AUG 07 1996	**ENGINEERING DATA TRANSMITTAL**	Page 1 of 1 1. EDT 617503

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Data Assessment and Interpretation	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Tank 241-AP-104/Waste Management/DAI/TWRS Technical Basis	6. Cog. Engr.: Wayne D. Winkelman	7. Purchase Order No.: N/A
8. Originator Remarks: This document is being released into the supporting document system for retrievability purposes.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: 241-AP-104
11. Receiver Remarks: For release.		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 07/22/96

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-ER-596	N/A	0	Tank Characterization Report for Double-Shell Tank 241-AP-104	N/A	2	1	1

16. KEY

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

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

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
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BD-7400-172-2 (04/94) GEF097

Tank Characterization Report for Double-Shell Tank 241-AP-104

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

EDT/ECN: EDT-617503 UC: 2070
Org Code: 79400 Charge Code: N4G4D
B&R Code: EW 3120074 Total Pages: 134

Key Words: Tank Characterization Report, TCR, Double-Shell Tank, Double-Shell, DST, Tank 241-AP-104, Tank AP-104, AP-104, AP Farm

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-AP-104. This report supports the requirements of Tri-Party Agreement Milestone M-44-09.

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Release Approval Date 8/7/96

Release Stamp

Approved for Public Release

Tank Characterization Report for Double-Shell Tank 241-AP-104

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Date Published
August 1996

Prepared for the U.S. Department of Energy
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Management and Operations Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for public release, distribution unlimited

EXECUTIVE SUMMARY

This characterization report summarizes available information on the historical uses and the current status of double-shell tank 241-AP-104 and provides the analytical results of the January 1996 grab sampling and analysis project. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order*, Milestone M-44-09 (Ecology et al. 1996).

Tank 241-AP-104 is one of eight double-shell tanks located in the 200 East Area AP Tank Farm at the Hanford Site. The tank was placed in service in July 1986 and received its first transfer of dilute noncomplexed waste from the 100 N area in October 1986. The tank received dilute phosphate waste from the 100 N area during the first quarter of 1987. Waste additions continued until the third quarter of 1987, at which time the tank was almost full. The tank was emptied of all but 84 kL (22 kgal) in the second quarter of 1988 and was largely inactive except for the receipt of a small amount of waste from two unknown sources. The tank was refilled to a volume of 4,258 kL (1,124 kgal) with dilute noncomplexed waste in a series of transfers and additions. Subsequently, it was emptied of all but 101 kL (27 kgal) by the 242-A Evaporator Campaign 96-1 completed in May 1996.

Table ES-1 describes the current status of tank 241-AP-104. The tank has an operating capacity of 4,390 kL (1,160 kgal). At the time of sampling, the tank contained 4,258 kL (1,124 kgal) of supernatant. This is based on the level measurement of 10.39 m (34 ft)

Table ES-1. Description and Status of Tank 241-AP-104.

TANK DESCRIPTION	
Type	Double-shell
Constructed	1983 to 1986
In service	July 1986
Diameter	23 m (75 ft)
Operating depth	10.7 m (35.2 ft)
Capacity	4,390 kL (1,160 kgal)
Bottom shape	Flat
Ventilation	Active
TANK STATUS (July 1, 1996)	
Waste classification	Dilute noncomplexed
Total waste volume	101 kL (27 kgal)
Sludge volume	0.00
Drainable interstitial liquid volume	0.00
Supernatant volume	101 kL (27 kgal)
Waste surface level (July 1996)	25 cm (9.7 in.)
Watch List status	Non-Watch List tank
Waste surface level (1988 to present)	Active tank
Temperature (July 1989 to July 1996)	7.7 °C (46 °F) to 21.2 °C (70.2 °F)
Integrity	Sound
SAMPLING DATES	
Grab samples and tank headspace flammability	January 18 - 23, 1996 Waste Volume 4,258 kL (1,125 kgal)
SERVICE STATUS	
In Service	1986 to present

from the Surveillance Analysis Computer System database). After sampling was completed in January 1996 the waste was processed through the 242-A Evaporator and stored in evaporator slurry tank 241-AW-106. As of July 1, 1996 the tank contains 25 cm (9.7 in.) of waste which corresponds to 101 kL (27 kgal).

This report summarizes the collection and analysis of grab samples taken January 18 to 23, 1996 while the tank was almost full. The sampling event was performed to evaluate the tank as a candidate for evaporator feed. The sampling event was designed to satisfy the requirements in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995), and the *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives* (Von Bargen 1995). Sampling and analyses were performed in accordance with the *Tank 241-AP-104 Grab Sampling and Analysis Plan* (Conner 1996). Thirteen grab samples of tank waste were taken from riser (1@30°) and riser (1@270°). The risers are widely spaced.

