-T-110 Analytical Results: Europium-154 (GEA)	B-28
B2-68	Tank 241-T-110 Analytical Results: Europium-155 (GEA).	B-28
B2-69	Tank 241-T-110 Analytical Results: Niobium-94 (GEA)	B-28
B2-70	Tank 241-T-110 Analytical Results: Ruthenium-103 (GEA)	B-28
B2-71	Tank 241-T-110 Analytical Results: Ruthenium-106 (GEA)	B-29
B2-72	Tank 241-T-110 Analytical Results: Tin-113 (GEA)	B-29
B2-73	Tank 241-T-110 Analytical Results: Zinc-65 (GEA)	B-29
B2-74	Tank 241-T-110 Analytical Results: Strontium-90	B-29
B2-75	Tank 241-T-110 Analytical Results: Total Organic Carbon	B-29
B2-76	Tank 241-T-110 Vapor Analysis Results	B-30
B3-1	95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Segment Sample Data	B-33
B3-2	95 percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Grab Sample Data	B-34
C1-1	95 percent Confidence Interval Upper Limits for Alpha for Tank 241-T-110	C-4
C1-2	95 Percent Confidence Interval Upper Limits for DSC for Tank 241-T-110	C-5
D2-1	Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-110	D-4

LIST OF TABLES (Continued)

D2-2	Hanford Defined Waste Model-Based Inventory Estimates for Selected Radioactive Components in Tank 241-T-110	D-4
D3-1	Component Concentrations for Tanks 241-T-111 and 241-T-112	D-7
D3-2	Comparison of Inventory Estimate for Selected Components in Tank 241-T-110 Solids	D-9
D4-1	Best Basis Inventory Estimate for Nonradioactive Components in Tank 241-T-110	D-14
D4-2	Best Basis Inventory Estimate for Radioactive Components in Tank 241-T-110	D-15

LIST OF TERMS

ANOVA	analysis of variance
Btu/hr	British thermal units per hour
Ci	curie
Ci/g	curies per gram
Ci/L	curies per liter
CI	confidence interval
cm	centimeter
cm ³	cubic centimeter
DQO	data quality objective
DCRT	double-contained receiver tank
DSC	differential scanning calorimetry
ft	feet
ft ²	square feet
g/L	grams per liter
g/mL	grams per milliliter
GEA	gamma energy analysis
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP\AES	inductively coupled plasma atomic emission spectroscopy
in.	inch
J/g	joules per gram
kg	kilogram
kg/L	kilograms per liter
kgal	kilogallon
kL	kiloliter
kW	kilowatt
LFL	lower flammability limit
LL	lower limit
m	meter
m ²	square meters
M	moles per liter
mg/L	micrograms per liter
mg/m ³	micrograms per cubic meter
mL	milliliter
mm	millimeter
mrad/hr	millirads per hour
n/a	not applicable
n/r	not reported
PHMC	Project Hanford Management Contractor

LIST OF TERMS (Continued)

ppbv	parts per billion by volume
ppm	parts per million
ppmv	parts per million by volume
QC	quality control
REML	restricted maximum likelihood estimation
RGS	retained gas samples
RPD	relative percent difference
SAP	sampling and analysis plan
SMM	supernatant mixing model
SpG	specific gravity
TCP	tank characterization plan
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
W	watt
WSTRS	Waste Status and Transaction Record Summary
WSCF	Waste Sampling and Characterization Facility
wt%	weight percent
%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/gal	microcuries per gallon
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg	microgram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter

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1.0 INTRODUCTION

A major function of the Tank Waste Remediation System (TWRS) is to characterize waste in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendices serve as the TCR for single-shell tank 241-T-110. The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-T-110 waste and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. Section 2.0 summarizes the response to technical issues, Section 3.0 shows the best-basis inventory estimate, Section 4.0 makes recommendations about the safety status of the tank and additional sampling needs. The appendices contain supporting data and information. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1997), Milestone M-44-15B, change request M-44-97-03, to "issue characterization deliverables consistent with the Waste Information Requirements Document developed for 1998."

1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. The results of recent sample events will be used to fulfill the requirements of the data quality objectives (DQO) and memoranda of understanding specified in Brown et al. (1997) for this tank. Other information can be used to support conclusions derived from these results. Appendix A contains historical information for tank 241-T-110 including surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model. Appendix B summarizes field sampling data (see Table 1-1), sample data obtained before 1989, and recent sampling results. Appendix C reports 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 a bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-T-110 and its respective waste types. The reports listed in Appendix E are available in the Tank Characterization and Safety Resource Center.

1.2 TANK BACKGROUND

The 241-T Tank Farm was constructed during 1943 and 1944 in the 200 West Area. The farm contains twelve 100 series tanks and four 200 series tanks. The 100 series tanks have a capacity of 2,010 kL (530 kgal) and diameter of 23 m (75 ft) (Leach and Stahl 1993). Built according to the first generation design, the 241-T Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F) (Brevick et al. 1997).

Table 1-1. Summary of Recent Sampling.

Sample/Date ¹	Phase	Location	Segmentation	% Recovery
Vapor samples (8/31/95)	Gas	Tank headspace, riser 3, 6.7 m (22 ft) below top of riser	n/a	n/a
Combustible gas (sniff) sampling (1/28-2/10/97)	Gas	Risers 2 and 6	n/a	n/a
Grab sample (1/8/97) 10T-96-1,2,3	Liquid	Riser 13	Attempted three elevations--first elevation sampled three times	Ample material was recovered for analysis.
Push core (1/29/97) Core 181	Solid/liquid	Riser 2	Eight segments, upper half and lower half	100%
Push core (2/6/97) Core 180	Solid/liquid	Riser 6	Eight segments, upper half and lower half	88% (Segment 5 empty)

Notes:

n/a = not applicable

¹Dates are in the mm/dd/yy format.

The tank was first used in December 1944 when it received second cycle waste (2C1) from the T Plant bismuth phosphate process. By the fourth quarter of that year it was cascading to tank 241-T-111. Tank 241-T-110 was allowed to cascade, filling tanks 241-T-111 in January 1946 and 241-T-112 in July 1946. The input was 2C1 waste until 1951, then second cycle waste 2C2 was introduced. The tank received 2C2 waste until 1956. In 1953 and 1954, some cascading was allowed to the cribs. Small transfers of waste type 224 were introduced in 1952

and 1953. Flush water was the only substance introduced after 1956. Tank 241-T-110 was declared inactive in 1976 and was partially interim stabilized in 1982. Currently, a salt well pump has been inserted and is removing liquid waste.

Table 1-2 summarizes the description of tank 241-T-110. The tank has an operating capacity of 2,010 kL (530 kgal), and presently contains an estimated 1,397 kL (369 kgal) of noncomplexed waste (Hanlon 1997). The tank is on the Flammable Gas Watch List (Public Law 101-510) but was not selected to be sampled to resolve that issue. The amount of information about flammable gases that could be obtained from core sampling and analysis was uncertain. The tanks selected for study first were double-shell waste storage tanks that had demonstrated sufficient level fluctuations to show rollover of the waste in the tank.

Table 1-2. Description of Tank 241-T-110.

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	Noncomplexed
Total waste volume ¹	1,397 kL (369 kgal)
Supernatant volume	0 kL (0 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	1,397 kL (369 kgal)
Drainable interstitial liquid volume	98 kL (26 kgal)
Waste surface level (9/30/97) ²	3.9 m (13 ft)
Temperature (9/75 through 1/97)	10 °C (50 °F) to 29 °C (84 °F)
Integrity	Sound
Watch List	Flammable Gas
Flammable Gas Facility Group	Group III
SAMPLING DATES	
Vapor samples	August 1995
Grab samples	January 1997
Push mode core samples	January - February 1997
SERVICE STATUS	
Declared inactive	1976
Partial interim isolated	1982
Interim stabilization (salt well pumping) begun	May 12, 1997

Notes:

¹Waste volume is estimated from surface level measurements, less salt well pumping results (Hanlon 1997).

²Dates are in the mm/dd/yy format.

2.0 RESPONSE TO TECHNICAL ISSUES

Three technical issues have been identified for tank 241-T-110 (Brown et al. 1997).

- **Safety screening:** Does the waste pose or contribute to any recognized potential safety problems?
- **Organic complexants:** Does the possibility exist for a point source ignition in the waste followed by a propagation of the reaction in the solid/liquid phase of the waste?
- **Organic solvents:** Does an organic solvent pool exist that may cause a fire or ignition of organic solvents in entrained waste solids?

These issues currently apply. Two additional issues were of concern at the time of sampling according to Osborne and Buckley (1995) and Mulkey and Miller (1997):

- **Hazardous vapor screening:** Do hazardous storage conditions exist associated with gases and vapors in the tank?
- **Compatibility:** Will the contents of this tank be a source of an unfavorable reaction when mixed or blended with waste from another source?

Two sampling and analysis plans (McCain 1996a and 1996b) describe the types of sampling and analysis used to address these issues. Data from the analysis of push core samples and tank vapor space measurements, along with available historical information, provided the means to respond to the technical safety issues. Data from the grab samples provided technical data required to resolve the compatibility issues. Data from the August 1995 vapor sample provided the means to address the vapor screening issue. See Appendix B for sample and analysis data for tank 241-T-110.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-T-110 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 condition is addressed separately.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to ensure that tank 241-T-110 does not contain sufficient exothermic constituents (organic or ferrocyanide) to pose a safety hazard. Because of this requirement, energetics in tank 241-T-110 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 whether the energetics exceeded the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry-weight basis. Results obtained using differential scanning calorimetry (DSC) indicated that no sample obtained from tank 241-T-110 had mean exothermic reactions (on a dry-weight basis) exceeding the safety screening DQO limit. The maximum dry-weight exotherm observed was 51 J/g. The maximum upper limit (UL) to a 95 percent confidence interval on the mean was 187 J/g from core 181, segment 5, upper half.

2.1.2 Flammable Gas

Headspace measurements were taken from risers 6 and 2 before the January 1997 push core samples were obtained. Flammable gas was not detected in the tank headspace (0 percent of the lower flammability limit (LFL)) before sampling. During sampling, the LFL in the tank headspace never rose above 0 percent. This is well below the safety screening limit of 25 percent of the LFL. Data for the August 1995 vapor phase measurements and from the Standard Hydrogen Monitoring System are provided in Appendix B.

2.1.3 Criticality

The safety screening DQO threshold for criticality, based on the total alpha activity, is 1 g/L. Because total alpha activity is measured in $\mu\text{Ci/mL}$ instead of g/L, the 1 g/L limit is converted to units of $\mu\text{Ci/mL}$ by assuming that all alpha decay originates from ^{239}Pu . The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all alpha is from ^{239}Pu and assuming a density of 1.32 g/mL (the maximum density measured in both cores), 1 g/L of ^{239}Pu is 46.6 $\mu\text{Ci/g}$ of alpha activity. The maximum total alpha activity result was 0.09 $\mu\text{Ci/g}$ (core 180, segment 8, lower half). The maximum UL to a 95 percent confidence interval on the mean was 0.13 $\mu\text{Ci/g}$ for that half segment, indicating that the potential for a criticality event is extremely low. Therefore, criticality is not a concern for this tank. Appendix C explains the method used to calculate confidence limits.

2.2 ORGANIC COMPLEXANTS

The data required to support the issue of organic complexants are documented in *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements* (Schreiber 1997). Although the memorandum was published after sampling for tank 241-T-110 was completed, it is still important to note that no exotherms were found in either core, except for the one subsection mentioned in Section 2.1.1. The energetics value was fairly low (core 181, section 5, lower half) and was not confirmed by the duplicate analysis, which had no exotherms. Because less than 25 percent of the samples exhibited exotherms, the requirements of the Memorandum of Understanding are met for this tank. The liquid sample collected by grab sampling had no exotherms.

2.3 HAZARDOUS VAPOR SAFETY SCREENING

The data required to support vapor screening are documented in *Data Quality Objective for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995). The vapor screening DQO addresses the following two issues. Does the vapor headspace exceed 25 percent of the LFL, and if so, what are the principal fuel components? Does the potential exist for worker hazards associated with the toxicity of constituents in any fugitive vapor emissions from these tanks?

2.3.1 Flammable Gas

This is the same as the safety screening flammability requirement. As noted previously, flammable gas was not detected in the tank headspace (0 percent of the LFL) before sampling.

2.3.2 Toxicity

The vapor screening DQO requires the analysis of ammonia, carbon dioxide (CO₂), carbon monoxide (CO), nitric oxide (NO), nitrous oxide (N₂O), and nitrogen dioxide (NO₂) from a vapor sample. The vapor screening DQO specifies a threshold limit for each compound. Data from the vapor sampling event described in *Tank Vapor Characterization Project--Headspace Vapor Characterization of Hanford Waste Tank 241-T-110: Results from Samples Collected on 08/31/95* (McVeety et al. 1996) were used to address the issue of toxicity (see Appendix B). All analytes were within the threshold limits except ammonia. No analyte value exceeded the notification levels established in *Vapor Sampling and Analysis Plan* (Homi 1995). The toxicity issue has been closed for all tanks (Hewitt 1996).

2.4 ORGANIC SOLVENTS SCREENING

The data supporting the organic solvent screening issue are documented in Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue (Meacham et al. 1997). The DQO requires that tank headspace samples be analyzed for total nonmethane organic compounds to determine whether the organic extractant pool in the tank is a hazard. This assessment is performed to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur. Data from the August 1995 vapor sampling of tank 241-T-110 (McVeety et al. 1996) provided a nonmethane organic carbon concentration value that ranged from 0.96 mg/m³ to 1.43 mg/m³ in the three tank headspace samples taken, with an average concentration of 1.12 mg/m³. The threshold limit of concern is the presence of an organic solvent pool greater than 1 m² (10.8 ft²) in area. Using calculations that combine nonmethane organic carbon concentration with tank headspace temperature and tank ventilation rates, Huckaby et al. (1997) have calculated the potential pool area for tank 241-T-110 to be 0.07 m² (0.13 ft²). This area is well below the established threshold for this safety issue.

2.5 COMPATIBILITY

Tank 241-T-110 has not yet been fully interim stabilized. Photographic evidence of a pool of liquid on the surface, near the center of tank 241-T-110, made this tank a candidate for further pumping. Before salt well pumping the supernatant and other drainable liquids from tank 241-T-110, a waste compatibility assessment was performed by tank farm operations. The waste compatibility assessment ensures that the waste in tank 241-T-110 is compatible with the waste that it would contact in transfers to tank 241-SY-102 via double-contained receiver tank 241-244-TX. *The Data Quality Objectives for Tank Farms Waste Compatibility Program* (Mulkey and Miller 1997) directs the waste compatibility assessment.

Grab sampling was initiated per requirements in waste compatibility DQO for tank 241-T-110 as specified in the sampling and analysis plan (McCain 1996a). However, during the sampling operation, an obstruction was encountered that allowed sampling from only a single depth in the liquid. Three samples were obtained from that elevation. The analyses specified in the sampling and analysis plan (SAP) were modified in accordance with letters of instruction (see Appendix B for details on sampling and analysis). An effort was made to obtain liquid samples by centrifuging segments from the push mode core sampling performed in the same time frame as the grab sampling. It was anticipated that any supernatant resulting from the centrifugation would serve as a second data point for analyte ranges of pumpable liquid. Unfortunately, no liquid portion was available from the core segments. Compatibility assessments were then made on material from the original grab sample.

A waste compatibility assessment to transfer this waste (Fowler 1997) recommended that up to 2,270 kL (60,000 gal), including flush water, of tank 241-T-110 waste could be transferred to tank 241-SY-102 via double-contained receiver tank 241-244-TX. Various requirements were specified in the waste compatibility assessment. One condition requires an adjustment of the

hydroxide concentration and possibly the nitrite concentration before a transfer from tank 241-244-TX to tank 241-SY-102. The pH of the grab samples was relatively low (8.4). An organic end-state analysis of tank 241-T-110 was performed (Lechelt 1997) and concluded that "salt well pumping of the tank will not cause the waste in the tank to be categorized as unsafe." Salt well pumping began on May 12, 1997. The salt well pump removed 16.7 kgal (63.1 kL) of supernatant through August 31, 1997 which included the sluicing liquids introduced to the tank to install the pump. The pump was shut down on September 13, 1997.

2.6 OTHER TECHNICAL ISSUES

One concern about the 177 underground nuclear waste storage tanks is the propensity of the waste to generate and periodically release flammable gases. Tank 241-T-110 was placed on the Flammable Gas Watch List (Hanlon 1997) because of a cyclic change in its waste level. This was construed as a sign that the tank could be storing and releasing flammable gases. Contributing to the initial evaluation was an unexplained surface level rise that corresponded to a gas content that was 31.8 percent of the LFL. Further investigation of this 9.1 cm (3.6 in.) "slow increase" in the level reported at the end of 1974 revealed a previously unreported 30 kL (8 kgal) waste addition during the last quarter of 1974. This change reduced the predicted flammable gas concentration to nine percent of the LFL, not accounting for any evaporation that might have occurred. When these data were reviewed, the resulting conclusion was that "there is no positive, conclusive evidence to support a hypothesis that this tank retains any large quantity of flammable gas" (Barton 1997). Barton's evaluation of the cyclic variations are still somewhat inconclusive, although trapped gas expansion has been ruled out for reasons that include lack of correlation between waste level and atmospheric pressure fluctuations and the fact that the level changes track more closely with temperatures close to the surface of the waste. These surface fluctuations coincide with October and April temperature transition times noted sitewide.

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 1997 core sampling event was not possible because the radionuclide analyses were not required. However, the heat load estimate based on the tank process history was 19.3 W (65.9 Btu/hr) (Agnew et al. 1997). The heat load estimate based on the tank headspace temperature was 346 W (1,180 Btu/hr) (Kummerer 1995). These estimates both are quite 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).

Investigation of an alternative method for determining moisture content in solid core solids is an ongoing project at the 222-S Laboratory. The alternative method involves using a near-infrared-range hot cell probe. Homogenized samples from each segment were analyzed using both the near-infrared and gravimetric methods. Results are available in *Near Infrared Moisture Results from Tank 241-T-110* (Crawford 1997). Generally speaking, the new method appears to report values significantly lower than those determined by gravimetry or

thermogravimetric analysis (TGA). Whereas the typical TGA result was in the 75- to 80-percent range, the near-infrared results rarely exceeded 70 percent moisture. The discrepancies were attributed to differences in free water versus total water in the sample, sample drying, or calibration bias.

2.7 SUMMARY

The results of all analyses performed to address potential safety issues showed that primary analytes did not exceed safety decision threshold limits. Sampling and analyses were concluded well before publication of new organic complexant requirements, but the limited information available leads to the conclusion that no safety issue exists on that point. The analytical results are summarized in Table 2-1.

Table 2-1. Summary of Technical Issues.

Issue	Sub-issue	Result
Safety screening	Energetics	No significant exotherms observed in any sample.
	Flammable gas	Vapor measurement reported 0 percent of lower flammability limit (combustible gas meter).
	Criticality	All analyses well below 41 $\mu\text{Ci/g}$ total alpha (within 95 percent confidence limit on each sample).
Organic complexants	Safety categorization	No significant exotherms.
Hazardous vapor	Flammability	See safety screening - flammable gas.
	Toxicity	All analytes except ammonia were within the toxicity threshold limits. Tank headspace vapors are no longer considered a safety issue.
Organic solvents	Solvent pool size	The total nonmethane hydrocarbon content was measured. The estimated size of the potential organic solvent pool was significantly smaller than the 1 m^2 limit.
Compatibility	Waste compatibility assessment	All compatibility and safety requirements were in compliance. Transfer of waste to tank 241-SY-102 via 244-TX was recommended if requirements specified by Fowler (1997) are met.

3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

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

Chemical and radiological inventory information are generally derived using one of three approaches: 1) component inventories are estimated using results of sample analyses, 2) component inventories are estimated using the Hanford defined waste (HDW) model based on process knowledge and historical information, or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material use, and other operating data. The information derived from these different approaches is often inconsistent.

An effort is under way to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, chemical information for tank 241-T-110 was evaluated. The evaluation included the following:

- Data from two 1997 core samples (Nuzum 1997). The analytical results for this tank were too limited to provide a sample basis for component inventories in tank 241-T-110.
- An inventory estimate generated by the HDW model (Agnew et al. 1997).
- Comparing total waste concentrations with similar 241-T Tank Farm tanks 241-T-111 (Field et al. 1997) and 241-T-112 (Steen 1997).

The results from this evaluation support using the sampling data from tanks 241-T-111 and 241-T-112 as the basis for the best estimate inventory for tank 241-T-110 for the following reasons.

- Data from the core composite samples for these tanks were used to estimate the component inventories for 241-T-110. The core sample recoveries were relatively complete.

- The inventory estimate generated by the HDW model is based on a predicted 2C:224 waste volume ratio of 92:8, whereas sample analyses for tanks 241-T-111 and 241-T-112 of components that are unique to these two waste types indicate a higher contribution of 224 waste; for example, 80:20 or 75:25. Based on an examination of the transaction history, the ratio of 2C:224 waste for tank 241-T-110 is assumed to be approximately the same as for the two cascade tanks (241-T-111 and 241-T-112).
- Concentration factors were calculated for fully precipitated components (bismuth, for example) based on comparing flowsheet concentrations with analysis-based concentrations. The relative concentrations of components in the waste solids were found to be consistent with those expected for waste resulting from BiPO₄ process 2C and 224 process flowsheets (Field et al. 1997). For nearly all components, the concentration factors and partitioning factors are consistent with the predicted chemical behaviors of the components in alkaline media. Thus, it can be concluded that the sample data for tanks 241-T-111 and 241-T-112 are consistent with the flowsheet basis and can be used to assess the inventory in tank 241-T-110.

Best basis inventory estimates for tank 241-T-110, presented in Tables 3-1 and 3-2, are subject to change. The evaluation that generated these tables is shown in Appendix D. Refer to the Tank Characterization Database for the most current inventory values.

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

Table 3-1. Best Basis Standard Inventory Estimate for Tank 241-T-110
(Nonradioactive Chemical Species).

Analyte	Total inventory (kg)	Basis (S, M, C, or E) ¹	Comment
Al	5,030	E	
Bi	47,700	E	
Ca	3,590	E	
Cl	781	E	
TIC as CO ₃	16,800	M	No sample basis
Cr	3,560	E	
F	2,350	E	Based on analysis of water leach
Fe	30,800	E	
Hg	2.54	E	
K	2,030	E	
La	7,970	E	
Mn	10,900	E	
Na	92,700	E	
Ni	235	E	
NO ₂	25,600	E	Based on analysis of water leach
NO ₃	51,900	E	Based on analysis of water leach
OH _{TOTAL}	65,400	C	Charge balance calculation
Pb	633	E	
P as PO ₄	39,100	E	
Si	12,900	E	
S as SO ₄	11,300	E	
Sr	544	E	
TOC	5,550	E	Based on analysis of water leach
U _{TOTAL}	4,960	E	
Zr	0	M	

Notes:

TIC = total inorganic carbon
TOC = total organic carbon

¹S = Sample-based; M = Hanford defined waste model-based; E = Engineering assessment-based;
C = Calculated by charge balance; includes oxides as "hydroxide," not including CO₃, NO₂, NO₃, PO₄, SO₄, and SiO₃. Waste volumes used to generate these inventories are 1,423 kL (376 kgal) sludge and 11.6 kL (3.07 kgal) supernatant. Density used was 1.25 g/mL.

Table 3-2. Best Basis Inventory Estimate for Radioactive Components in Tank 241-T-110 Decayed to January 1, 1994. (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, E, or C) ¹	Comment
³ H	0.0494	M	
¹⁴ C	0.0169	M	
⁵⁹ Ni	0.0048	M	
⁶⁰ Co	0.00324	M	
⁶³ Ni	0.428	M	
⁷⁹ Se	0.00355	M	
⁹⁰ Sr	9,180	E	Based on ⁹⁰ Sr
⁹⁰ Y	9,180	E	
^{93m} Nb	0.0144	M	
⁹³ Zr	0.0169	M	
⁹⁹ Tc	14	E	
¹⁰⁶ Ru	9.78 E-10	M	
^{113m} Cd	0.0385	M	
¹²⁵ Sb	0.00264	M	
¹²⁶ Sn	0.00532	M	
¹²⁹ I	2.19 E-04	M	
¹³⁴ Cs	9.87 E-05	M	
^{137m} Ba	266	E	Based on ¹³⁷ Cs
¹³⁷ Cs	281	E	
¹⁵¹ Sm	13.3	M	
¹⁵² Eu	0.0102	M	
¹⁵⁴ Eu	0.0540	M	
¹⁵⁵ Eu	0.836	M	
²²⁶ Ra	1.19 E-06	M	
²²⁷ Ac	6.05 E-06	M	
²²⁸ Ra	4.76 E-11	M	
²²⁹ Th	9.22 E-09	M	
²³¹ Pa	1.29 E-05	M	
²³² Th	4.98 E-12	M	
²³² U	6.54 E-06	M	

Table 3-2. Best Basis Inventory Estimate for Radioactive Components in
Tank 241-T-110 Decayed to January 1, 1994. (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, E, or C) ¹	Comment
²³³ U	3.61 E-07	M	
²³⁴ U	0.460	M	
²³⁵ U	0.0206	M	
²³⁶ U	0.00328	M	
²³⁷ Np	7.13 E-04	M	
²³⁸ Pu	0.541	M	
²³⁸ U	0.466	M	
^{239/240} Pu	247	E	
²⁴¹ Am	75.8	E	
²⁴¹ Pu	17.6	M	
²⁴² Cm	1.74 E-04	M	
²⁴² Pu	7.71 E-05	M	
²⁴³ Am	1.40 E-07	M	
²⁴³ Cm	3.54 E-06	M	
²⁴⁴ Cm	3.27 E-06	M	

Note:

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

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4.0 RECOMMENDATIONS

Safety screening DQO (Dukelow et al. 1995) issues have been reviewed, and no significant exotherms exist. The flammable gas concentrations are 0 percent of the LFL, and the maximum total alpha activity is a factor of 500 times lower than the threshold for criticality. Because less than 25 percent of the samples had exotherms, the memorandum of understanding (Schreiber 1997) indicates that organic complexants are not an issue. Hazardous vapor screening DQO (Osborne and Buckley 1995) issues were addressed during sampling, and no analyte value exceeded the notice limits. The calculated pool site for organic extractants is a factor of 15 times smaller than the threshold limit of concern (Meacham et al. 1997). Sampling for the waste compatibility DQO (Mulkey and Miller 1997) yielded results of significantly low pH, which requires a hydroxide concentration adjustment before final transfer to tank 241-SY-102. This was anticipated because of the water-like appearance of the samples. Organic end-state analysis of tank 241-T-110 (Lechelt 1997) confirmed that "salt well pumping of the tank will not cause the waste in the tank to be categorized as unsafe."

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 1. Column 2 indicates by "yes" or "no" whether the sampling and analysis activities met the DQO requirements. Column 3 indicates that the Project Hanford Management Contractor (PHMC) TWRS program responsible for the DQO agrees that the sampling and analysis activities performed meet the needs of the DQO. A "yes" or "no" in column 3 indicates acceptance or disapproval of the sampling and analysis information in the TCR.

Table 4-1. Acceptance of Tank 241-T-110 Sampling and Analysis.

Issue	Sampling and Analysis Performed	Program ¹ Acceptance
Safety screening DQO	Yes	Yes
Organic complexant MOU	Yes	Yes
Hazardous vapor screening DQO	Yes	Yes
Organic solvents DQO	Yes	Yes
Waste compatibility DQO	Yes	Yes

Note:

¹PHMC TWRS Program Office

Table 4-2 summarizes the status of the PHMC TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations outlined in this report are those made to determine whether the tank is safe, conditionally safe, or unsafe and the best-basis inventory evaluation. Column 1 lists the issues evaluated. Columns 2 and 3 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.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-T-110.

Issue	Evaluation Performed	TWRS Program Acceptance
Safety screening analysis	Yes	Yes
Organic complementant analysis	Yes	Yes
Organic solvents	Yes	Yes
Waste compatibility evaluation	Yes	Yes

Note:

PHMC TWRS Program Office

Presently, there is no reason to recommend further sampling of tank 241-T-110. As stated throughout this report, the single exotherm reported was neither reproducible nor of significant energy to generate concern for the safety of the tank. The tank segments, which extruded easily and were full segments, exhibited no anomalies. One segment was not retrieved, but of those successfully retrieved, all were virtually uniform in composition. At a later date, the inventory of the tank may need to be determined more accurately based on core sample analytical data rather than the "similar tank" inferences from Section 3.0 and Appendix D. No information needs warrant the cost and exposure potential resulting from additional sampling. In view of this information, tank 241-T-110 can be considered safe.

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-T-110 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 A1.0:** Current status of the tank, including the current waste levels as well as the stabilization and isolation status of the tank.
- **Section A2.0:** Information about the design of the tank.
- **Section A3.0:** Process knowledge of the tank, i.e., the waste transfer history and the estimated contents of the tank based on modeling data.
- **Section A4.0:** Surveillance data for tank 241-T-110, including surface-level readings, temperatures, and a description of the waste surface based on photographs.
- **Section A5.0:** Appendix A References

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

A1.0 CURRENT TANK STATUS

As of September 30, 1997, tank 241-T-110 contained an estimated 1,397 kL (369 kgal) of waste classified as noncomplexed (Hanlon 1997). Liquid waste volume is estimated from photographs. Solid waste volume is estimated using a combination of a surface-level gauge and photographs. The solid waste volume was last updated on September 30, 1997. The amounts of waste phases in the tank are presented in Table A1-1. Salt well pumping of tank 241-T-110 was started after the sampling was completed in January and February 1997. Therefore, current tank conditions may not be the same as those predicted from sample results.

Tank 241-T-110 is out of service and is sound. The tank is on the Flammable Gas Watch List and is passively ventilated (Hanlon 1997). The tank is partially interim isolated, but neither

interim stabilization nor interim isolation have been completed. All monitoring systems were in compliance with documented standards as of September 30, 1997 (Hanlon 1997).

Table A1-1. Tank Contents Status Summary.¹

Waste type	kL (kgal)
Total waste	1,370 (369)
Supernatant liquid	0 (0)
Sludge	1,370 (369)
Saltcake	0 (0)
Drainable interstitial liquid	98 (26)
Drainable liquid remaining	98 (26)
Pumpable liquid remaining	87 (23)

Note:

¹Hanlon (1997)

A2.0 TANK DESIGN AND BACKGROUND

The 241-T Tank Farm was constructed during 1943 and 1944 in the 200 West Area. The farm contains twelve 100 series tanks and four 200 series tanks. The 100 series tanks have a capacity of 2,010 kL (530 kgal) and a diameter of 23 m (75 ft) (Leach and Stahl 1993). Built according to the first generation design, the 241-T Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F) (Brevick et al. 1995). A cascade line 76 mm (3 in.) in diameter connects tank 241-T-110 as first in a cascade series of three tanks with tanks 241-T-111 and -112. Each tank in the cascade series is set 0.3 m (1 ft) lower in elevation from the preceding tank.

The tank has a dished bottom with a 1.2-m (4-ft) radius knuckle. Tank 241-T-110 was designed with a primary liner of mild steel and a concrete dome with risers. The tank is set on a reinforced concrete foundation. The tank and foundation were waterproofed by a coating of tar covered by a three-ply, asphalt-impregnated, waterproofing fabric. The waterproofing was protected by a cement-like mixture reinforced with welded wire. Two coats of primer were sprayed on all exposed interior tank surfaces (Rogers and Daniels 1944). The tank ceiling dome was covered with three applications of magnesium zinc fluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the risers in the tank dome.

Tank 241-T-110 has 9 risers according to the drawings. The risers range in diameter from 102 mm (4 in.) to 305 mm (12 in.). Table A2-1 shows numbers, diameters, and descriptions

of the risers and the inlet, overflow, and spare nozzles. Figure A2-1 is a plan view showing the riser and nozzle configuration. Risers 2 and 6 (305 mm [12 in.] in diameter) are available for use (Lipnicki 1997). Figure A2-2 is a tank cross section showing the approximate waste level along with a schematic of the tank equipment.

Table A2-1. Tank 241-T-110 Risers.¹

Number	Diameter (in.)	Description and Comments
1	4	ENRAF ¹ 854 ATG Engineering Change Notification (ECN) 620751, February 27, 1995
2 ²	12	Blind flange
3	12	Breather filter, (12 in.) to 4 in. branch spool adapter w/standard hydrogen monitoring system and air filter ECN-W369-14 August 8, 1995
4	4	Liquid level well in caisson
5	4	B-436 liquid observation well
6	12	B-222 observation port
7	12	Liquid level well in caisson
8	4	Thermocouple tree
13	12	Salt well screen, benchmark
N1	3	Outlet overflow
N2	3	Inlet nozzle capped in diversion box 241-T-153
N3	3	Inlet nozzle capped in diversion box 241-T-153
N4	3	Inlet nozzle capped in diversion box 241-T-153
N5	3	Inlet nozzle capped

Notes:

¹Alstad (1993), Tran (1993)²Denotes riser tentatively available for sampling (Lipnicki 1997)¹ENRAF is a trademark of ENRAF Corporation, Houston, Texas.

Figure A2-1. Riser Configuration for Tank 241-T-110.

Figure A2-2. Tank 241-T-110 Cross Section and Schematic.

A3.0 PROCESS KNOWLEDGE

The following sections: 1) provide information about the waste transfer history of 241-T-110, 2) describe the process wastes that were transferred, and 3) give an estimate of the current tank contents based on waste transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-T-110 (Agnew et al. 1997b). Tank 241-T-110 first began receiving second-cycle waste from T Plant in December 1944. The waste cascaded into tank 241-T-111 until the third quarter of 1946. Additional second cycle waste was again added to tank 241-T-110 from T Plant in the first quarter of 1948 until the third quarter of 1956. From the second quarter of 1952 to the first quarter of 1953, tank 241-T-110 also received lanthanum fluoride waste from the plutonium concentration facility. Flush water was added in the second and third quarters of 1956 before tank 241-T-110 was placed on standby.

Tank 241-T-110 was inactive and full until the second quarter of 1974 when supernatant waste was sent to tank 241-S-110. Tank 241-T-110 was removed from service in the first quarter of 1976. Supernatant waste was sent to tank 241-T-101 in the first and second quarters of 1976 and to tank 241-TX-118 in the third quarter of 1978. The last transfer from tank 241-T-110 before the push mode core was taken consisted of salt well pumping liquids to tank 241-AN-103 in the fourth quarter of 1983.

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1997), Milestone M-41-21, required starting two single-shell tanks for interim stabilization by May 31, 1997. Each tank scheduled for this stabilization had problems accessing the liquids in the tank. Because tank 241-T-110 photographs clearly showed a standing pool of liquid, it was determined to be an excellent tank for salt well pumping in order to achieve the milestone. Compatibility sampling indicated that the transfer of materials from tank 241-T-110 to tank 241-SY-102 via double-contained receiver tank 241-TX-244 could be safely performed. Salt well pumping began on May 12, 1997. In order to install the salt well pump, it was necessary to introduce more liquids into the tank via the sluicing process used to cut through the crust layers within the tank. As of August 31, 1997, 63.2 kL (16.7 kgal) of supernatant liquid had been pumped from the tank, including the sluice water and any liquids that may have intruded into the tank from outside, such as rain water.