The purpose of the safety screening data quality objective (DQO) is to verify the non-Watch List status of the tank 241-AP-104 and to identify any unknown safety issues associated with the tank. To accomplish this purpose, the safety screening DQO requires the waste samples be measured for exothermic chemical energy by differential scanning calorimetry (DSC), weight percent water by thermogravimetric analysis (TGA), specific gravity, total alpha activity by alpha proportional counting, and a visual examination of waste samples for an organic layer. The safety screening DQO also requires a determination of the flammability of the tank headspace gases. To satisfy this requirement, vapor samples were taken prior to

sampling, and the flammability was measured as a percent of the lower flammability limit using a combustible gas meter.

The waste compatibility DQO governs the acquisition of analytical data while addressing issues associated with combining wastes from two or more sources. The waste compatibility DQO requires all the same analyses as the safety screening DQO except for total alpha analyses.

The safety screening DQO requires total alpha analysis to assess criticality whereas the compatibility DQO only requires $^{239,240}Pu$ analysis. The data required by the evaporator DQO assist evaporator personnel in the safe and efficient operation of the evaporator. The data also enable the evaporator and Liquid Effluent Retention Facility operators to ensure that downstream facilities are not damaged and to fulfill all requirements of discharge permits. The evaporator DQO required the same analyses as the safety screening DQO as well as analyses of selected metals, anions, radionuclides, carbon, and physical properties. A boildown test to predict the behavior of the waste during and after concentration by evaporation also was performed.

All waste analyses performed for tank 241-AP-104 exhibited results well within the limits imposed by the safety screening DQO. The mean total alpha activity was 3.28E-04 μCi/mL, well below the notification limit of 61.5 μCi/mL; the DSC scans showed only endothermic reactions; no organic layer was detected; and the weight percent water results were 96.6 percent by TGA. The flammability of the tank vapor headspace was measured at 0 percent

of the lower flammability limit. The analyses performed in accordance with the waste compatibility and evaporator DQOs exhibited no results that would preclude waste transfers or the concentration of the waste by evaporation. The waste is not transuranic (TRU) or complexant; therefore, no segregation for those purposes is required.

The heat load in the tank produced by radioactive decay was calculated to be 90.5 W (309 Btu/hr), well below the 20,500 W (70,000 Btu/hr) design specification for the tanks in the 241-AP Tank Farm (Harris 1992). The actual heat load is significantly less now that the tank is almost empty.

All quality control results were within the limits specified by the safety and analysis plan with the exception of a low standard recovery for ^{237}Np and high-matrix spike recoveries for acetone and 1-butanol. The quality control discrepancies should not affect data usability. The mean values for major analytes and analytes of interest are provided in Table ES-2. A current profile of tank 241-AP-104 is shown in Figure ES-1.

Samples taken from the tank appeared homogenous; however, analysis indicates the concentration of several analytes was significantly greater in samples taken from lower in the tank than in samples taken near the surface. This observation indicates that some compounds have settled, and there is vertical heterogeneity.

Table ES-2. Major Analytes and Analytes of Concern.[1] (2 sheets)

Analyte	Overall Mean Concentration	RSD (Mean)	Projected Inventory[2]
METALS	**μg/mL**	**%**	**kg**
Aluminum	198	82.4	843
Chromium	34.5	52.9	147
Sodium	9810	55.2	41,767
Uranium	15.8	56.2	67.27
ANIONS/CATIONS	**μg/mL**	**%**	**kg**
Ammonia	71.6	85.9	305
Fluoride	494	59.6	2,103
Hydroxide	2620	58.3	11,155
Nitrate	14800	63.9	63,013
Nitrite	1820	35.6	7,749
Phosphate	750	42.4	3,193
Sulfate	762	38.1	3,244
RADIONUCLIDES	**μCi/mL**	**%**	**Ci**
^{14}C	0.0000619	64.5	0.264
^{137}Cs	4.4	17.5	18,734
$^{89/90}Sr$	0.0663	37.9	282
Total alpha	0.000328	15.2	1.40
Total beta	4.48	15.6	19,074
$^{139,240}Pu$	<3.45 E-05	n/a	<0.147
CARBON	**μg C/mL**	**%**	**kg**
Total carbon	944	26.8	4,019
Total inorganic carbon	740	38.7	3,151
Total organic carbon	154	26	656
ORGANICS	**μg/mL**	**%**	**kg**
Acetone	1.18	27	5.02
2-Butoxyethanol	0.795	38.6	3.38
Tri-n-butyl phosphate	4.69	87.8	19.97

Table ES-2. Major Analytes and Analytes of Concern.[1] (2 sheets)

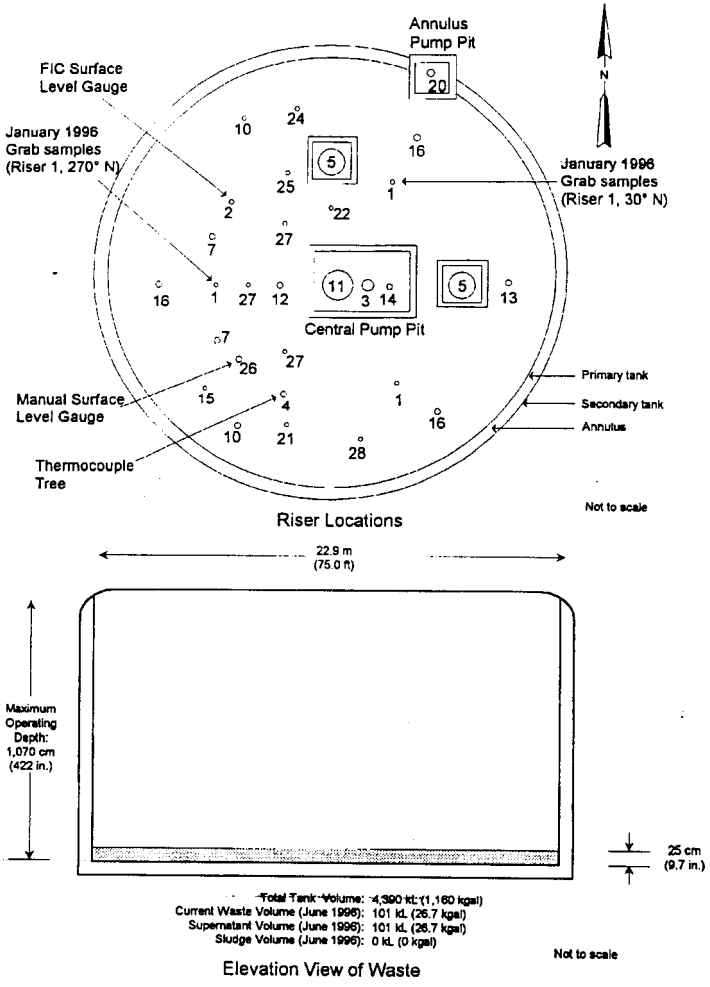
Analyte	Overall Mean Concentration	RSD (Mean)	Projected Inventory[2]
PHYSICAL PROPERTIES			
pH	12.7	2.72	---
Weight percent water	96.6	2.1	---
Specific gravity	1.02	not applicable	---

Notes:

[1]Miller (1996)

[2] Based on the waste volume at the time of sampling of 4,258 kL (1,125 kgal)

Figure ES-1. Profile of Tank 241-AP-104.



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LIST OF TERMS

ANOVA	analysis of variance
Btu/hr	British thermal units per hour
CERCLA	*Comprehensive Environmental Response Compensation and Liability Act*
Ci	curies
Ci/g	curies per gram
cm	centimeters
DQO	data quality objective
DSC	differential scanning calorimetry
FIC	Food Instrument Corporation
ft	feet
g	grams
g/L	grams per liter
g/mL	grams per milliliter
GEA	gamma energy analysis
HTCE	historical tank content estimate
in.	inches
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
J/g	joules per gram
kg	kilograms
kgal	kilogallons
kL	kiloliters
L	liters
LEL	lower explosive limit
LFL	lower flammability limit
m	meters
M	moles per liter
mL	milliliters
mm	millimeters
mR/hr	milliroentgens per hour
nCi/g	nanocuries per gram
ppm	parts per million
PNNL	Pacific Northwest National Laboratory
RPD	relative percent difference
RSD	relative standard deviation
SAP	sampling and analysis plan
SU	supernatant
SVOA	semi-volatile organic analysis
TC	total carbon
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	Tank Layer Model

LIST OF TERMS (CONTINUED)

TOC	total organic carbon
TRU	transuranic
VOA	volatile organic analysis
W	watts
WHC	Westinghouse Hanford Company
WSTRS	Waste Status and Transaction Record Summary
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter
μg C/mL	micrograms carbon per milliliter

1.0 INTRODUCTION

This tank characterization report provides an overview of double-shell tank 241-AP-104 and its waste components. It provides estimated concentrations and inventories for the waste constituents based on the latest sampling and analysis activities, background tank information, and a brief description of the material condition and process history of the tank.
Tank 241-AP-104 was grab sampled January 18 to 23, 1996 in accordance with the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995), and the *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives* (Von Bargen 1995). The requirements of the three DQOs are integrated in the *Tank 241-AP-104 Grab Sampling and Analysis Plan* (Conner 1996).