Table A3-1. Tank 241-T-110 Major Transfers.^{1,2}

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
T Plant		2C1	1944 - 1946	6,020	1,590
	241-T-111	SU	1945 - 1946	-3,990	-1,054
T Plant		2C1	1948 - 1949	6,330	1,672
	241-T-111	SU	1948 - 1956	-79 153	-20 909
T Plant		2C2	1950 - 1956	67,743	17,895
T Plant		224	1952 - 1953	4,620	1,220
		FLSH	1956	570	150
	241-S-110	SU	1974	-220	-59
	241-T-101	SU	1976	-64	-17
	241-TX-118	SU	1978	-45	-12
	241-AN-103	SWLIQ	1983	-330	-87

Notes:

Waste volumes and types are best estimates based on historical data.

2C1 = 2nd Cycle Waste from BiPO₄ process (T Plant), 1944 to 1951

2C2 = 2nd Cycle Waste from BiPO₄ process (T Plant), 1942 to 1956

224 = LaF finishing waste

FLSH = Flush water

SU = Supernatant waste

SWLIQ = Dilute, noncomplexed waste from single-shell tanks

¹Agnew et al. 1997a

²Because only major transfers are listed, the sum of these transfers will not equal the current tank waste volume. Also, this table does not reflect salt well pumping after the January 1997 sampling date.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

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

- The *Waste Status and Transaction Record Summary: WSTRS, Rev. A*, (Agnew et al. 1997b) is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- The *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4* (Agnew et al. 1997a) contains the HDW list, the supernatant mixing model (SMM), the tank layer model (TLM), and the historical tank content estimate (HTCE).
- The HDW list is comprised of approximately 50 waste types defined by concentration for major analyses/compounds for 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 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 the inventory estimate for each tank. These model predictions are considered estimates that require further evaluation using analytical data.

Based on the TLM and the SMM, tank 241-T-110 contains a bottom solids layer of 840 kL (222 kgal) of second cycle waste from the BiPO_4 process (1944 to 1951) (2C1), a middle layer of 545 kL (144 kgal) of second cycle waste from the BiPO_4 process (1952 to 1956) (2C2), and a top layer of 38 kL (10 kgal) of lanthanum fluoride finishing waste (224). Any supernatant previously calculated to reside in tank 241-T-110 has been removed through salt well pumping. Figure A3-1 is a graphical representation of the estimated waste types and volumes for each tank layer.

The 2C1 layer should contain, from highest concentration above one weight percent, the following constituents: phosphate, sodium, nitrate, iron, hydroxide, and bismuth. Constituents contained in this layer above a tenth of a weight percent are: carbonate, calcium, sulfate, fluoride, silicate, and uranium. The 2C2 layer should contain, from highest concentration above one weight percent, the following constituents: iron, hydroxide, nitrate, sodium, carbonate, and phosphate. Constituents contained in this layer above a tenth of a weight percent are: calcium, bismuth, sulfate, and fluoride. The 224 layer should contain, from highest concentration above one weight percent, the following constituents: strontium, sodium, hydroxide, nitrate, oxalate, fluoride, lanthanum, iron, and carbonate. Constituents contained in this layer above a tenth of a weight percent are: bismuth, calcium, phosphate, and potassium. Tables A3-2 and A3-3 show analyte and radionuclide estimates of the expected waste constituents and concentrations, respectively.

Figure A3-1. Tank Layer Model.

Table A3-2. Historical Tank Inventory Estimate Analytes.^{1,2} (2 sheets)

Total Inventory Estimate					
Physical Properties				-95 CI	+95 CI
Total waste	1.72E+06 (kg) (379 kgal)				
Heat load	1.93E-02 (kW) (65.9 Btu/hr)			1.73E-02	2.13E-02
Bulk density	1.20 (g/cm ³)			1.12	1.27
Water wt%	75.0			70.1	81.6
TOC wt% C (wet)	5.59E-02			5.30E-02	6.00E-02
Chemical Constituents	M	ppm	kg ³	-95 CI M	+95 CI
Na ⁺	3.02	5.78E+04	9.96E+04	1.48	4.42
Al ³⁺	0	0	0	0	0
Fe ³⁺ (total Fe)	0.636	2.96E+04	5.10E+04	0.627	0.646
Cr ³⁺	4.05E-03	176	302	3.59E-03	4.52E-03
Bi ³⁺	7.11E-02	1.24E+04	2.13E+04	5.62E-02	8.00E-02
La ³⁺	8.91E-05	10.3	17.8	6.66E-05	1.10E-04
Hg ²⁺	0	0	0	0	0
Zr (as ZrO(OH) ₂)	0	0	0	0	0

Table A3-2. Historical Tank Inventory Estimate Analytes.^{1,2} (2 sheets)

Chemical Constituents (Cont'd)	Total Inventory Estimate				
	M	ppm	kg ³	-95 CI M	+95 CI M
Pb ²⁺	0	0	0	0	0
Ni ²⁺	1.35E-03	66.1	114	1.21E-03	3.54E-03
Sr ²⁺	0	0	0	0	0
Mn ⁴⁺	1.20E-04	5.47	9.43	8.94E-05	1.47E-04
Ca ²⁺	0.196	6.52E+03	1.12E+04	0.158	0.233
K ⁺	9.75E-03	317	547	8.39E-03	1.10E-02
OH ⁻	1.97	2.78E+04	4.80E+04	1.93	2.03
NO ₃ ⁻	0.835	4.31E+04	7.43E+04	0.765	0.893
NO ₂ ⁻	1.79E-02	684	1.18E+03	1.35E-02	2.20E-02
CO ₃ ²⁻	0.196	9.77E+03	1.68E+04	0.158	0.233
PO ₄ ³⁻	0.652	5.15E+04	8.88E+04	0.175	0.949
SO ₄ ²⁻	3.26E-02	2.61E+03	4.49E+03	2.96E-02	3.49E-02
Si (as SiO ₃ ²⁻)	5.28E-02	1.23E+03	2.13E+03	2.18E-02	0.188
F ⁻	0.170	2.68E+03	4.62E+03	0.148	0.645
Cl ⁻	2.06E-02	607	1.05E+03	1.88E-02	2.20E-02
C ₆ H ₅ O ₇ ³⁻	0	0	0	0	0
EDTA ⁴⁻	0	0	0	0	0
HEDTA ³⁻	0	0	0	0	0
glycolate ⁻	0	0	0	0	0
acetate ⁻	0	0	0	0	0
oxalate ²⁻	2.80E-02	2.05E+03	3.54E+03	2.67E-02	2.87E-02
DBP	0	0	0	0	0
Butanol	0	0	0	0	0
NH ₃	4.95E-06	7.01E-02	0.121	3.89E-06	6.34E-06
Fe(CN) ₆ ⁴⁻	0	0	0	0	0

Notes:

CI = confidence interval

¹Agnew et al. (1997b)²These predictions have not been validated and should be used with caution.³Differences exist between 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	1.72E+06 (kg) (379 kgal)				
Heat load	1.93E-02 (kW) (65.9 Btu/hr)			1.73E-02	2.13E-02
Bulk density	1.20 (g/cm ³)			1.12	1.27
Water wt%	75.0			70.1	81.6
TOC wt% C (wet)	5.59E-02			5.30E-02	6.00E-02
Radiological Constituents	Ci/L	μ Ci/g	Ci	-95 CI (Ci/L)	+95 CI (Ci/L)
H-3	3.46E-08	2.88E-05	4.96E-02	2.68E-08	4.17E-08
C-14	1.18E-08	9.84E-06	1.70E-02	1.07E-08	1.30E-08
Ni-59	3.36E-09	2.80E-06	4.82E-03	3.04E-09	9.30E-09
Ni-63	3.00E-07	2.50E-04	0.430	2.70E-07	8.21E-07
Co-60	2.28E-09	1.90E-06	3.27E-03	1.97E-09	2.59E-09
Se-79	2.49E-09	2.07E-06	3.57E-03	2.25E-09	2.73E-09
Sr-90	1.12E-03	0.931	1.60E+03	1.00E-03	1.23E-03
Y-90	1.12E-03	0.931	1.60E+03	1.00E-03	1.23E-03
Zr-93	1.18E-08	9.86E-06	1.70E-02	1.07E-08	1.30E-08
Nb-93m	1.01E-08	8.39E-06	1.45E-02	9.12E-09	1.10E-08
Tc-99	8.19E-08	6.82E-05	0.117	7.40E-08	8.98E-08
Ru-106	6.91E-16	5.75E-13	9.91E-10	5.35E-16	8.48E-16
Cd-113m	2.70E-08	2.25E-05	3.87E-02	2.40E-08	3.00E-08
Sb-125	1.86E-09	1.55E-06	2.66E-03	1.54E-09	2.17E-09
Sn-126	3.73E-09	3.10E-06	5.35E-03	3.36E-09	4.09E-09
I-129	1.54E-10	1.28E-07	2.20E-04	1.39E-10	1.69E-10
Cs-134	6.97E-11	5.80E-08	1.00E-04	5.53E-11	8.41E-11
Cs-137	1.27E-03	1.05	1.82E+03	1.13E-03	1.40E-03
Ba-137m	1.20E-03	0.997	1.72E+03	1.07E-03	1.32E-03
Sm-151	9.33E-06	7.77E-03	13.4	8.44E-06	1.02E-05
Eu-152	7.10E-09	5.91E-06	1.02E-02	7.06E-09	7.14E-09
Eu-154	3.80E-08	3.16E-05	5.45E-02	3.21E-08	4.39E-08
Eu-155	5.83E-07	4.85E-04	0.836	5.80E-07	5.86E-07
Ra-226	8.34E-13	6.94E-10	1.20E-06	7.51E-13	8.94E-13

Table A3-3. Historical Tank Inventory Estimate Radionuclides.^{1,2} (2 sheets)

Total Inventory Estimate					
Radiological Constituents (Cont'd)	Ci/L	$\mu\text{Ci/g}$	Ci	-95 CI (Ci/L)	+95 CI (Ci/L)
Ra-228	3.32E-17	2.76E-14	4.76E-11	3.31E-17	3.33E-17
Ac-227	4.23E-12	3.52E-09	6.07E-06	3.81E-12	4.53E-12
Pa-231	9.00E-12	7.49E-09	1.29E-05	8.13E-12	9.63E-12
Th-229	6.43E-15	5.35E-12	9.23E-09	6.41E-15	6.45E-15
Th-232	3.49E-18	2.91E-15	5.01E-12	3.18E-18	3.80E-18
U-232	4.58E-12	3.81E-09	6.57E-06	3.04E-12	1.20E-11
U-233	2.53E-13	2.10E-10	3.63E-07	1.60E-13	6.97E-13
U-234	3.22E-07	2.68E-04	0.461	1.91E-07	9.48E-07
U-235	1.44E-08	1.20E-05	2.07E-02	8.56E-09	4.26E-08
U-236	2.30E-09	1.91E-06	3.29E-03	1.46E-09	6.30E-09
U-238	3.26E-07	2.71E-04	0.468	1.94E-07	9.60E-07
Np-237	5.00E-10	4.16E-07	7.17E-04	4.51E-10	5.50E-10
Pu-238	3.78E-07	3.14E-04	0.542	1.59E-07	9.29E-07
Pu-239	7.20E-05	6.00E-02	103	3.64E-05	1.41E-04
Pu-240	5.42E-06	4.51E-03	7.77	2.77E-06	1.21E-05
Pu-241	1.23E-05	1.02E-02	17.6	2.69E-06	3.65E-05
Pu-242	5.38E-11	4.48E-08	7.72E-05	9.92E-12	1.65E-10
Am-241	1.52E-08	1.26E-05	2.18E-02	1.22E-08	1.82E-08
Am-243	9.92E-14	8.26E-11	1.42E-07	7.74E-14	1.21E-13
Cm-242	1.21E-10	1.01E-07	1.74E-04	1.20E-10	1.22E-10
Cm-243	2.47E-12	2.05E-09	3.54E-06	2.45E-12	2.49E-12
Cm-244	2.31E-12	1.92E-09	3.31E-06	1.79E-12	2.83E-12
Totals	<i>M</i>	$\mu\text{g/g}$	kg	-95 CI (<i>M</i> or g/L)	+95 CI (<i>M</i> or g/L)
Pu	1.18E-03 (g/L)	----	1.70	6.01E-04	2.31E-03
U	4.10E-03	813	1.40E+03	2.44E-03	1.21E-02

Notes:

¹Agnew et al. (1997b)²These predictions have not been validated and should be used with caution.

A4.0 SURVEILLANCE DATA

Tank 241-T-110 surveillance data include surface level measurements (liquid and solid) and temperature monitoring inside the tank (waste and vapor space). The data provide the basis for determining tank integrity.

Liquid level measurements may indicate if a major leak occurs from a tank. Solid surface level measurements indicate physical changes and consistency of the solid layers.

A4.1 SURFACE LEVEL READINGS

The waste surface level for tank 241-T-110 was measured by a manual tape until January 1981 and a Food Instrument Corporation gauge until April 1995. An ENRAF™ surface-level gauge has monitored the waste surface level since June 1995. On January 5, 1998, the waste surface level was 3.94 m (155.2 in.), as measured by the manual ENRAF™ system. Figure A4-1 shows the volume measurements as a level history graph. Surface fluctuations are discussed in Section 2.6 of this report.

A4.2 DRY WELL READINGS

Tank 241-T-110 has four dry wells, none of which have had any readings above radiation background (> 50 counts/second).

A4.3 INTERNAL TANK TEMPERATURES

Tank 241-T-110 contains a single thermocouple tree, located in riser 8, with 11 thermocouples. The elevations of the thermocouples on this tree are unavailable. The Surveillance Automated Computer System (SACS) recorded temperature data from September 1975 through November 1997 (LMHC 1997). The average temperature of the SACS data is 16.9 °C (62.5 °F), the minimum is 10.22 °C (50.4 °F), and the maximum is 29 °C (84 °F). The average temperature of the SACS data from November 1996 through November 1997 was 16.3 °C (61.3 °F). (Only readings from thermocouples 1 through 7, 9, and 11 were available.) The minimum over the last year was 11 °C (51.8 °F), and the maximum was 20.4 °C (68.7 °F). The high temperature on November 30, 1997, was 17.5 °C (63.5 °F) on thermocouples 6 (located in the waste) and 11C (located in the headspace), and the minimum was 16.6 °C (61.9 °F) on thermocouples 2 and 3 (located in the waste). Figure A4-2 is a graph of the weekly high temperatures. Plots of the individual thermocouple readings can be found in the T Tank Farm supporting document for the HTCE (Brevick et al. 1995).

A4.4 TANK 241-T-110 PHOTOGRAPHS

The July 1984 photographic montage of tank 241-T-110's interior shows a damp, dark rough solid sludge surface, with a pool of liquid on the surface of the waste. Pieces of equipment and risers that are identifiable have been labeled. The waste level had not changed from the time the photographs were taken until May 1997; therefore, the photographic montage represents the appearance of the tank's waste before the May 1997 salt well pumping activity began. The tank 241-T-110 photograph is available at the Tank Characterization and Safety Resource Center.

Figure A4-1. Tank 241-T-110 Level History.

Figure A4-2. Tank 241-T-110 Weekly High Temperature Plot.

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APPENDIX B

SAMPLING OF TANK 241-T-110

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APPENDIX B

SAMPLING OF TANK 241-T-110

Appendix B provides sampling and analysis information for each known sampling event for tank 241-T-110 and assesses the grab and the push mode sample results. It includes the following.

- **Section B1.0:** Tank Sampling Overview
- **Section B2.0:** Sampling Events
- **Section B3.0:** Assessment of Characterization Results
- **Section B4.0:** Appendix B References

Future sampling information for tank 241-T-110 will be added to this list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the sampling and analysis events for tank 241-T-110. Each sampling event (vapor, grab, push mode) is listed in Table B2-1 along with respective data quality objectives for each sample. The sampling and analysis plan that directed the vapor sampling is the *Vapor Sampling and Analysis Plan* (Homi 1995). The grab sampling event was directed by the *Compatibility Grab Sampling and Analysis Plan for Fiscal Year 1997* (McCain 1996a). The push mode core sampling was directed by *Tank 241-T-110 Push Mode Core Sampling and Analysis Plan* (McCain 1996b). Two liquid samples, which probably did not represent materials other than supernatant, were taken from this tank in 1974; they are discussed in Section B2.5.

B2.0 SAMPLING EVENTS

This section describes sampling events. Tables B2-7 through B2-76 show analytical results. The reader is cautioned to be aware that the tank was salt well pumped after the 1997 sampling. The pumping began on May 12, 1997. Historical sample results are presented in the Section 2.5. Table B2-1 summarizes the sampling and analytical requirements for all three sampling events.