Tank 241-AP-104 began operation in 1986 and received waste from the 100 N Area. It has remained active. The tank was selected as a candidate feed tank for the 96-1 Evaporator Campaign completed in May 1996. The tank was filled with waste from three other waste sources, then sampled to determine whether the waste could be safety processed. The analyte concentrations reported in this document reflect the best composition estimates of the waste at the time of sampling, based on the available analytical data (Miller 1996). The waste was suitable for processing, and the tank was almost emptied to its current state. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order*, Milestone M-44-09 (Ecology et al. 1996).

1.1 PURPOSE

This report summarizes information about the use and contents of tank 241-AP-104. This information is used to assess issues associated with safety, operational, environmental, and process activities. This report also provides a reference point for more detailed information about tank 241-AP-104.

1.2 SCOPE

The 1996 grab sampling event was guided by the requirements of three DQOs: safety screening (Dukelow et al. 1995), waste compatibility (Fowler 1995), and Evaporator (Von Bargen 1995). The objective of the safety screening DQO was to verify the non-Watch List status of the tank and to identify any unknown safety issues associated with the tank. The waste compatibility DQO addressed the issues associated with combining wastes from two or more sources. The evaporator DQO was concerned with the safe and efficient operation of the evaporator facility, the protection of facilities downstream from the evaporator, and the fulfillment of the requirements of discharge permits. In addition to the grab samples, the tank headspace vapor was analyzed for flammable gases as required by the safety screening DQO.

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2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-AP-104 based on historical information. It includes information on the following: the current condition of the tank, tank design, transfer history, the process sources that have contributed to the tank waste, and an estimate of the current contents based on the process history. It also describes events that may be related to tank safety issues, such as potentially hazardous tank contents or off-normal operating temperatures, and it summarizes available surveillance data. Solid and liquid level data are used to determine tank integrity (leaks) and to provide clues to internal activity in the solid layers of the tank. Temperature data are used to evaluate the heat generating characteristics of the waste.

2.1 TANK STATUS

In early January 1996, tank 241-AP-104 contained a measured 3,160 kL (834 kgal) of waste classified as dilute noncomplexed (Hanlon 1996). Later that same month, additional waste was added bringing the total volume at the time of sampling on January 18 to 23, 1996 to 4,258 kL (1,128 kgal). This corresponds to a waste elevation of 10.39 m (34 ft) as indicated in the Surveillance Analysis Computer System database. The volume of liquids in the tank was determined using a combination of automatic and manual level gauge measurements. In May 1996, the waste was pumped to the 242-A Evaporator. The waste elevation as of July 15, 1996 is 24.64 cm (9.7 in.). For additional surface level information, see Section 2.4.1. Table 2-1 shows the amounts of the waste in the tank on January 1 and 14, 1996 and on May 5, 1996.

Tank 241-AP-104 is actively ventilated and sound; it is not on the Wyden Amendment Watch List (Public Law 101-510, Section 3137). All monitoring systems were in compliance with documented standards as of February 29, 1996 (Hanlon 1996).

2.2 TANK DESIGN AND BACKGROUND

The 241-AP Tank Farm was constructed from 1983 to 1986 in the 200 East Area of the Hanford Site. The farm contains eight double-shell tanks. The tanks have a capacity of 4,390 kL (1,160 kgal), a diameter of 23 m (75 ft), and an operating depth of 10.7 m (35.2 ft). Tank 241-AP-104 entered service in July 1986 but did not receive waste until October 1986. The tanks were designed to hold boiling waste with a maximum temperature of 149 °C (300 °F) (Brevick et al. 1995a).

Table 2-1. Calculated Tank Contents.[1]

Waste Form	Calculated Volume					
	kL			kgal		
	1/1/96[1,2]	1/14/96[2,3]	5/3/96[2,3]	1/1/96[1,2]	1/14/96[2,3]	5/3/96[2,3]
Total waste	3,160	4,258	101	834	1,125	27
Supernatant liquid	3,160	4.258	101	834	1,125	27
Sludge	0.00	0.00	0.00	0.00	0.00	0.00
Saltcake	0.00	0.00	0.00	0.00	0.00	0.00
Drainable interstitial liquid	0.00	0.00	0.00	0.00	0.00	0.00
Drainable liquid remaining	3,160	4,258	101	834	1,125	27
Pumpable liquid remaining	3,160	4.258	101	834	1,125	27

Notes:

[1]Dates are given in the mm/dd/yy format.