Table B2-1. Integrated Data Quality Objective Requirements for Tank 241-T-110.¹

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Push mode core sampling	Safety screening - Energetics - Moisture content - Total alpha - Flammable gas (Dukelow et al. 1995) Organic complexants (Schreiber 1997)	Core samples from at least two risers separated radially to the maximum extent possible. Combustible gas measurement Total organic carbon measurement.	Energetics, moisture, total alpha activity, density, flammable gases
Grab sampling	Compatibility (Mulkey and Miller 1997)	Grab samples	222-S: Energetics, moisture, cations, specific gravity, pH, separable organics, GEA, percent solids WSCF: TIC, TOC, anions, radionuclides
Vapor sampling	Hazardous vapor (Osborne and Buckley 1995)	Steel canisters, triple sorbent traps, sorbent trap systems	Flammable gas, organic vapors, permanent gases
	Organic solvents (Meacham et al. 1997)	Steel canisters, triple sorbent traps, sorbent trap systems	Nonmethane hydrocarbons

Notes:

GEA = gamma energy analysis

WSCF = Waste Sampling and Characterization Facility

¹McCain 1996a and McCain 1996b

B2.1 1997 GRAB SAMPLING EVENT

Grab samples 10T-96-1, 2, and 3 were taken from riser 13 on January 8, 1997. This riser lies directly over the center of the tank. The object of the sampling was to obtain a sample that was representative of materials that would be transferred to tank 241-SY-102 via double-contained receiver tank 244-TX by salt well pumping. Even though the sampling and analysis plan (McCain 1996a) called for sampling at three distinct elevations, all three liquid grab samples were taken at the same level, because of an obstruction in the tank, probably a "salt bridge" (McCain 1997b). Concern was raised that such limited sampling elevations might result in only collecting the clear liquids on the surface, perhaps being an accumulation of rainwater that might have entered the tank through pump pits. Even though that "rainwater" would need to be pumped, earlier estimations (Hanlon 1996) indicated that there were approximately 227 kL (60 kgal) of pumpable liquid in the tank. A priority was placed on the pH and specific gravity measurements from these first three grab samples. When the results showed a low pH (average 8.42) and a low specific gravity (average 1.050), a letter of instruction (McCain 1997b) was issued to not spend any more resources analyzing those grab samples further because they might not be representative. The push mode core sampling was proceeding as planned (see Section B2.2), so it was anticipated that the liquid phase from those samples would provide a range of analytical values necessary to make a compatibility assessment. However, the push mode core samples contained no supernatant liquids. Fortunately, the 222-S Laboratory had been instructed to archive 60 mL (2 U.S. fluid ounces) of the grab samples. This archive was used to complete the required analyses for compatibility assessment directed by a second letter of instruction (McCain 1997a).

B2.1.1 Sample Handling and Analysis

All three grab samples (10T-96-1,2,3) were broken down in the 222-S Laboratory. Each sample consisted of 125 mL (4 fluid oz.) of dark yellow, clear liquid containing a trace of solids. No organic layer was visible on any of the samples. The 222-S Laboratory performed pH and specific gravity measurements on all three samples first to provide information on the degree of tank representation these samples provided. Analysis (McCain 1997b) was halted because the samples were deemed to not represent tank waste. As instructed, the sample materials were discarded except for 60 mL (2 fluid oz.) of sample 10T-96-01, which was archived. The halt was lifted (McCain 1997a), but then the 222-S Laboratory could not meet the sample result turnaround schedule. Portions of the archived sample were forwarded to the WSCF onsite to complete the slate of compatibility analyses. Table B2-1 indicates which laboratory performed which analyses.

B2.2 1997 PUSH-MODE CORE SAMPLING EVENT

Two push-mode core samples were collected from tank 241-T-110. Core 181 was obtained on January 29 through 31, 1997. The core consisted of eight 48 cm (19 in.) segments taken from

the material directly below riser 2. Core 180 was obtained on February 6 and 7, 1997. The core was to have consisted of eight segments taken from the material directly below riser 6, but one segment sampler was empty on extrusion. Extrusions for core 181 were performed from February 6 through February 18, 1997. Extrusions for core 180 were performed from February 18 through February 27, 1997.

Push mode sampling was used because the material appeared to be mostly sludge with a high water content. The sample was assigned low priority (value of 11 out of a possible 100 [Brown et al. 1997]) for information sake because the tank was in a cascade with other tanks whose contents have already been substantially characterized, particularly tank 241-T-111 (Field et al. 1997). Only the safety screening DQO (Dukelow et al. 1995) was applicable to the solid samples at the time of sampling. An effort was made to centrifuge segments from the push mode core sampling performed in the same time frame as the grab sampling to extract liquid to test for waste compatibility. Any supernatant resultant from the centrifugation was expected to serve as a second data point for analyte ranges of pumpable liquid. Unfortunately, no liquid portion was extracted from the core segments. Compatibility assessments were then made on materials from the original grab sample. Safety screening analytes are listed in Table B2-1. Analyses that correspond to the analytes listed are found in Table B2-2.

B2.2.1 Sample Handling

The core 180, segment 5 core sample, identified as sample 97-05 arrived at the 222-S Laboratory on February 10, 1997. Extrusion on February 18, 1997 revealed that the sampler was void of materials. The piston for the sampler was sticking out of the valve when the sampler was removed from the liner. Two possible reasons were presented for this anomaly: either the sampler was dropped a short distance in the drill string by the remote latch unit while it was being installed in the drill string or the retaining clip separated from the piston before connecting the sample actuator to the pintle rod and initiating the sample stroke. The most likely of the two events was the premature release of the spring clip. Table B2-3 gives the subsampling scheme and sample description for all 15 of the complete segments that were obtained. The samples are listed in chronological order of sampling, not numerically.

Table B2-2. Analytical Procedures.¹

Analysis	Method	Procedure Number
Energetics	Differential scanning calorimeter	LA-514-114, Rev. D-0 (Liquids) LA-514-113, Rev. C-1 (Solids)
Percent water	Thermogravimetric analysis	LA-514-114, Rev. D-0 (Liquids) LA-560-112, Rev. C-0 (Solids)
Specific gravity	Gravimetric	LA-510-112, Rev. C-3 (Liquids) LA-510-112, Rev. D-1 (Solids)
pH	pH meter	LA-212-106, Rev. B-0
Metals by ICP/AES	Inductively coupled plasma spectrometer	LA-505-161, Rev. B-1
Radionuclides	Gamma energy analysis	LA-548-121, Rev. E-0 WSCF:LA-508-462
Alpha emitters	Alpha-emitting energy	LA-508-101, Rev. F-0 WSCF:LA-508-461
Anions	Ion chromatography	WSCF:EPA 300.0
Total organic carbon	Persulfate	WSCF:EPA 9060
Bulk density	Gravimetric	LO-160-103, Rev. B-0
⁹⁰ Sr	Beta proportional counter	WSCF:LA-220-404
Total beta activity	Beta proportional counter	WSCF:LA-508-410

Note:

¹Nuzum (1997a)Table B2-3. Tank 241-T-110 Subsampling Scheme and Sample Description.¹ (2 sheets)

Core/ Riser	Segment	Sample ID	Solids Recovered	Sample Characteristics
181/2	1	97-09	135.4-Lower half 184.5-Upper half	Solids were dark yellow and resembled a sludge slurry.
181/2	2	97-10	159.6-Lower half 161.6-Upper half	Solids were dark yellow and resembled a sludge slurry.
181/2	3	97-11	155.7-Lower half 182.5-Upper half	Solids were dark yellow and resembled a sludge slurry.
181/2	4	97-12	111.4-Lower half 178.6-Upper half	Solids were dark yellow and resembled a wet slurry.
181/2	5	97-13	164.7-Lower half 171.4-Upper half	Solids were dark yellow and resembled a wet sludge.

Table B2-3. Tank 241-T-110 Subsampling Scheme and Sample Description.¹ (2 sheets)

Core/ Riser	Segment	Sample ID	Solids Recovered	Sample Characteristics
181/2	6	97-14	161.6-Lower half 185.0-Upper half	Solids were dark yellow and resembled a wet sludge.
181/2	7	97-15	164.7-Lower half 186.6-Upper half	Solids were dark yellow and resembled a wet sludge.
181/2	8	97-16	183.0-Lower half 186.1-Upper half	Solids were dark yellow and resembled a wet sludge.
180/6	1	97-01	164.2-Lower half 175.7-Upper half	Solids were dark yellow and resembled a wet sludge.
180/6	2	97-02	155.7-Lower half 166.7-Upper half	Solids were dark yellow and resembled a wet sludge.
180/6	3	97-03	164.0-Lower half 167.9-Upper half	Solids were dark yellow and resembled a wet sludge.
180/6	4	97-04	210.1-Lower half 139.3-Upper half	Solids were dark yellow and resembled a wet sludge.
180/6	6	97-06	173.4-Lower half 192.9-Upper half	Solids were dark yellow and resembled a wet sludge.
180/6	7	97-07	148.5-Lower half 179.3-Upper half	Solids were dark yellow and resembled a dry sludge.
180/6	8	97-08	144.4-Lower half 218.4-Upper half	Solids were dark yellow and resembled a dry sludge.

Note:

¹Nuzum (1997a)

B2.3 ANALYTICAL RESULTS, NONVAPOR SAMPLING EVENTS

This section summarizes the sampling and analytical results associated with both the grab sampling activity of January 1997 and the push mode core sampling activity of late January and early February 1997. Table B2-4 references the data tables found later in this appendix. The results are documented in Nuzum (1997a and 1997b). Because most of the anion and cation analyses were performed on the grab samples, the concentrations are not representative of the majority of the tank waste.

Table B2-4. Analytical Tables.

Analysis	Table Number
Cations determined by ICP analysis	B2-7 through B2-43
Anions by ion chromatography	B2-44 through B2-50
Bulk density and specific gravity	B2-51 and B2-55
Differential scanning calorimetry exotherm	B2-52
Percent water	B2-53
pH	B2-54
Radiological components	B2-56 through B2-74
Total organic carbon	B2-75

The four quality control (QC) parameters assessed in conjunction with tank 241-T-110 samples were standard recoveries, spike recoveries, duplicate analyses (relative percent differences [RPDs]), and blanks. The QC criteria are specified in the SAPs (McCain 1996a and 1996b). The only QC parameter, for which limits are not specified in the SAP, is blank contamination. The limits for blanks are set forth in guidelines followed by the laboratory, and all data results cited in this report have met those guidelines. Sample and duplicate pairs, in which any QC parameter was outside these limits, are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, or e defined as follows.

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

In the analytical tables in this section, the "mean" is the average of the result and duplicate value. All values, including those below the detection level (<), were averaged. If both sample and duplicate values were nondetected, the mean is expressed as a nondetected value. If one value was detected and the other was not, the mean is expressed as a detected value. If both values were detected, the mean is expressed as a detected value.

B2.3.1 Total Alpha Activity

Analyses for total alpha activity were performed on the samples recovered from tank 241-T-110. The solid samples were prepared by fusion digestion. Two fusions were prepared for each sample to obtain duplicate results. Each fused dilution was analyzed twice; the results were averaged and reported as one value. The highest result observed was 0.0896 $\mu\text{Ci/g}$.

B2.3.2 Thermogravimetric Analysis

Thermogravimetric analysis measures the mass of a sample as its temperature is increased at a constant rate. Nitrogen is passed over the sample during heating to remove any released gases. A decrease in the weight of a sample during TGA represents a loss of gaseous matter from the sample through evaporation or a reaction that forms gas-phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 to 200 °C [300 to 390 °F]) is caused by water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well. All of the percent water analyses for the solid samples were in the 70 percent to 80 percent range. Liquid sample results were 86.8 percent water.

B2.3.3 Differential Scanning Calorimetry

In a DSC analysis, heat absorbed or emitted by a substance, is measured while the sample is heated at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically. Only one exothermic reaction was noted; but it was insignificant, even at the 95 percent confidence level in comparison to the threshold value for this analysis.

B2.3.4 Inductively Coupled Plasma

Full suites of analytes were reported for the liquid grab sample, as well as for the field blank sample for the core samples. The former has little significance in total inventory because it was salt well pumped starting in May 1997.

B2.3.5 Specific Gravity/Bulk Density

Specific gravity was determined for the liquid grab samples. The mean value for the three grabs samples was equal to 1.05. There were no exceptions to the QC parameters stated

in McCain 1997a. Bulk density was requested only on the lower half segments of the push mode sample in accordance with McCain 1997b. Results from bulk density ranged from 1.16 g/mL to 1.32 g/mL.

B2.3.6 Ion Chromatography

Because the large nitrate concentration in the sample solution masked bromide at the lower dilution factor, bromide was reported at the higher dilution. Oxalate was not detected. The spike recoveries for oxalate were 99.5 percent and 98.4 percent. The standard recoveries for oxalate were 103 percent, 103 percent and 104.2 percent, all of which were acceptable for QC parameters stated in McCain (1997a).

B2.3.7 Total Organic Carbon

Total organic carbon content was determined using the persulfate method. No exceptions to the QC parameters for this analyte were found. This analysis was run on liquid samples only for compatibility. Conclusions for organic fuels issues were made based on lack of exotherms not from analyses of TOC data.

B2.3.8 pH Measurements

The pH measurements were made using a standard pH meter on liquid samples only. The values were extremely low compared to standard tank wastes. Determination of these values led to confirmation of suspicion that supernatant was nothing more than rain water that had intruded the tank. No exceptions to the specified QC parameters were noted.

B2.3.9 Gamma Energy Analysis

Cesium-137 results were considered as QC-type analytes in this report. The values for cobalt-60 were included as "opportunistic" without the prescribed QC parameters. No exceptions to the QC parameters for the cesium isotopes were noted.

B2.3.10 Beta and Strontium Analyses

Strontium-90 and total beta analyses were performed using a beta proportional counter. Because of the high activity of the sample, small volumes were used by the Waste Sampling and Characterization Facility. However, no exceptions to the QC parameters were noted during analyses.

B2.4 VAPOR PHASE MEASUREMENT

During the 1997 grab and push mode core sampling of tank 241-T-110, a series of vapor phase "sniff" measurements were taken using a combustible gas meter. The vapor in the headspace of tank 241-T-110 was sampled on August 31, 1995. Samples were obtained using sorbent trains for selected inorganic analytes, triple sorbent traps for semivolatile organic analytes and SUMMA² canisters for permanent gases and volatile organic analytes. The vapor phase samples were taken to characterize the vapors present in the tank headspace and to support safety evaluations and tank farm operations. Detailed results are given in Table B2-76.

Table B2-5. Results of Headspace "Sniff" Measurements of Tank 241-T-110.

Measurement	Results (Maximum Values)	
	Core 181	Core 180
Lower explosive limit	0.0%	0.0%
Oxygen	21.1%	21.0%
TOC	15 ppm	n/a
Ammonia	60 ppm	60 ppm

In March 1995, a standard hydrogen monitoring system-B monitor was installed on tank 241-T-110. As described in Wilkins et al. (1996), the average H₂, N₂O, and CH₄ concentrations in the dome headspace were 7 ppm, 5 ppm, and 10 ppm, respectively. Vapor space grab samples were taken during the period from June 27, 1995, through February 6, 1996, for this report. Wilkins states, "Tank...T-110...[has] not exhibited any GRE [gas release event] behavior to date..."

B2.5 DESCRIPTION OF HISTORICAL SAMPLING EVENT

Two historical sample reports were reviewed for this report (Wheeler 1974 and 1975). These reports are rudimentary, with little sampling or analytical information about sampling method or location. The first report, dated May 24, 1974, has a sample number of T-4340. The second report, dated January 20, 1975, has a sample number of T-5313. Results are summarized in Table B2-6. The contents of this tank apparently were scheduled to be used as feed to the 242-S Evaporator, particularly because among the analyses requested was a cooling curve analysis. Because the sample was liquid and the tank has since been pumped of liquids, the sample does not represent present tank contents. These data have not been validated and should be used with caution.

²SUMMA is a trademark of Moetrics, Inc., Cleveland, Ohio.

Table B2-6. Historical Analytical Information.¹

Analyte	T-4340	T-5313
Color	Light yellow ^a	Clear yellow
Solids content	None 30% reduction-0.909% solids 50% reduction-1.5% solids	25% Solids
Over-the-top radiation	< 5 mrad/hr	5 mRad/hr (filtrate)
pH	9.4	9.1
Specific gravity	1.082	1.084
Aluminum	< 1.02E-02 <i>M</i>	< 7.17E-04 <i>M</i>
Sodium	1.24 <i>M</i>	1.87 <i>M</i>
Nitrite	6.29 E-03 <i>M</i>	6.41 E-03 <i>M</i>
Nitrate	0.914 <i>M</i>	0.908 <i>M</i>
Pu	Insufficient sample	1.24 E-05 gm/gal
Differential thermal analysis	No exotherms	No exotherms
Sulfate	Insufficient sample	2.03E-02 <i>M</i>
Phosphate	Insufficient sample	0.279 <i>M</i>
Fluoride	Insufficient sample	0.317 <i>M</i>
Carbonate	Insufficient sample	2.20 E-02 <i>M</i>
¹³⁷ Cs	97.62 μ Ci/gal	123 μ Ci/gal
Water	90.02%	89.68%
Cooling curves	No solids	Approximately 1% solids

Note:

¹These data have not been validated and should be used with caution.

The following tables are the result of the more recent sampling events, i.e., January and February, 1997.