[2] Hanlon (1996)

[3]Surveillance Analysis Computer System data. Calculated by total gals = total in. * 2750 gals per in.

Tank 241-AP-104 was constructed with a primary carbon steel liner (heat-treated and stress-relieved), a secondary carbon steel liner (not heat-treated), and a reinforced concrete shell. The bottom of the primary liner is 1.3 cm (0.5 in.) thick, the lower portion of the sides is 1.9 cm (0.75 in.) thick, the upper portion of the sides is 1.3 cm (0.5 in.) thick, and the dome liner is 0.95 cm (0.375 in.) thick. The secondary liner is 0.95 cm (0.375 in.) thick. The concrete walls are 46 cm (1.5 ft) thick and the dome is 38 cm (1.25 ft) thick. The tank has a flat bottom. The bottoms of the primary and secondary liners are separated by an insulating concrete layer. There is a grid of drain slots in the insulating concrete layer and in the concrete foundation under the secondary steel liner. The function of the grid in the concrete between the primary and secondary liners is to allow air circulation for cooling and to drain any leaks from the primary tank to leak detectors in the annulus. The function of the grid in the foundation is to collect any waste that may leak from the tank and divert it to the leak detection well (Leach and Stahl 1993).

Tank 241-AP-104 has 29 risers, ranging in diameter from 10 cm (4 in.) to 1.1 m (3.5 ft), that provide access to the tank; and 42 risers that provide access to the annulus. Table 2-2 shows numbers, diameters, and descriptions of the risers. (Annular risers are not included.) Figure 2-1 shows the riser configuration. Fifteen 10-cm- (4-in.-) diameter risers (15, 21, 24, 28, and three no. 27s), seven 30-cm- (12-in-.) diameter risers (two no. 7s, two no. 10s, and three no. 16s), and add to 4 in. riser no. list (three 1s, 2, 14, 22, 25, 26)

Table 2-2. Tank 241-AP-104 Risers.[1,2] (2 sheets)

Riser No.[3]	Diameter (in.)	Description and Comments
1@30	4	Sludge measurement port
1@150	4	Sludge measurement port
1@270	4	Sludge measurement port
2	4	Liquid level, level indicating transmitter
3	12	Supernatant pump, central pump pit (pit)
4	12	Thermocouple tree
5@0	42	Manhole; riser plug
5@90	42	Manhole; riser plug
7@240	12	Spare; riser plug
7@285	12	Primary tank exhaust
10@210	12	Spare; riser plug
10@330	12	Tank pressure
11	42	Slurry distributor, central pump pit (pit)
12	12	Observation port, spare
13	12	Grout feed pump
14	4	Supernatant return
15	4	Spare; riser plug
16@30	12	Sludge measurement port
16@150	12	Sludge measurement port
16@270	12	Sludge measurement port
21	4	Spare; riser plug
22	4	Sludge measurement port
24	4	Spare; riser plug
25	4	High-liquid level sensor
26	4	Liquid level indicator
27@210	4	Spare; riser plug
27@270	4	Spare; riser plug
27@315	4	Spare; riser plug
28	4	Spare; riser plug

Notes:

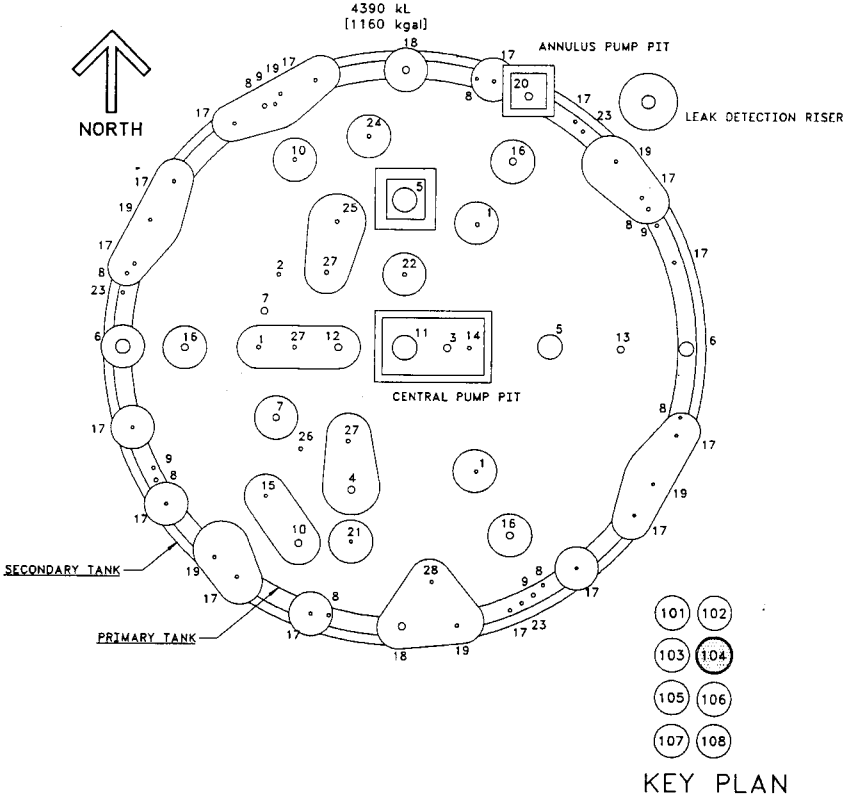
[1]Salazar (1994)

[2]Tank risers only, annulus risers excluded.

Other Sources: Hanford Drawings, H-2-90556, Rev. 4, H-2-90539, Rev. 1

[3]Indicates degrees clockwise from north for risers without identification numbers.

Figure 2-1. Riser Configuration.



two 107 cm (42 in.) diameter risers (two 5s) are available to reach the tank interior. Figure 2-2 shows a tank cross section with the approximate waste level as of February 29, 1996, and a schematic of the tank equipment.

2.3 PROCESS KNOWLEDGE

2.3.1 Waste Transfer History

After adding water to tank 241-AP-104 to test its integrity, dilute noncomplexed waste from the 100 N Area was received in the fourth quarter of 1986. Tank 241-AP-104 received additional dilute noncomplexed waste and dilute phosphate waste from 100 N Area during the first quarter of 1987. These waste additions continued until the tank was almost filled in the third quarter of 1987.

A waste transfer of 3,970 kL (1,049 kgal) to tank 241-AP-102 almost emptied tank 241-AP-104. Two unknown waste additions were made during the fourth quarter of 1989 and the first quarter of 1992. These transfers are summarized in Table 2-3. No additional waste additions or transfers occurred from that time until January 1, 1994. Transfers after this date are not included in the historical evaluation.

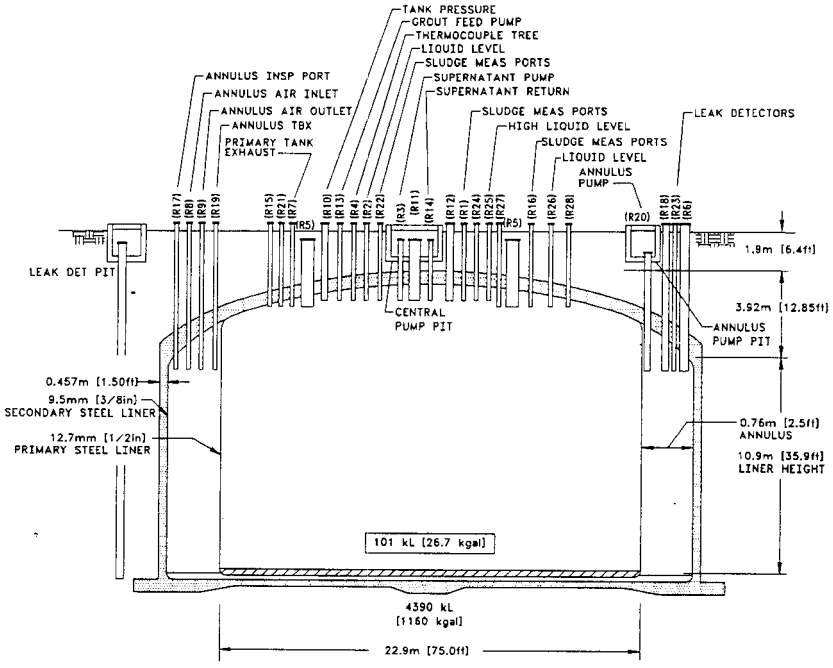
Table 2-3. Summary of Tank 241-AP-104 Waste Input History.[1]

Transfer Source	Waste Type Received	Time Period	Volume	
			kL	kgal
100 N Area	Supernatant, dilute noncomplexed waste from 100 N Area	1986 to 1987	553	146
100 N Area	Supernatant, dilute phosphate waste from 100 N Area	1987	3,005	794
Unknown waste addition	Unknown dilute noncomplexed waste	1989, 1992	15	4

Note:
[1]Agnew et al. (1996)

2.3.1.1 Waste Transfer History Following January 1, 1994. There have been several recent additions of waste and tank-to-tank transfers involving tank 241-AP-104 since the historical end date of January 1, 1994. These transfers are noted in Table 2-4 although the table data have not been validated.