Table B2-7. Tank 241-T-110 Analytical Results: Aluminum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			μ g/mL	μ g/mL	μ g/mL
S97T000008	Riser 13	Grab sample	<5	<5	<5

Table B2-8. Tank 241-T-110 Analytical Results: Antimony (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<6	<6	<6

Table B2-9. Tank 241-T-110 Analytical Results: Arsenic (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-10. Tank 241-T-110 Analytical Results: Barium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<5	<5	<5

Table B2-11. Tank 241-T-110 Analytical Results: Beryllium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<0.5	<0.5	<0.5

Table B2-12. Tank 241-T-110 Analytical Results: Bismuth (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-13. Tank 241-T-110 Analytical Results: Boron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<5	<5	<5

Table B2-14. Tank 241-T-110 Analytical Results: Cadmium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<0.5	<0.5	<0.5

Table B2-15. Tank 241-T-110 Analytical Results: Calcium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-16. Tank 241-T-110 Analytical Results: Cerium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-17. Tank 241-T-110 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	34.6	34.5	34.5

Table B2-18. Tank 241-T-110 Analytical Results: Cobalt (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<2	<2	<2

Table B2-19. Tank 241-T-110 Analytical Results: Copper (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<1	<1	<1

Table B2-20. Tank 241-T-110 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<5	<5	<5

Table B2-21. Tank 241-T-110 Analytical Results: Lanthanum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<5	<5	<5

Table B2-22. Tank 241-T-110 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-23. Tank 241-T-110 Analytical Results: Lithium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	< 1	< 1	< 1

Table B2-24. Tank 241-T-110 Analytical Results: Magnesium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	< 10	< 10	< 10

Table B2-25. Tank 241-T-110 Analytical Results: Manganese (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	< 1	< 1	< 1

Table B2-26. Tank 241-T-110 Analytical Results: Molybdenum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	< 5	< 5	< 5

Table B2-27. Tank 241-T-110 Analytical Results: Neodymium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	< 10	< 10	< 10

Table B2-28. Tank 241-T-110 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<2	<2	<2

Table B2-29. Tank 241-T-110 Analytical Results: Phosphorus (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	5,550	5,560	5,560 ^{C,d}

Table B2-30. Tank 241-T-110 Analytical Results: Potassium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	316	338	327

Table B2-31. Tank 241-T-110 Analytical Results: Samarium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-32. Tank 241-T-110 Analytical Results: Selenium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<10	<10	<10

Table B2-33. Tank 241-T-110 Analytical Results: Silicon (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	64.3	64.7	64.5

Table B2-34. Tank 241-T-110 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	2.61	2.7	2.66

Table B2-35. Tank 241-T-110 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	37,000	36,900	37,000 ^{QC:d}

Table B2-36. Tank 241-T-110 Analytical Results: Strontium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	< 1	< 1	< 1

Table B2-37. Tank 241-T-110 Analytical Results: Sulfur (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	1,580	1,590	1,590

Table B2-38. Tank 241-T-110 Analytical Results: Thallium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<20	<20	<20

Table B2-39. Tank 241-T-110 Analytical Results: Titanium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<1	<1	<1

Table B2-40. Tank 241-T-110 Analytical Results: Total Uranium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<50	<50	<50

Table B2-41. Tank 241-T-110 Analytical Results: Vanadium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<5	<5	<5

Table B2-42. Tank 241-T-110 Analytical Results: Zinc (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<1	<1	<1

Table B2-43. Tank 241-T-110 Analytical Results: Zirconium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
S97T000008	Riser 13	Grab sample	<1	<1	<1

Table B2-44. Tank 241-T-110 Analytical Results: Bromide (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	<0	n/a	<0

Table B2-45. Tank 241-T-110 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	4,220	n/a	4,220

Table B2-46. Tank 241-T-110 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	18,300	n/a	18,300

Table B2-47. Tank 241-T-110 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	59	n/a	59

Table B2-48. Tank 241-T-110 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	1,490	n/a	1,490

Table B2-49. Tank 241-T-110 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	4,360	n/a	4,360

Table B2-50. Tank 241-T-110 Analytical Results: Oxalate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	0	n/a	0

Table B2-51. Tank 241-T-110 Analytical Results: Bulk Density. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			g/mL	g/mL	g/mL
S97T000206	180: 1	Lower half	1.29	n/a	1.29
S97T000249	180: 2	Lower half	1.25	n/a	1.25
S97T000208	180: 3	Lower half	1.32	n/a	1.32
S97T000210	180: 4	Lower half	1.31	n/a	1.31
S97T000212	180: 6	Lower half	1.30	n/a	1.3
S97T000251	180: 7	Lower half	1.23	n/a	1.23
S97T000253	180: 8	Lower half	1.23	n/a	1.23
S97T000124	181: 1	Lower half	1.16	n/a	1.16
S97T000128	181: 2	Lower half	1.18	n/a	1.18
S97T000130	181: 3	Lower half	1.21	n/a	1.21
S97T000132	181: 4	Lower half	1.20	n/a	1.2

Table B2-51. Tank 241-T-110 Analytical Results: Bulk Density. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
S97T000165	181: 5	Lower half	1.23	n/a	1.23
S97T000172	181: 6	Lower half	1.29	n/a	1.29
S97T000156	181: 7	Lower half	1.23	n/a	1.23
S97T000190	181: 8	Lower half	1.28	n/a	1.28

Table B2-52. Tank 241-T-110 Analytical Results: Exotherm - Transition 1 (DSC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			J/g	J/g	J/g
S97T000170	181: 5	Upper half	12.6	0	6.3 ^{QC} e

Note:

All other subsegments had no exotherms.

Table B2-53. Tank 241-T-110 Analytical Results: Percent Water (TGA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
S97T000216	180: 1	Upper half	77.0	77.4	77.2
S97T000214		Lower half	77.1 77.3 (P-E)	76.9 77.2 (P-E)	77.0 77.2 (P-E)
S97T000262	180: 2	Upper half	77.1	76.4	76.7
S97T000261		Lower half	75.8	75.6	75.7
S97T000218	180: 3	Upper half	76.6	76	76.3
S97T000217		Lower half	76.3	76.8	76.5
S97T000220	180: 4	Upper half	77.2	76.6	76.9
S97T000219		Lower half	76.3	74.8	75.5
S97T000222	180: 6	Upper half	72.8	74.9	73.8
S97T000221		Lower half	72.0	71.3	71.6

Table B2-53. Tank 241-T-110 Analytical Results: Percent Water (TGA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids (Cont'd)			%	%	%
S97T000264	180: 7	Upper half	74.2	74.3	74.3
S97T000263		Lower half	72.6	73.2	72.9
S97T000266	180: 8	Upper half	74.8	74.8	74.8
S97T000265		Lower half	74.2	74.0	74.1
S97T000141	181: 1	Upper half	79.1	77.8	78.5
S97T000125		Lower half	79.7	79.7	79.7
S97T000143	181: 2	Upper half	75.9	76.1	76.0
S97T000142		Lower half	77.5	76.1	76.8
S97T000145	181: 3	Upper half	78.3	85.1	81.7
S97T000144		Lower half	78.8	73.5	76.1
S97T000147	181: 4	Upper half	76.0	76.8	76.4
S97T000146		Lower half	75.5	75.9	75.7
S97T000170	181: 5	Upper half	75.3	75.6	75.4
S97T000168		Lower half	74.9	75.1	75.0
S97T000175	181: 6	Upper half	65.4	75.3	70.3
S97T000174		Lower half	76.3	75.8	76.0
S97T000159	181: 7	Upper half	74.8	73.8	74.3
S97T000158		Lower half	71.3	72.8	72.0
S97T000193	181: 8	Upper half	72.1	72.6	72.4
S97T000192		Lower half	73.1	72.7	72.9
Liquids			%	%	%
S97T000008	Riser 13	Grab sample	87.0	86.6	86.8

Table B2-54. Tank 241-T-110 Analytical Results: Acidity Measurement (pH).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			unitless	unitless	unitless
S97T000008	Riser 13	Grab sample	8.44	8.43	8.43
S97T000009		Grab sample	8.43	8.46	8.45
S97T000010		Grab sample	8.39	8.38	8.39

Table B2-55. Tank 241-T-110 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			unitless	unitless	unitless
S97T000204	181: 2	Lower half	1.11	1.11	1.11
S97T000008	Riser 13	Grab sample	1.05	1.05	1.05
S97T000009		Grab sample	1.05	1.05	1.05
S97T000010		Grab sample	1.05	1.04	1.05

Table B2-56. Tank 241-T-110 Analytical Results: Americium-241 (AEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	3.14E-06	2.71E-06	2.92E-06

Table B2-57. Tank 241-T-110 Analytical Results: Plutonium-238 (AEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	2.10E-06	n/a	2.10E-06

Table B2-58. Tank 241-T-110 Analytical Results: Plutonium-239/40 (AEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	1.66E-04	n/a	1.66E-04

Table B2-59. Tank 241-T-110 Analytical Results: Total Beta (Alpha Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	0.0037	0.0042	0.00395

Table B2-60. Tank 241-T-110 Analytical Results: Total Alpha (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			$\mu\text{Ci/g}$	$\mu\text{Ci/g}$	$\mu\text{Ci/g}$
S97T000230	180: 1	Lower half	0.0447	0.0463	0.0455 ^{QC:c}
S97T000268	180: 2	Lower half	0.0441	0.0390	0.0416
S97T000231	180: 3	Lower half	0.0288	0.0355	0.0322 ^{QC:f}
S97T000232	180: 4	Lower half	0.0456	0.0626	0.0541 ^{QC:c,f}
S97T000233	180: 6	Lower half	0.0404	0.0603	0.0504 ^{QC:f}
S97T000269	180: 7	Lower half	0.0778	0.0722	0.075 ^{QC:c}
S97T000270	180: 8	Lower half	0.0896	0.0762	0.0829
S97T000148	181: 1	Lower half	0.0750	0.0668	0.0709
S97T000149	181: 2	Lower half	0.0466	0.0512	0.0489
S97T000150	181: 3	Lower half	0.0342	0.0302	0.0322 ^{QC:a}
S97T000151	181: 4	Lower half	0.0391	0.0398	0.0395 ^{QC:a}
S97T000169	181: 5	Lower half	0.0429	0.0532	0.048 ^{QC:f}
S97T000178	181: 6	Lower half	0.0552	0.0504	0.0528
S97T000162	181: 7	Lower half	0.0605	0.0651	0.0628 ^{QC:c}
S97T000196	181: 8	Lower half	0.0588	0.0614	0.0601 ^{QC:c}
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	9.50E-05	0.109	0.0545

Table B2-61. Tank 241-T-110 Analytical Results: Antimony-125 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<6.44E-07	n/a	<6.44E-07

Table B2-62. Tank 241-T-110 Analytical Results: Ce/Pr-144 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<9.06E-07	n/a	<9.06E-07

Table B2-63. Tank 241-T-110 Analytical Results: Cesium-134 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<6.21E-08	n/a	<6.21E-08

Table B2-64. Tank 241-T-110 Analytical Results: Cesium-137 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
S97T000008	Riser 13	Grab sample	0.00336	0.00336	0.00336
W97000008		Grab sample	0.00357	n/a	0.00357

Table B2-65. Tank 241-T-110 Analytical Results: Cobalt-60 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
S97T000008	Riser 13	Grab sample	<2.79E-05	<2.15E-05	<2.47E-05
W97000008		Grab sample	<3.00E-08	n/a	<3.00E-08

Table B2-66. Tank 241-T-110 Analytical Results: Europium-152 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<6.99E-08	n/a	<6.99E-08

Table B2-67. Tank 241-T-110 Analytical Results: Europium-154 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<1.26E-07	n/a	<1.26E-07

Table B2-68. Tank 241-T-110 Analytical Results: Europium-155 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<1.05E-06	n/a	<1.05E-06

Table B2-69. Tank 241-T-110 Analytical Results: Niobium-94 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<3.30E-09	n/a	<3.30E-09

Table B2-70. Tank 241-T-110 Analytical Results: Ruthenium-103 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<2.80E-07	n/a	<2.80E-07

Table B2-71. Tank 241-T-110 Analytical Results: Ruthenium-106 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<3.07E-06	n/a	<3.07E-06

Table B2-72. Tank 241-T-110 Analytical Results: Tin-113 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<6.25E-07	n/a	<6.25E-07

Table B2-73. Tank 241-T-110 Analytical Results: Zinc-65 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	<3.65E-08	n/a	<3.65E-08

Table B2-74. Tank 241-T-110 Analytical Results: Strontium-90.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$	$\mu\text{Ci/mL}$
W97000008	Riser 13	Grab sample	5.60E-04	5.00E-04	5.30E-04

Table B2-75. Tank 241-T-110 Analytical Results: Total Organic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			$\mu\text{g/mL}$	$\mu\text{g/mL}$	$\mu\text{g/mL}$
W97000008	Riser 13	Grab sample	45	n/a	45

Table B2-76. Tank 241-T-110 Vapor Analysis Results.¹

Analyte of Interest	Concentration
NH ₃	108 ppmv
NO ₂	≤0.05 ppmv
NO	≤0.06 ppmv
Gravimetric (primarily water)	16.9 mg/L
CO ₂	358 ppmv
CO	<25 ppmv
CH ₄	<25 ppmv
H ₂	<25 ppmv
N ₂ O	<25 ppmv
Total nonmethane hydrocarbons	1.12 mg/m ³
Acetonitrile	6 ppbv
Trichlorofluoromethane	8 ppbv
2-Butanone	9 ppbv
Tridecane	7 ppbv
Acetone	7 ppbv
Methylene chloride	13 ppbv
1-chloro, 1-difluoroethane	101 ppbv

Note:

¹McVeety et al. (1996)

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

This section discusses the overall quality and consistency of the current sampling results for tank 241-T-110. This section also evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess overall data quality and consistency and to identify limitations in data use.

B3.1 FIELD OBSERVATIONS

Sample recovery from the grab sample from tank 241-T-110 was not ideal because it was taken from the same elevation for all three waste samples. Estimates of pumpable supernatants before sampling indicated that the tank contained fluids in excess of a clear, visible pool of liquid around the tank center. When the grab sampling yielded only materials from this pool, there was concern that they might be unrepresentative of waste to be pumped (see Section B2.1). The grab samples were considered to be of little informational value.

However, when the subsequent push mode core samples were extruded, no liquid sample was available to represent those pumpable liquids found anywhere other than in the surface pool. Fortunately, some of the grab sample was archived, and this material was used to complete the compatibility analyses in time for salt well pumping commitments. Push mode core sampling was a much more successful event, returning segments that were full on extrusion, with the notable exception of one segment. Core 180 (the second of two cores taken), segment 5, was empty on extrusion at the 222-S Laboratory. Scenarios for possible explanation of this event are described in Section B2.2.

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All pertinent QC tests were conducted on the 1997 push mode core samples, allowing a full assessment regarding the accuracy and precision of the data. The SAP (McCain 1996b) established specific criteria for all analytes. Sample and duplicate pairs with one or more QC results, outside the specified criteria, were identified by footnotes in the data summary tables.

The standard and spike recovery results provide an estimate of analysis accuracy. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. The precision is estimated by the RPD, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean times 100. The RPD between sample and duplicate DSC analyses for upper half segment 5 of core 181 (S97T000170) was 200 percent. The high RPD is caused by a very small exotherm detected on the duplicate in comparison to no exotherm present for the sample. Because no other exotherms were present, no rerun was requested.

Low alpha activity in the tank caused a number of RPD anomalies between sample and duplicate values for four subsamples. Segments 3, 4, and 6 of core 180 (S97T000231, S97T000232, and S97T000233, respectively) and segment 5 of core 181 (S97T000169) had RPDs of 20.8 percent, 31.4 percent, 39.5 percent and 21.4 percent, respectively. Because the activity was so low, rerun analyses were not requested. Alpha total analysis of five subsamples resulted in low spike recoveries. Three of those were rerun with the same results, suggesting the cause to be matrix interference (segments 1 and 7 of core 180

[S97T000230 and S97T000269] and segment 8 of core 181 [S97T000196]). For segment 4 of core 180 (S97T000232) and segment 7 of core 181 (S97T000230), the rerun spike recoveries were within control limits for the QC standard. Again, no rerun analyses were requested because the activity was well below threshold limits.

In summary, the vast majority of QC results were within the boundaries specified in the SAPs. The discrepancies mentioned here and footnoted in the data summary tables should not impact data validity or use.

B3.3 DATA CONSISTENCY CHECKS

Because of limited data in this tank sampling and analysis activity, there is nothing to compare except historical values for specific gravity and alpha activity (see Appendix D). Further activity in such comparisons is of no value in this report. Charge balance checks are done to derive a hydroxide values; therefore, the charges will balance because of the default hydroxide value. Differences between historical estimates for this tank and others is discussed in Section 3.0 and Appendix D.

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The following evaluation was performed on the analytical data from the samples from tank 241-T-110.

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 solid segment level data and liquid grab sample data. The solid segment level data and liquid grab sample data were analyzed separately.

The lower limit (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 degrees of freedom (df) degrees of freedom for a two-sided 95 percent confidence interval.

The mean, $\hat{\mu}$, and the standard deviation, $\hat{\sigma}_{\hat{\mu}}$, were estimated using restricted maximum likelihood estimation (REML) methods. The df for solid segment level data is the number of cores sampled minus one. The df, for liquid grab sample data, is either the number of samples

minus one for analytes with measurements from multiple samples or the number of observations minus one for analytes with measurements from only one sample.

B3.4.1 Solid Segment 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-110. Analysis of variance (ANOVA) techniques were used to estimate the mean and calculate confidence limits on the mean for all analytes that had at least 50 percent of reported values above the detection limit. If at least 50 percent of the reported values were above the detection limit, all the data were used in the computations. The detection limit was used as the value for nondetected results. No ANOVA estimates were computed for analytes with less than 50 percent detected values. Only arithmetic means were computed for these analytes.

The results given below are ANOVA estimates based on the core segment data and grab sample data from core 180 and core 181 for tank 241-T-110. Estimates of the mean concentration and confidence interval on the mean concentration are given in Table B3-1 for the solid segment sample data and Table B3-2 for the 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 LL is reported as zero, whenever this occurred.

Table B3-1. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Segment Sample Data.