Figure 2-2. Tank 241-AP-104 Cross Section.



In January 1994, tank 241-AP-104 was almost empty, but it was filled again to near capacity with 4,255 kL (1,124 kgal) of dilute noncomplexed waste starting in July 1995. The additional waste was received from tanks 241-SY-102, 241-AW-105, and 241-AY-102, and from B Plant dilute low-level waste.

Table 2-4 shows data obtained from an unvalidated database. The database was developed for waste volume projections. The columns are divided into the following categories: transfer type, source, destination, start date, end date, and volume.

"Unknown waste gains or losses may be the result of rounding calculations. Clean water slowly leaking through a valve, changes in levels (expansion/contraction) because of ambient temperature changes, different measuring devices being used by tank farm operators. Trnasfers taking place during the end of the month. Tank farm activities such as miscellaneous water additions not associated with facility waste generation, or the additonal water which is added to aging waste tanks and then evaporated off.".

Table 2-4. Summary of Tank 241-AP-104 Waste Transfer History after January 1, 1994.[1]

Type of Entry	From	To	Start Date	End Date	Estimated Volume	
					kL	kgal
GA	UNKN		9/1/94[2]	9/30/94	8	2
LO		UNKN	11/1/94	11/30/94	-8	-2
GA	Water		6/8/95	6/8/95	15	4
TR	102SY	104AP	7/28/95	7/31/95	1620	427
GA	Water		8/1/95	8/2/95	87	23
TR	102SY	104AP	8/2/95	8/2/95	11	3
GA	B860N		11/5/95	11/25/95	79	21
TR	105AW	104AP	11/13/95	11/15/95	1250	330
GA	Water		11/13/95	11/15/95	4	1
GA	B860N		12/20/95	12/20/95	26	7
GA	B860N		1/9/96	1/9/96	23	6
GA	Water		1/10/96	1/10/96	4	1
TR	102AY	104AP	1/10/96	1/10/96	1075	284
LO		UNKN	2/1/96	2/29/96	-4	-1

Notes:

TR = transfer
LO = loss of volume
Water addition to tank
GA = gain of volume
UNKN = unknown waste type
B860N = dilute, noncomplexed waste from B Plant cell drainage

[1]The data contained within this table have not been validated.

[2]Dates are given in the mm/dd/yy format.

2.3.2 Historical Estimation of Tank Contents

Current historical estimates are based on waste transfers prior to 1994. Because of the recent transfer history of tank 241-AP-104, the historical estimate does not represent tank contents. However, a summary of the historical estimate process of tank contents information as of 1994 is included to give a more complete picture of the tank's history.

Historical data used for the estimate are from the *Waste Status and Transaction Record Summary for the Southeast Quadrant* (Agnew et al. 1996), the *Hanford Defined Wastes: Chemical and Radionuclide Compositions* (Agnew 1995), the *Tank Layer Model (TLM)* (Agnew et al. 1995), the supernatant mixing model (Agnew 1995), and the *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 Areas* (Brevick et al. 1995a). The waste status and transaction record summary (WSTRS) is a compilation of available waste transfer and volume status data. The Hanford Defined Wastes (HDW) provides the assumed typical compositions for all known Hanford waste types stored in the double-shell and single-shell tanks. In some cases, the available data are incomplete, thereby reducing the usefulness of the transfer data and the derived modeling results. The TLM predicts the waste types and solid volumes in the tanks based on the WSTRS. The supernatant mixing model describes the supernatant portion of each double-shell tank as a combination of Hanford defined waste supernates concentrated by some factor. These model predictions should be considered estimates only. They require further evaluation using analytical data. For a discussion of the assumptions used by these models, refer to Brevick et al. (1995a).

Based on the HTCE and the TLM, tank 241-AP-104 contained 68 kL (18 kgal) of supernatant waste as of January 1, 1994. There was no historical data on the exact contents of the supernatant except for the hydroxide content. Hydroxide levels were determined to be less than 0.001 M with a pH range of 9.99 to 10.04. The supernatant layer was most probably dilute noncomplexed and phosphate wastes from the 100 N area and water.