Analyte	Units	$\bar{\mu}$	$\sigma_{\bar{\mu}}$	df	LL	UL
Alpha	$\mu\text{Ci/g}$	5.31E-02	3.86E-03	1	4.04E-03	1.02E-01
Bulk density	g/mL	1.25E+00	2.66E-02	1	9.11E-01	1.59E+00
DSC dry	J/g	8.55E-01	8.55E-01	1	0	1.17E+01
% water	%	7.44E+01	1.24E+00	1	5.87E+01	9.01E+01

Table B3-2. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Grab Sample Data. (3 sheets)

Analyte	Units	μ	σ_{μ}	df	LL	UL
DSC	J/g	0	0	1	0	0
SpG ¹	g/mL	1.05E+00	2.02E-03	2	1.04E+00	1.06E+00
pH ¹	pH	8.42E+00	1.39E-02	2	8.36E+00	8.48E+00
% water	%	8.68E+01	1.80E-01	1	8.45E+01	8.91E+01
Alpha	μ Ci/mL	5.30E-05	4.21E-05	1	0	5.87E-04
Am-241	μ Ci/mL	2.92E-06	2.15E-07	1	1.92E-07	5.66E-06
Beta	μ Ci/mL	3.95E-03	2.50E-04	1	7.74E-04	7.13E-03
CePr-144 ²	μ Ci/mL	9.06E-07	n/a	n/a	n/a	n/a
Co-60 ³	μ Ci/mL	< 1.65E-05	n/a	n/a	n/a	n/a
Cs-134 ²	μ Ci/mL	6.21E-08	n/a	n/a	n/a	n/a
Cs-137	μ Ci/mL	3.47E-03	1.07E-04	1	2.11E-03	4.83E-03
Eu-152 ²	μ Ci/mL	6.99E-08	n/a	n/a	n/a	n/a
Eu-154 ²	μ Ci/mL	1.27E-07	n/a	n/a	n/a	n/a
Nb-94 ²	μ Ci/mL	3.30E-09	n/a	n/a	n/a	n/a
Pu-238 ²	μ Ci/mL	2.10E-06	n/a	n/a	n/a	n/a
Pu-239/40 ²	μ Ci/mL	1.66E-04	n/a	n/a	n/a	n/a
Sr-90	μ Ci/mL	5.30E-04	3.00E-05	1	1.49E-04	9.11E-04
Ag _{ICP,a}	μ g/mL	2.66E+00	4.50E-02	1	2.08E+00	3.23E+00
Al _{ICP,a} ³	μ g/mL	< 5.00E+00	n/a	n/a	n/a	n/a
As _{ICP,a} ³	μ g/mL	< 1.00E+01	n/a	n/a	n/a	n/a
B _{ICP,a} ³	μ g/mL	< 5.00E+00	n/a	n/a	n/a	n/a
Ba _{ICP,a} ³	μ g/mL	< 5.00E+00	n/a	n/a	n/a	n/a
Be _{ICP,a} ³	μ g/mL	< 5.00E-01	n/a	n/a	n/a	n/a
Bi _{ICP,a} ³	μ g/mL	< 1.00E+01	n/a	n/a	n/a	n/a
Bromide ²	μ g/mL	0	n/a	n/a	n/a	n/a
Ca _{ICP,a} ³	μ g/mL	< 1.00E+01	n/a	n/a	n/a	n/a
Cd _{ICP,a} ³	μ g/mL	< 5.00E-01	n/a	n/a	n/a	n/a
Ce _{ICP,a} ³	μ g/mL	< 1.00E+01	n/a	n/a	n/a	n/a
Chloride ²	μ g/mL	9.58E+02	n/a	n/a	n/a	n/a
Co _{ICP,a} ³	μ g/mL	< 2.00E+00	n/a	n/a	n/a	n/a
Cr _{ICP,a}	μ g/mL	3.46E+01	5.00E-02	1	3.39E+01	3.52E+01

Table B3-2. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Grab Sample Data. (3 sheets)

Analyte	Units	$\bar{\mu}$	$\hat{\sigma}_{\bar{\mu}}$	df	LL	UL
Cu _{ICP.a} ³	µg/mL	<1.00E+00	n/a	n/a	n/a	n/a
Fe _{ICP.a} ³	µg/mL	<5.00E+00	n/a	n/a	n/a	n/a
Fluoride ²	µg/mL	4.22E+03	n/a	n/a	n/a	n/a
K _{ICP.a}	µg/mL	3.27E+02	1.10E+01	1	1.87E+02	4.67E+02
La _{ICP.a} ³	µg/mL	<5.00E+00	n/a	n/a	n/a	n/a
Li _{ICP.a} ³	µg/mL	<1.00E+00	n/a	n/a	n/a	n/a
Mg _{ICP.a} ³	µg/mL	<1.00E+01	n/a	n/a	n/a	n/a
Mn _{ICP.a} ³	µg/mL	<1.00E+00	n/a	n/a	n/a	n/a
Mo _{ICP.a} ³	µg/mL	<5.00E+00	n/a	n/a	n/a	n/a
Na _{ICP.a}	µg/mL	3.70E+04	5.00E+01	1	3.63E+04	3.76E+04
Nd _{ICP.a} ³	µg/mL	<1.00E+01	n/a	n/a	n/a	n/a
Ni _{ICP.a} ³	µg/mL	<2.00E+00	n/a	n/a	n/a	n/a
Nitrate ²	µg/mL	1.83E+04	n/a	n/a	n/a	n/a
Nitrite ²	µg/mL	5.90E+01	n/a	n/a	n/a	n/a
Oxalate ²	µg/mL	0	n/a	n/a	n/a	n/a
P _{ICP.a}	µg/mL	5.56E+03	5.00E+00	1	5.49E+03	5.62E+03
Pb _{ICP.a} ³	µg/mL	<1.00E+01	n/a	n/a	n/a	n/a
Phosphate ²	µg/mL	1.49E+03	n/a	n/a	n/a	n/a
S _{ICP.a}	µg/mL	1.59E+03	5.00E+00	1	1.52E+03	1.65E+03
Sb _{ICP.a} ³	µg/mL	<6.00E+00	n/a	n/a	n/a	n/a
Se _{ICP.a} ³	µg/mL	<1.00E+01	n/a	n/a	n/a	n/a
Si _{ICP.a}	µg/mL	6.45E+01	2.00E-01	1	6.20E+01	6.70E+01
Sm _{ICP.a} ³	µg/mL	<1.00E+01	n/a	n/a	n/a	n/a
Sr _{ICP.a} ³	µg/mL	<1.00E+00	n/a	n/a	n/a	n/a
Sulfate ²	µg/mL	4.36E+03	n/a	n/a	n/a	n/a
TOC ⁴	µg/mL	4.51E+01	3.48E+00	3	3.40E+01	5.62E+01
Ti _{ICP.a} ³	µg/mL	<1.00E+00	n/a	n/a	n/a	n/a
Tl _{ICP.a} ³	µg/mL	<2.00E+01	n/a	n/a	n/a	n/a
U _{ICP.a} ³	µg/mL	<5.00E+01	n/a	n/a	n/a	n/a
V _{ICP.a} ³	µg/mL	<5.00E+00	n/a	n/a	n/a	n/a

Table B3-2. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Grab Sample Data. (3 sheets)

Analyte	Units	μ	σ_p	df	LL	UL
Zn _{ICP,a} ³	μg/mL	< 1.00E+00	n/a	n/a	n/a	n/a
Zr _{ICP,a} ³	μg/mL	< 1.00E+00	n/a	n/a	n/a	n/a

Notes:

¹Three samples were measured for pH and specific gravity²Only one observation was measured; therefore, no confidence interval was constructed.³More than 50 percent of the analytical results were below the detection limit.⁴Wet basis

B3.4.2 Analysis of Variance Models

A statistical model is needed to account for the spatial and measurement variability in σ_p . This cannot be done using an ordinary standard deviation of the data (Snedecor and Cochran 1980).

The statistical model fit to the solid segment sample data for bulk density is

$$Y_{ij} = \mu + C_i + A_{ij},$$

$$i=1,\dots,a, j=1,\dots,b_i,$$

where

Y_{ij} = laboratory results from the j^{th} duplicate from the i^{th} core in the tank

μ = the grand mean

C_i = the effect of the i^{th} core

A_{ij} = the effect of the j^{th} analytical result from the i^{th} core

a = the number of cores

b_i = the number of analytical results from the i^{th} core

The variable C_i is assumed to be a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2_{C_i}$ and $\sigma^2(A)$, respectively. Estimates of $\sigma^2_{C_i}$ and $\sigma^2(A)$ were obtained using REML techniques. This method, applied to variance component estimation, is described in Harville (1977). The

statistical results were obtained using the statistical analysis package S-PLUS³ (Statistical Science 1993).

The statistical model fit to the solid segment sample data for total alpha is

$$Y_{ijk} = \mu + C_i + S_{ij} + A_{ijk},$$

$$I = 1, \dots, a, j = 1, \dots, b_i, k = 1, \dots, c_{ij}$$

where

Y_{ijk}	=	laboratory results from the k^{th} duplicate from the j^{th} segment in the i^{th} core in the tank
μ	=	the grand mean
C_i	=	the effect of the i^{th} core
S_{ij}	=	the effect of the j^{th} segment in the i^{th} core
A_{ijk}	=	the effect of the k^{th} analytical result from the j^{th} segment in the i^{th} core
a	=	the number of cores
b_i	=	the number of segments from the i^{th} core
c_{ij}	=	the number of analytical results from the j^{th} segment in the i^{th} core

The variables C_i and S_{ij} are assumed to be random effects. These variable and A_{ijk} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(C)$, $\sigma^2(S)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(C)$, $\sigma^2(S)$, and $\sigma^2(A)$ were obtained using REML techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using the statistical analysis package S-PLUS³ (Statistical Science 1993).

The statistical model fit to the solid segment sample data for DSC and TGA is

$$Y_{ijkm} = \mu + C_i + S_{ij} + L_{ijk} + A_{ijkm},$$

$$I = 1, \dots, a, j = 1, \dots, b_i, k = 1, \dots, c_{ij}, m = 1, \dots, d_{ijk},$$

³S-PLUS is a registered trademark of Statistical Sciences, Seattle, Washington.

where

- Y_{ijkm} = laboratory results from the m^{th} duplicate in the k^{th} location in the j^{th} segment in the i^{th} core in the tank
 μ = the grand mean
 C_i = the effect of the i^{th} core
 S_{ij} = the effect of the j^{th} segment from the i^{th} core
 L_{ijk} = the effect of the k^{th} location in the j^{th} segment in the i^{th} core
 A_{ijkm} = the effect of the m^{th} analytical result from the k^{th} location in the j^{th} segment in the i^{th} core
 a = the number of cores
 b_i = the number of segments in the i^{th} core
 c_{ij} = the number of locations from the j^{th} segment in the i^{th} core
 d_{ijk} = the number of analytical results from the k^{th} location in the j^{th} segment in the i^{th} core

The variables C_i , S_{ij} , and L_{ijk} are assumed to be random effects. These variables and A_{ijkm} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(C)$, $\sigma^2(S)$, $\sigma^2(L)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(C)$, $\sigma^2(S)$, $\sigma^2(L)$, and $\sigma^2(A)$ were obtained using REML techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using statistical analysis package S-PLUS® (Statistical Science 1993).

The statistical model fit to the liquid grab sample data for Cs-137, pH, and specific gravity is

$$Y_{ij} = \mu + S_i + A_{ij},$$

$$I=1,\dots,a, j=1,\dots,b_i,$$

where

- Y_{ij} = laboratory results from the j^{th} duplicate from the i^{th} grab sample in the tank
 μ = the grand mean

S_i	=	the effect of the i^{th} grab sample
A_{ij}	=	the effect of the j^{th} analytical result from the i^{th} grab sample
a	=	the number of grab samples
b_i	=	the number of analytical results from the i^{th} grab sample

The variable S_i is assumed to be a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means of zero and variances of $\sigma^2(S)$ and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(S)$ and $\sigma^2(A)$ were obtained using REML techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using the statistical analysis package S-PLUS® (Statistical Science 1993).

A statistical model was not fit to the remaining liquid grab sample analytes because measurements were made from one sample for these analytes. Only the arithmetic mean, the standard deviation of the arithmetic mean, and the LL and UL of the 95 percent confidence interval of the arithmetic mean were computed.

After the sample means are calculated for the tank for each analyte, the sample-based inventory may be calculated. Sample-based inventories and explanations for how they were determined are presented in Appendix D.

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

Appendix C documents the results of the analyses and statistical and numerical manipulations required by the DQOs applicable for tank 241-T-110. The analyses required for tank 241-T-110 are reported as follows:

- **Section C1.0:** Statistical analysis and numerical manipulations supporting the safety screening DQO (Dukelow et al. 1995).
- **Section C2.0:** Appendix C References

C1.0 STATISTICS FOR THE 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, the results of calculating one-sided confidence limits supporting the safety screening DQO are reported for tank 241-T-110. All data in this section are from the final laboratory data package for the 1997 core sampling event (Nuzum 1997b) and from the final laboratory data package for the 1997 grab sampling event (Nuzum 1997a) for tank 241-T-110.

Confidence intervals were computed for each sample number from tank 241-T-110 analytical data. The sample numbers and confidence intervals are provided in Table C1-1 for Alpha and Table C1-2 for DSC.

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-110 data (per sample number), df equals the number of observations minus one.

The UL of the 95 percent confidence interval for each sample number based on alpha data is listed in Table C1-1. Each confidence interval can be used to make the following statement. If the UL is less than 46.6 $\mu\text{Ci/g}$ (61.5 $\mu\text{Ci/mL}$ for drainable liquid), reject the null hypothesis

that the alpha is greater than or equal to 46.6 $\mu\text{Ci/g}$ (61.5 $\mu\text{Ci/mL}$ for drainable liquid) at the 0.05 level of significance. The maximum UL to a 95 percent CI on the mean for alpha was 0.125 $\mu\text{Ci/g}$, for core 180 segment 8, lower half. This is well below the threshold limit of 46.6 $\mu\text{Ci/g}$.

The UL of the 95 percent confidence interval for each sample number based on DSC data is listed in Table C1-2. Each confidence interval can be used to make the following statement. If the UL is less than 480 J/g, reject the null hypothesis that DSC is greater than or equal to 480 J/g at the 0.05 level of significance. The maximum UL to a 95 percent CI on the mean for DSC was 187 J/g, for core 181, segment 5, upper half. This is below the threshold limit of 480 J/g. This was the only location where an exotherm was measured.

Table C1-1. 95 percent Confidence Interval Upper Limits for Alpha for Tank 241-T-110 (Units are $\mu\text{Ci/g}$ or $\mu\text{Ci/mL}$).

Sample Number	Core: Segment, Portion	$\hat{\mu}$	$\hat{\sigma}_p$	UL
S97T000230	180:1 Lower half	4.55E-02	8.00E-04	5.06E-02
S97T000268	180:2 Lower half	4.16E-02	2.55E-03	5.77E-02
S97T000231	180:3 Lower half	3.22E-02	3.35E-03	5.33E-02
S97T000232	180:4 Lower half	5.41E-02	8.50E-03	1.08E-01
S97T000233	180:6 Lower half	5.04E-02	9.95E-03	1.13E-01
S97T000269	180:7 Lower half	7.50E-02	2.80E-03	9.27E-02
S97T000270	180:8 Lower half	8.29E-02	6.70E-03	1.25E-01
S97T000148	181:1 Lower half	7.09E-02	4.10E-03	9.68E-02
S97T000149	181:2 Lower half	4.89E-02	2.30E-03	6.34E-02
S97T000150	181:3 Lower half	3.22E-02	2.00E-03	4.48E-02
S97T000151	181:4 Lower half	3.95E-02	3.50E-04	4.17E-02
S97T000169	181:5 Lower half	4.81E-02	5.15E-03	8.06E-02
S97T000178	181:6 Lower half	5.28E-02	2.40E-03	6.80E-02
S97T000162	181:7 Lower half	6.28E-02	2.30E-03	7.73E-02
S97T000196	181:8 Lower half	6.01E-02	1.30E-03	6.83E-02
W970000908	Liquid grab sample	5.30E-05	4.21E-05	3.18E-04

Table C1-2. 95 Percent Confidence Interval Upper Limits for DSC for Tank 241-T-110
(Units are J/g-Dry).

Sample Number	Core:Segment, Portion	$\bar{\mu}$	$\hat{\sigma}_s$	UL
S97T000214	180:1 Lower half	0	0	0
S97T000216	180:1 Upper half	0	0	0
S97T000261	180:2 Lower half	0	0	0
S97T000262	180:2 Upper half	0	0	0
S97T000170	181:5 Upper half	2.56E+01	2.56E+01	1.87E+02

Statistical limits for the other half segment samples were not presented because no exotherm was detected.

C2.0 APPENDIX C REFERENCES

- 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.
- Nuzum, J. L., 1997a, *Waste Compatibility Safety Issues and Final Results for Tank 241-T-110 Grab Samples*, HNF-SD-WM-DP-239, Rev. 0, Rust Federal Services of Hanford Inc., Richland, Washington
- Nuzum, J. L., 1997b, *Waste Compatibility Safety Issues and Final Results for Tank 241-T-110 Push Mode Samples*, HNF-SD-WM-DP-238, Rev. 0, Rust Federal Services of Hanford Inc., Richland, Washington

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APPENDIX D

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

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APPENDIX D

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

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

D1.0 CHEMICAL INFORMATION SOURCES

Two core samples (cores 180 and 181) were obtained from tank 241-T-110 in 1997. However, only limited analytical data (Nuzum 1997) are provided to support the safety screening DQO (Dukelow et al. 1995). Analytical results are available for a 1997 supernatant grab sample, however, the supernatant has since been removed from the tank by salt well pumping operations. The analytical data from core samples from tanks 241-T-111, and 241-T-112, which historically contain the same bismuth phosphate (BiPO_4) process second cycle waste type as tank 241-T-110, provide useful comparison information. Tanks 241-T-111 and 241-T-112 also contain BiPO_4 process 224 waste, a waste type that is thought to be present in tank 241-T-110. The HDW model (Agnew et al. 1997a) also provides tank content estimates in terms of component concentrations and inventories.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Inventories derived from the HDW model are shown in Tables D2-1 and D2-2. The tank volume used to generate these inventories is 1,423 kL (376 kgal) sludge and 11.6 kL (3.07 kgal) supernatant. The volume reported in Hanlon (1997), is the same as that used by Agnew et al. (1997a). However, since Agnew et al. and Hanlon were issued, the supernatant in tank 241-T-110 has been salt well pumped. Please note that the Hanlon reference in this paragraph is for a report that does not have the salt well volume adjustment. Because the pumping is an on-going operation at publication of this document, it would be presumptive to adjust the inventories to account for the supernatants pumped. The HDW model predicted density of 1.20 g/mL (Agnew et al. 1997a) was used to calculate the component inventories in

Tables D2-1 and D2-2. The analytically determined density for the tank waste solids for cores 180 and 181 was 1.25 g/mL (Nuzum 1997).

Radionuclide inventories in this appendix are decayed to January 1, 1994, to be consistent with the decay date used in the HDW model. The chemical species in this appendix are reported without charge designation per the best-basis inventory convention.

Table D2-1. Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-110.

Analyte	HDW Model Inventory Estimate ¹ (kg)	Analyte	HDW Model Inventory Estimate ¹ (kg)
Al	0	NO ₂	1,180
Bi	21,300	NO ₃	74,300
Ca	11,200	P as PO ₄	88,800
Cl	1,050	Pb	0
Cr	302	Si	2,130
F	4,620	S as SO ₄	4,490
Fe	51,000	Sr	0
Hg	0	TIC as CO ₃	16,800
K	547	TOC	961
La	17.8	U _{TOTAL}	1,400
Mn	9.43	Zr	0
Na	99,600	H ₂ O (wt%)	75.0
Ni	114	Density g/mL	1.20

Note:

¹Agnew et al. (1997a)

Table D2-2. Hanford Defined Waste Model-Based Inventory Estimates for Selected Radioactive Components in Tank 241-T-110 (Values Decayed to January 1, 1994).

Analyte	HDW Model Inventory Estimate ¹ (Ci)
¹³⁷ Cs	1,820
⁹⁰ Sr	1,600
^{239/240} Pu	111

Note:

¹Appendix E of Agnew et al. (1997a)

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information and that would influence the sample-based and HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Reported Waste Types in Tank 241-T-110:

Anderson (1990): 2C, 224
Agnew et al. (1997a): 2C, 224
Hill et al. (1995): 2C, 224

Model-Based Current Solids Inventory (Agnew et al. 1997a):

Waste Type	Waste Volume -- kL (kgal)
2C1	840 (222)
2C2	545 (144)
224	38 (10)

The following abbreviations are used to designate waste types:

2C1	=	Second decontamination cycle BiPO_4 process waste, operational 1944 to 1949
2C2	=	Second decontamination cycle BiPO_4 process waste, operational 1950 to 1956
224	=	Lanthanum fluoride precipitation process wastes originating in the 224-B and 224-T buildings

D3.1.1 Waste Transaction History

Tank 241-T-110 is the first tank in a cascade that includes tanks 241-T-111 and 241-T-112. Tank 241-T-110 first received second-cycle decontamination (2C) waste from the bismuth phosphate process in December 1944. Cascading of 2C waste to tank 241-T-111 began late in 1945 (Anderson 1990 and Agnew et al. 1997b). From 1945 to 1956, tank 241-T-110 continued to receive 2C waste with significant amounts being cascaded to tank 241-T-111 when

tank 241-T-110 reached capacity. Tank 241-T-110 began receiving BiPO₄ process 224 waste in 1952 and periodically thereafter through 1953. During this period, 2C and 224 waste were cascaded to tank 241-T-111.

D3.1.2 Predicted Current Waste Types

Transaction records clearly indicate direct transfers of second cycle BiPO₄ waste and 224 waste to tank 241-T-110. There is good agreement on the existing solids volume in this tank between Agnew et al. (1997a) and Hanlon (1997) (1,423 kL [376 kgal]). However, based on the transaction records, accurately predicting the relative proportions of 2C waste solids and 224 solids is difficult. Agnew et al. predicts only 38 kL (10 kgal) 224 waste (approximately 2.7 volume percent of the total solids volume). This predicted 224 waste volume may be low because the inventory estimate generated by the HDW model for tank 241-T-111 predicted 8 volume percent 224 waste, whereas sample analyses for tank 241-T-111 indicate a higher contribution of 224 waste, i.e., 20 to 25 volume percent. Tank 241-T-111 received 2C and 224 waste cascaded from tank 241-T-110 (Field et al. 1997). Analytical data for tank 241-T-112, which received cascaded waste from tank 241-T-111, also shows the presence of 224 waste, which is not predicted by Agnew et al. Boldt (1997) calculates approximately 20 volume percent 224 waste in tank 241-T-112.

It is assumed, for this evaluation, that the 224 waste was evenly distributed with 2C waste between tanks 241-T-110, 241-T-111, and 241-T-112. This assumption is based on the fact that only 2C and 224 waste was received and cascaded through the three tanks, and that the analytical data suggest that both tanks 241-T-111 and 241-T-112 contain approximately 20 volume percent 224 waste. Core sampling and analysis of tank 241-T-110 waste would be required to verify this assumption.

The assumed waste volumes in tank 241-T-110 are approximately as follows:

2C waste	1,138 kL (301 kgal)
224 waste	285 kL (75 kgal)
Total	1,423 kL (376 kgal)

D3.2 BASIS FOR ASSESSING 2C AND 224 WASTE COMPOSITION IN TANK 241-T-110

An estimate of the 2C sludge layer composition in tank 241-T-110 can be made by comparing this tank to other tanks containing 2C sludge. Tank 241-T-110 received 2C waste directly from T Plant (Agnew et al. 1997b). The 2C waste was cascaded from tank 241-T-110 to tanks 241-T-111 and 241-T-112.

The sample-basis composition of waste in tanks 241-T-111 and 241-T-112 based on the core sample data (Field et al. 1997, Steen 1997) is provided in Table D3-1. Also shown, for comparison, are the HDW model-indicated concentrations for tank 241-T-110.

Calculations show that analyte concentrations for the samples from T Plant 2C waste are consistent with the flowsheet basis (Schneider 1951 and Kupfer et al. 1997) for the second cycle BiPO₄ process. As shown in Table D3-1, the concentrations of components expected to precipitate 100 percent to the waste solids (e.g., bismuth, iron, silicon) are relatively consistent (up to a factor of two) between the samples and are approximately proportionate to the relative 2C flowsheet concentrations for those components (see Appendix C of Kupfer et al. 1997). It can be concluded that the sample data for these tanks are consistent with the flowsheet basis. In addition, the concentrations of components that partition between solids and supernatants are comparable between the tanks and in general represent expected chemical behavior.

Table D3-1. Component Concentrations for Tanks 241-T-111 and 241-T-112. (2 sheets)

Analyte	241-T-111 Solids ¹ (μg/g)	241-T-112 Solids ² (μg/g)	Average (μg/g)	241-T-110 HDW Model Solids ² (μg/g)
Al	556	5,110	2,830	0
Bi	24,750	28,800	26,800	12,500
Ca	2,150	<1,890	2,020	6,570
Cr	1,890	2,110	2,000	176
Fe	18,250	16,400	17,300	29,800
Hg	1.43	n/r	1.43	0
K	1,140	n/r	1,140	319
La	4,165	4,800	4,480	10.4
Mn	6,305	5,970	6,140	5.51
Na	36,950	67,300	52,100	58,100
Ni	132	n/r	132	66.2
Pb	356	<1,730	356	0
Si	5,670	8,810	7,240	1,240
Sr	299	313	306	0
U	2,790	<8,630	2,790	816
Zr	n/r	<172	<172	0
CO ₃	n/r	n/r	n/r	9,830
Cl	450	428	439	609
F	2,300	339	1,320	2,690

Table D3-1. Component Concentrations for Tanks 241-T-111 and 241-T-112. (2 sheets)

Analyte	241-T-111 Solids ¹ (μg/g)	241-T-112 Solids ² (μg/g)	Average (μg/g)	241-T-110 HDW Model Solids ³ (μg/g)
OH ⁻	n/r	n/r	n/r	28,000
NO ₃	41,200	17,300	29,300	43,200
NO ₂	793	28,100	14,400	687
P as PO ₄	31,700	12,350	22,000	51,800
S as SO ₄	3,660	9,030	6,340	2,610
TOC	3,120	n/r	3,120	563
% H ₂ O	76.5	73.9	75.2 ⁴	74.8
Density (kg/L)	n/r	1.28	1.28 ⁵	1.20
Radionuclides⁶ (μCi/g)				
²⁴¹ Am	0.0426	n/r	0.0426	1.26E-05
¹³⁷ Cs	0.158	n/r	0.158	1.05
^{234/239} Pu	0.139	n/r	0.139	0.0648
⁹⁰ Sr	5.16	n/r	5.16	0.931
⁹⁹ Tc	0.00792	n/r	0.00792	6.82E-05

Notes:

n/r = not reported

¹Field et al. (1997). This is the average mean for fusion and acid digest methods if both analyses were available. The exception is silicon for which the fission result alone was used.²Steen (1997)³Agnew et al. (1997a)⁴The average percent H₂O from cores 180 and 181 solids for tank 241-T-110 is 79.4 wt%.⁵The average density from core 180 and 181 solids from tank 241-T-110 is 1.25 kg/L.⁶Radionuclides are decayed to January 1, 1994.

Similarly the solids component concentrations (e.g., lanthanum, manganese) for samples containing 224 waste have been shown to be consistent with the flowsheet basis for the 224 final decontamination cycle BiPO₄ process (Field et al. 1997). The composition of the 224 solids layer composition in tank 241-T-110 can be estimated from tanks 241-T-111 and 241-T-112, which are known to contain 224 waste. Kupfer et al. (1997) describes the process for applying component concentration factors for reconciling process-based flowsheet compositions and sample data to determine the consistency of the sample and flowsheet basis.

D3.3 ESTIMATED INVENTORY FOR TANK 241-T-110

The estimated inventory for the 2C/224 waste components in tank 241-T-110 was calculated as the product of the average components concentrations (see Table D3-1) for the two comparison tanks 241-T-111 and 241-T-112 using a waste volume of 1,423 kL (376 kgal) and the density of 1.25 kg/L for the solids in tank 241-T-110 (Nuzum 1997).

Table D3-2 summarizes the chemical and radionuclide inventories for selected analytes in tank 241-T-110. The inventories estimated by the HDW model (Agnew et al. 1997a) are included for comparison. The inventories from this assessment differ significantly from the HDW inventories for several components. Comments and observations regarding these inventories are provided by component in the following text.

Table D3-2. Comparison of Inventory Estimate for Selected Components in Tank 241-T-110 Solids.

Analyte	This Evaluation (kg)	HDW Model Inventory ¹ (kg)
Al	5,030	0
Bi	47,700	21,300
Cr	3,560	300
Fe	30,800	51,000
K	2,030	546
La	7,970	17.8
Mn	10,900	9.43
Na	92,700	99,400
Si	12,900	2,120
Sr	544	0
F	2,350	4,610
NO ₃	51,900	74,000
NO ₂	25,600	1,180
P as PO ₄	39,100	88,700
S as SO ₄	11,300	4,470

Note:

¹Agnew et al. (1997a); TLM inventory (excludes the 11.6 kL [3.07 kgal] of supernatant that was removed in May 1997).

Aluminum. Because aluminum was not added as a flowsheet constituent in the BiPO₄ second cycle (2C) or 224 process, the HDW model predicts no aluminum in the waste solids. However, sample data for the two tanks that contain these waste types show an average of approximately 2,800 µg/g waste solids. Much of this aluminum may exist as the aluminate anion from small amounts of saltcake associated with the 1C and 224 waste solids. The presence of aluminum would tend to indicate that waste transaction records for this cascade are incomplete.

Bismuth. The reference inventory predicted by this assessment is about a factor of two higher than the HDW model inventory. The HDW model inventory reflects the assumptions that only 60 percent, 24 percent, and 34 percent of the bismuth in the 2C1 stream, 2C2 stream, and 224 stream, respectively, precipitated. This basis resulted in a significant amount of bismuth being cascaded to cribs based on the HDW model. Comparison of tank sample data with flowsheet data shows that essentially all bismuth precipitates with the insoluble solids.

Chromium. The chromium content of tank 241-T-110, based on the two comparison tanks, is approximately tenfold higher than predicted by the HDW model. The HDW model-defined waste streams indicate higher concentrations of chromium in the 2C and 224 wastes than given in Schneider (1951). These concentrations may be inflated somewhat from the corrosion source terms assumed for the HDW model because no corrosion source term was used in this assessment. However, the HDW model assumes that none of the chromium precipitated in the 2C and 224 streams. The only chromium contribution to the solids is from the interstitial liquids associated with the solids. For this assessment, the assumption that a considerable amount of chromium precipitated is substantiated by comparing the analytical results for tanks 241-T-111 and 241-T-112 with the concentrations of chromium in the 2C and 224 flowsheets. In addition, most of the chromium is expected to precipitate as Cr(OH)₃ or Cr₂O₃ · xH₂O in alkaline waste solutions.

Iron. The reference iron inventory predicted by this assessment is approximately 40 percent smaller than for the HDW model inventory. This evaluation does not predict a corrosion source term for iron, which may explain the smaller inventory for this assessment. However, the HDW model inventory prediction may be biased high based on a corrosion global source term for iron that is considered high.

Potassium. The reference potassium inventory predicted by this assessment is approximately four times that predicted by the HDW model. This is, in part, caused by the predicted small contribution of the 224 waste stream (2.7 volume percent) by the HDW model for this tank versus the 20 percent contribution predicted by this assessment.

Lanthanum. The reference lanthanum inventory predicted by this assessment is five hundredfold higher than that predicted by the HDW model. The HDW model predicts that none of the lanthanum will precipitate, which is in disagreement with the analyte data for the waste solids (tanks 241-T-111 [Field et al. 1997] and 241-T-112 [Boldt 1997]). Also, the

contribution of the 224 waste stream that contains lanthanum is predicted to be only 2.7 volume percent by the HDW model versus approximately 20 volume percent by this assessment.

Manganese. The manganese inventory predicted by this assessment is a thousandfold higher than the inventory projected by the HDW model. Based on known chemistry of manganese in alkaline solution, all the manganese in 224 waste will precipitate. The HDW model assumes that none of the manganese will precipitate from the 224 waste streams. The only manganese contribution in the solids for the HDW model is from interstitial liquids. The HDW model predicts that the 224 waste contributes only 2.7 percent of the waste volume, whereas this independent assessment predicts approximately 20 percent.

Sodium. The sodium inventory predicted by this evaluation is comparable to the HDW model inventory. Some partitioning of sodium probably occurs. Some saltcake likely is mixed with the 2C and 224 waste solids.

Silicon. The reference silicon inventory predicted by this assessment is approximately six times that predicted by the HDW model. The apparent explanation is that nearly all silicon precipitates, and the HDW model assumes a significant portion of the silicon is in the aqueous stream that is sent to cribs.

Fluoride. The inventory predicted by this assessment is about 50 percent of the inventory predicted by the HDW model. The inventory is based on analysis of the aqueous portion generated from water leaching of the sample. The water insoluble solids may contain fluoride, but determining how much is not possible until an analytical method that measures total fluoride is used. This assessment may therefore, underestimate the fluoride content of this tank. The HDW model assumes that a portion of the fluoride is present in the solids as NaF, although this compound should be measured by the water digestion analytical method.

Nitrate. The nitrate inventory predicted by this assessment is about 70 percent of that predicted by the HDW model. Because the nitrite concentration based on this assessment is high, the nitrate may have been reduced by radiolytic reduction to nitrite.

Nitrite. The sample analyses indicate significantly higher inventories of nitrite than predicted by the HDW model. This may be the result of radiolytic reduction of nitrate to produce nitrite.

Phosphate. The phosphate inventory predicted by this assessment is approximately 40 percent lower than that predicted by the HDW model. Because the analytical data for the two comparison tanks consistently showed lower concentrations than predicted by the HDW model, the average phosphate concentration for these tanks is used to estimate the inventory in tank 241-T-110.

Sulfate. The HDW inventory is about threefold smaller than the inventory estimated by this evaluation. The HDW model assumed that the sulfate partitions entirely to the aqueous phase. Based on analyses of the comparison tanks (241-T-111 and 241-T-112), some sulfate must partition to the solid phase.

Total Hydroxide. Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997a).

D4.0 DEFINE THE BEST BASIS AND ESTABLISH COMPONENT INVENTORIES

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

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

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

- Data from two 1997 core samples (Nuzum 1997). The analytical results for this tank were too limited to provide a basis for component inventories in tank 241-T-110.
- An inventory estimate generated by the HDW model (Agnew et al. 1997a)
- Comparing total waste concentrations with similar 241-T Tank Farm tanks 241-T-111 (Field et al. 1997) and 241-T-112 (Steen 1997).

The results from this evaluation support using the sampling data from tanks 241-T-111 and 241-T-112 as the basis for the best estimate inventory to tank 241-T-110 for the following reasons.

- Data from the core composite samples were used to estimate the component inventories. The core sample recoveries were relatively complete.
- The inventory estimate generated by the HDW model is based on a predicted 2C:224 waste volume ration 92:8, whereas sample analyses for tanks 241-T-111 and 241-T-112 of components that are unique to these two waste types indicate a higher contribution of 224 waste, for example, 80:20 or 75:25. Based on an examination of the transaction history, the ratio of 2C:224 waste for tank 241-T-110 is assumed to be approximately the same as for the two cascade tanks (241-T-111 and 241-T-112).
- Concentration factors were calculated for fully precipitated components (e.g., bismuth) based on comparing flowsheet concentrations with analytical-based concentrations. The relative concentrations of components in the waste solids were found to be consistent with those expected for waste resulting from BiPO₄ process 2C and 224 process flowsheets (Field et al. 1997). For nearly all components, the concentration factors and partitioning factors are consistent with the predicted chemical behaviors of the components in alkaline media. It can be concluded that the sample data for tanks 241-T-111 and 241-T-112 are consistent with the flowsheet basis and can be used to assess the inventory in tank 241-T-110.

Best basis inventory estimates for tank 241-T-110 are presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database for the most current inventory values.

Table D4-1. Best Basis Inventory Estimate for Nonradioactive Components in Tank 241-T-110.

Analyte	Total inventory (kg)	Basis (S, M, C, or E) ¹	Comment
Al	5,030	E	
Bi	47,700	E	
Ca	3,590	E	
Cl	781	E	
TIC as CO ₃	16,800	M	No sample basis
Cr	3,560	E	
F	2,350	E	Based on analysis of water leach
Fe	30,800	E	
Hg	2.54	E	
K	2,030	E	
La	7,970	E	
Mn	10,900	E	
Na	92,700	E	
Ni	235	E	
NO ₂	25,600	E	Based on analysis of water leach
NO ₃	51,900	E	Based on analysis of water leach
OH _{TOTAL}	65,400	C	Charge balance calculation
Pb	633	E	
P as PO ₄	39,100	E	
Si	12,900	E	
S as SO ₄	11,300	E	
Sr	544	E	
TOC	5,550	E	Based on analysis of water leach
U _{TOTAL}	4,960	E	
Zr	0	M	

Note:

¹S = Sample-based; M = Hanford Defined Waste model-based; E = Engineering assessment-based;
 C = Calculated by charge balance; includes oxides as "hydroxide" not including CO₃, NO₂, NO₃, PO₄,
 SO₄, and SiO₃

Table D4-2. Best Basis Inventory Estimate for Radioactive Components in Tank 241-T-110 (Values Decayed to January 1, 1994). (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, E, or C) ¹	Comment
³ H	0.0494	M	
¹⁴ C	0.0169	M	
⁵⁹ Ni	0.0048	M	
⁶⁰ Co	0.00324	M	
⁶³ Ni	0.428	M	
⁷⁹ Se	0.00355	M	
⁹⁰ Sr	9,180	E	Based on ⁹⁰ Sr
⁹⁰ Y	9,180	E	
^{93m} Nb	0.0144	M	
⁹³ Zr	0.0169	M	
⁹⁹ Tc	14	E	
¹⁰⁶ Ru	9.78E-10	M	
^{113m} Cd	0.0385	M	
¹²⁵ Sb	0.00264	M	
¹²⁶ Sn	0.00532	M	
¹²⁹ I	2.19E-04	M	
¹³⁴ Cs	9.87E-05	M	
^{137m} Ba	266	E	Based on ¹³⁷ Cs
¹³⁷ Cs	281	E	
¹⁵¹ Sm	13.3	M	
¹⁵² Eu	0.0102	M	
¹⁵⁴ Eu	0.0540	M	
¹⁵⁵ Eu	0.836	M	
²²⁶ Ra	1.19E-06	M	
²²⁷ Ac	6.05E-06	M	
²²⁸ Ra	4.76E-11	M	
²²⁹ Th	9.22E-09	M	
²³¹ Pa	1.29E-05	M	
²³² Th	4.98E-12	M	
²³² U	6.54E-06	M	

Table D4-2. Best Basis Inventory Estimate for Radioactive Components in Tank 241-T-110 (Values Decayed to January 1, 1994). (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, E, or C)	Comment
²³³ U	3.61E-07	M	
²³⁴ U	0.460	M	
²³⁵ U	0.0206	M	
²³⁶ U	0.00328	M	
²³⁷ Np	7.13E-04	M	
²³⁸ Pu	0.541	M	
²³⁸ U	0.466	M	
^{239/240} Pu	247	E	
²⁴¹ Am	75.8	E	
²⁴¹ Pu	17.6	M	
²⁴² Cm	1.74E-04	M	
²⁴² Pu	7.71E-05	M	
²⁴³ Am	1.40E-07	M	
²⁴³ Cm	3.54E-06	M	
²⁴⁴ Cm	3.27E-06	M	

Note:

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

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

discussion of typical error between model-derived values and sample-derived values, see Kupfer et al. (1997).

D5.0 APPENDIX D REFERENCES

- Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.
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- Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.
- Boldt, A. L., 1997, *Preliminary Tank Characterization Report for Single-Shell Tank 241-T-112: Best-Basis Inventory*, HNF-SD-WM-ER-699, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.
- 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.
- Field, J. G., J. H. Baldwin, M. J. Kupfer, and L. Jensen, 1997, *Tank Characterization Report for Single-Shell Tank 241-T-111*, HNF-SD-WM-ER-540, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.
- Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending April 30, 1997*, HNF-EP-0182-109, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.
- Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

- Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.
- Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, R. A. Watrous, S. L. Lambert, D. E. Place, R. M. Orme, G. L. Borsheim, N. G. Colton, M. D. LeClair, R. T. Winward, and W. W. Schulz, 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.
- Nuzum, J. L. 1997, *Waste Compatibility Safety Issues and Final Results for 241-T-110 Push Mode Sample*, HNF-SD-WM-DP-238, Rev. 0, Waste Management Federal Services Northwest Operations, Richland, Washington.
- Schneider, K. L., 1951, *Flow Sheets and Flow Diagrams of Precipitation Separations Process*, HW-23043, Hanford Atomic Products Operation, Richland, Washington.
- Steen, F. H., 1997, *Tank 241-T-112 Cores 185 and 186 Analytical Results for the Final Report*, HNF-SD-WM-DP-243, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.
- Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989*, HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-T-110

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APPENDIX E**BIBLIOGRAPHY FOR TANK 241-T-110**

Appendix E provides a bibliography that supports the characterization of tank 241-T-110. 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-110 and its respective waste types.

The references in this bibliography are separated into three broad categories broken down into subgroups.

I. NONANALYTICAL 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-110
- IIb. Sampling of similar waste types

III. COMBINED ANALYTICAL/NONANALYTICAL 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 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 is available in the Lockheed Martin Hanford Corporation Tank Characterization and Safety Resource Center.

I. NONANALYTICAL 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.

- Contains single-shell tank fill history and primary campaign and 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.

- 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.

- 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.

- Contains spreadsheets showing all known tank additions and transfers.

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

- Contains tank fill histories and primary campaign and 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.

- Shows riser location in relation to tank aerial view and describes each riser and its contents.

Lipnicki, J., 1997, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

- Gives an assessment of riser locations for each tank; however, not all tanks are included or completed. It also includes 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.

- 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.

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

Id. Sample Planning, Tank Prioritization

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1997, *Tank Characterization Technical Sampling Basis*, HNF-SD-WM-TA-164, Rev. 3, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Richland, Washington.

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

DOE-RL, 1996, *Recommendation 93-5 Implementation Plan*, DOE/RL-94-0001, Rev. 1, U.S. Department of Energy, Richland, Washington.

- Describes the organic solvents issue and other tank issues.

McCain, D. J., and W. W. Winkelman, 1996, *Tank 241-T-110 Tank Characterization Plan*, WHC-SD-WM-TP-511, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Contains a detailed sampling and analysis scheme for core samples to be taken from tank 241-T-110.

McCain, D. J., 1996, *Tank 241-T-110 Push Mode Core Sampling and Analysis Plan*, WHC-SD-WM-TSAP-113, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains a detailed sampling and analysis scheme for core samples to be taken from tank 241-T-110 to address applicable DQOs.

McCain, D. J., 1996, *Compatibility Grab Sampling and Analysis Plan for Fiscal Year 1997*, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains a detailed sampling and analysis scheme for grab samples to be taken from many tanks to determine compatibility, including tank 241-T-110, to address applicable DQOs.

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 *Washington Administrative Code (WAC)* 173-303 and *Title 40 Code of Federal Regulation (CFR)* Part 265.

Stanton, G. A., 1997, *Baseline Sampling Schedule, Change 97-03*, (internal letter 75610-97-004 to Distribution, October 8), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Richland, Washington.

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

Winkelman, W. D., M. R. Adams, T. M. Brown, J. W. Hunt, D. J. McCain, and L. J. Fergestrom, 1997, *Fiscal Year 1997-1998 Waste Information Requirements Document*, HNF-SD-WM-PLN-126, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford Inc., Richland, Washington.

- Contains requirements and planned characterization activities from sources such as the *Hanford Federal Facility Agreement and Consent Order* and the *Recommendation 93-5 Implementation Plan* for Fiscal Years 1997 and 1998.

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 whether tanks are under safe operating conditions.

Fowler, K. D., 1997, *Transmittal: Waste Compatibility Assessment of tank 241-T-110 Waste (WTF-97-1) with Tank 241-SY-102 Waste via DCRT 244-TX*, (internal letter 74330-97-012, to G. L. Dunford, March 25), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford Inc., Richland, Washington.

- Gives results of compatibility assessment for tanks 241-T-110 and 241-SY-102.

Fowler, K. D., 1997, *Transmittal: Waste Compatibility Assessment of tank 241-T-110 Waste (WTF-97-1) and 241-T-104 Waste (WTF-97-02) with Tank 241-SY-102 Waste via DCRT 244-TX*, (internal letter 74330-97-015, to G. L. Dunford, March 25), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Gives results of compatibility assessment for tanks 241-T-110 and 241-T-104 with tank 241-SY-102.

Meacham, J. E., D. L. Banning, M. R. Allen, and L. D. Muhlestein, 1997, *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue*, HNF-SD-WM-DQO-026, Rev. 0, Duke Engineering & Services, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains requirements for the organic solvents DQO.

Mulkey, C. H., and M. S. Miller, 1997, *Data Quality Objectives for Tank Farms Waste Compatibility Program*, WHC-SD-WM-DQO-001, Rev. 2, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford Inc., Washington.

- Contains waste transfer compatibility program data needs, list of tanks to be evaluated, decision thresholds, and decision logic flow diagram.

Osborne, J. W., J. L. Huckaby, and E. R. Hewitt, 1995, *Data Quality Objective for Generic In-Tank Health and Safety Vapor Issue Resolution*, WHC-SD-WM-DQO-002, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine whether tank vapor spaces contain potentially toxic gases and vapors.

Schreiber, R. D., 1997, *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements*, HNF-SD-WM-RD-060, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains requirements, methods, and logic for analyses to support organic complexant issue resolution.

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

IIa. Sampling of tank 241-T-110

Caprio, G. S., 1995, *Vapor and Gas Sampling of Single-Shell Tank 241-T-110 Using the Vapor Sampling System*, WHC-SD-WM-RPT-183, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains vapor sample analysis results.

Esch, R. A., 1997, *Waste Compatibility Results for T-110 Grab Samples*, (external letter RFSH-9752254 to D. J. McCain, March 13), Waste Management Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sample analysis results from the January 8, 1997, grab sample event.

Esch, R. A, 1997, *Analysis Results for Tank 241-T-110 Grab Samples*, (external letter RFSH-9750693 to D. J. McCain, January 24), Waste Management Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sample analysis results from the January 8, 1997, grab sample event.

McVeety, B. D., B. L. Thomas, J. C. Evans, K. H. Pool, K. B. Olsen, J. S. Fruchter, and K. L. Silvers, 1996, *Headspace Vapor Characterization of Hanford Waste Tank 241-T-110: Results from Samples Collected on 8/31/95*, Pacific Northwest National Laboratory, Richland, Washington.

- Contains vapor sample analysis results from August 31, 1995, sample event.

Nuzum, J. L., 1997, *Waste Compatibility Safety Issues and Final Results for Tank 241-T-110, Grab Samples*, HNF-SD-WM-DP-239, Rev. 0, Waste Management Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sample analysis results from the January 8, 1997, grab sample event.

Nuzum, J. L., 1997, *Waste Compatibility Safety Issues and Final Results for Tank 241-T-110, Push Mode Samples*, HNF-SD-WM-DP-238, Rev. 0B, Waste Management Federal Services of Hanford, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sample analysis results from the January and February 1997 push mode sample event.

Wheeler, R. E., 1974, *Analysis of Tank Farm Samples, Sample: T4340, 110-T*, (internal letter to R. L. Walser, May 24), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical sample analysis results.

Wheeler, R. E., 1975, *Analysis of Tank Farm Samples, Sample: T5313, 110-T*, (internal letter to R. L. Walser, January 20), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains historical sample analysis results.

IIb. Sampling of Similar Waste Types

Field, J. G., 1997, *Tank 241-T-111 Characterization Report*, HNF-SD-WM-ER-540, Rev. 1A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information on 2C waste type.

III. COMBINED ANALYTICAL, NONANALYTICAL 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, Los Alamos National Laboratory, Los Alamos, New Mexico.

- 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.

- Attempts to account for the disposition of soluble organics and provides estimates of TOC content for each tank.

Allen, G. K., 1976, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944 - 1975*, ARH-CD-601B, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

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

Allen, G. K., 1975, *Hanford Liquid Waste Inventory as of September 30, 1974*, ARH-CD-229, Rev. 0, Atlantic Richfield Company, Richland, Washington.

- Contains major components for waste types and some assumptions.

Klem, M. J., 1988, *Inventory of Chemicals Used at Hanford Production Plants and Support Operations (1944 - 1980)*, WHC-EP-0172, Westinghouse Hanford Company, Richland, Washington.

- Lists chemicals used in production facilities and support operations that sent waste to the single-shell tanks. List is based on chemical process flowsheets, essential materials consumption records, letters, reports, and other historical data.

Kupfer, M. J., 1997, *Preliminary Tank Characterization Report Single-Shell Tank 241-T-110: Best Basis Inventory*, HNF-SD-WM-ER-686, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains a component inventory for tank 241-T-110, including 21 chemical and approximately 40 radionuclide components.

Kupfer, M. J., M. J. Boldt, A. L. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, R. A. Watrous, M. D. LeClair, G. L. Borsheim, R. T. Winward, R. M. Orme, N. G. Colton, S. L. Lambert, D. E. Place, and W. W. Schultz, 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains a global and tank-by-tank component inventory for 200 Area waste tanks, including 21 chemical and approximately 40 radionuclide components.

Schmittroth, F. A., 1995, *Inventories for Low-Level Tank Waste*, WHC-SD-WM-RPT-164, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains a global inventory based on process knowledge and radioactive decay estimations using ORIGEN2. Plutonium and uranium waste contributions are taken at 1 percent of the amount used in processes. Also compares information on ⁹⁹Tc 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.

- 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. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Document contains summary information for tanks in T, TX, and TY 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*, HNF-SD-WM-ER-320, Rev. 1, Fluor Daniel Northwest, Inc., for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains summary information for tanks in the C Tank Farm as well as appendices containing more detailed information including tank waste level history, tank temperature history, cascade and dry well charts, riser information, in-tank photograph collages, and a tank layer model bar chart and spreadsheet.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1996, *Tank Waste Source Term Inventory Validation, Vol I, II, and III*, WHC-SD-WM-ER-400, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Contains a quick reference to sampling information in spreadsheet or graphical form for all the tanks.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending September 30, 1997*, HNF-EP-0182-114, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

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

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.

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

Husa, E. I., 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Westinghouse Hanford Company, Richland, Washington.

- Contains in-tank photographs and summaries of the tank description, leak detection system, and tank status.

Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Gives an assessment of the relative dryness of tank waste.

Lechelt, J. A., *Organic End State Analysis of Tank 241-T-110*, HNF-SD-WM-CN-100, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Determines whether the tank can be interim stabilized safely.

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.

- 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, August 8), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Radionuclide Inventories for Single- and Double-Shell Tanks*, (internal memorandum 71320-95-002 to F. M. Cooney, February 14), Westinghouse Hanford Company, Richland, Washington.

- Contains a tank inventory estimate based on analytical information.

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.

- Contains selected sample analysis tables for pre-1993 contents for single-shell tanks.

Washenfelder, D. J., 1997, *Transmittal of Engineering Change Notice 635136 "Evaluation of Hanford Tanks For Trapped Gas, WHC-SD-WM-ER-526,"* (external letter FDH-9751568 to J. K. McClusky, U.S. Department of Energy, March 4), Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains flammable gas evaluation on many tanks, including 241-T-110.

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DE&S Hanford, Inc.

R. J. Cash	S7-14	X
W. L. Cowley	R2-54	X
G. L. Dunford	A2-34	X
G. D. Johnson	S7-14	X
J. E. Meacham	S7-14	X

Fluor Daniel Northwest

E. D. Johnson	E6-08	X
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Lockheed Martin Hanford, Corp.

K. M. Hodgson	H0-34	X
T. J. Kelley	S7-21	X
D. J. McCain	R2-12	X
L. M. Sasaki	R2-12	X
B. C. Simpson	R2-12	X
R. R. Thompson	R2-12	X
L. R. Webb	R2-12	X
ERC (Environmental Resource Center)	R1-51	X
T.C.S.R.C.	R1-10	5

Lockheed Martin Services, Inc.

B. G. Lauzon	R1-08	X
Central Files	B1-07	X
EDMC	H6-08	X

Numatec Hanford Corporation

J. S. Garfield	H5-49	X
D. L. Herting	T6-07	X
J. S. Hertzfel	H5-61	X
D. L. Lamberd	H5-61	X

Pacific Northwest National Laboratory

A. F. Noonan	K9-91	X
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