From January 1, 1994 to the present, there were several transfers to the tank from other tanks, and it also received dilute, noncomplexed waste from B Plant. The largest waste additions were three transfers of waste from tanks 241-SY-102, 241-AW-105, and 241-AY-102. The records indicate the tank, which was filled to near capacity the first quarter of 1996, contained 4,258 kL (1,125 kgal) of dilute, noncomplexed waste. In May 1996, the waste was transferred and condensed in the 242-A Evaporator 96-1 Campaign, then sent to evaporator slurry holding tank 241-AW-106. As of May 11, 1996, the tank was almost empty with approximately 101 kL (26.7 kgal) of waste.

The chemical prediction of waste contents is not provided because it does not include transfers since 1994.

2.4 SURVEILLANCE DATA

Tank 241-AP-104 surveillance consists of surface level measurements (liquid and solid), temperature monitoring inside the tank (waste and vapor space), and leak detection well monitoring for radioactive liquids outside the primary tank. Liquid level measurements indicate major leaks into or out of the tank. Solid surface level measurements indicate the physical changes and consistency of the solid layers in the tank. Leak detection systems within the annulus of the tank detect leaks from the primary tank. These data provide the basis for determining tank integrity.

2.4.1 Surface Level Readings

The tank 241-AP-104 waste surface level is monitored with an automatic Food Instrument Corporation gauge and a manual tape. Because this is an active tank, the waste surface level is continually subject to change. The measured surface level at the time of sampling (January 18, 1996 through January 23, 1996) was 10.4 m (34 ft) and represents a volume of 4,258 kL (1,125 kgal). The tank volume listed by Hanlon (1996) is 3,160 kL (834 kgal), which corresponds to a waste level of 7.70 m (25.25 ft). The numbers do not agree because the data for surveillance and by Hanlon were taken at different times, and the tank level was changing (see Figure 2-3). For this reason, the data presented in Hanlon was not used for inventory estimates in this document. The tank was pumped starting approximately May 6, and as of May 11 the surface level was 24.6 cm (9.7 in.), which equals approximately 101 kL (26.7 kgal) of waste. Figure 2-4 shows a graphical representation of the complete history of volume measurements.

2.4.2 Internal Tank Temperatures

Temperature data for tank 241-AP-104 are recorded by 18 thermocouples on one thermocouple tree located in riser 4. Temperature data from the Computer Automated Surveillance System (SACS), recorded from April 1986 to March 1995, are available for the 18 thermocouples. Not all 18 thermocouples have data for this period. The mean temperature of the SACS data was 15.6 °C (60.1 °F), the minimum temperature was 7.7 °C (46 °F), and the maximum temperature was 21.2 °C (70.2 °F). The mean temperature of the computer system data for 1995 was 17.5 °C (63.5 °F), the minimum temperature was 12.2 °C (54 °F), and the maximum temperature was 21.2 °C (70.2 °F). The minimum temperature on April 1, 1996 was 13 °C (55.4 °F) on thermocouple 17, and the maximum was 15.5 °C (59.9 °F) on thermocouple 7. Figure 2-5 shows the weekly high temperature. Plots of individual thermocouple readings for tank 241-AP-104 are in the supporting documents for the HTCE (Brevick et al. 1995b).

2.4.3 Tank 241-AP-104 Photographs

No interior photographs are available.

Figure 2-3. Comparing Surface Level Measurements by Hanlon and by Sample for Tank 241-AP-104.

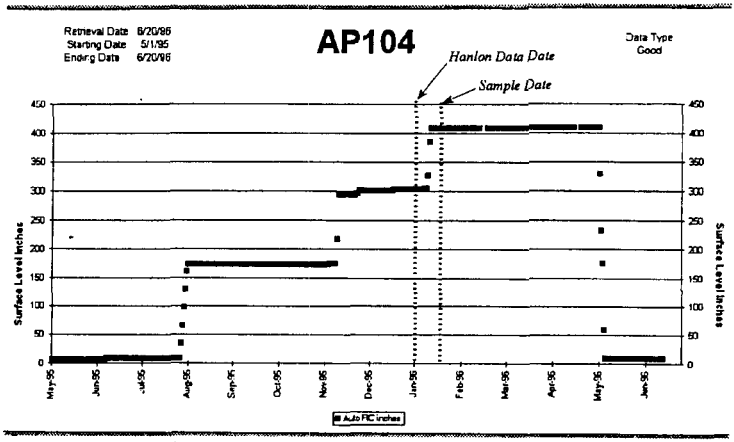


Figure 2-4. Tank 241-AP-104 Level History.

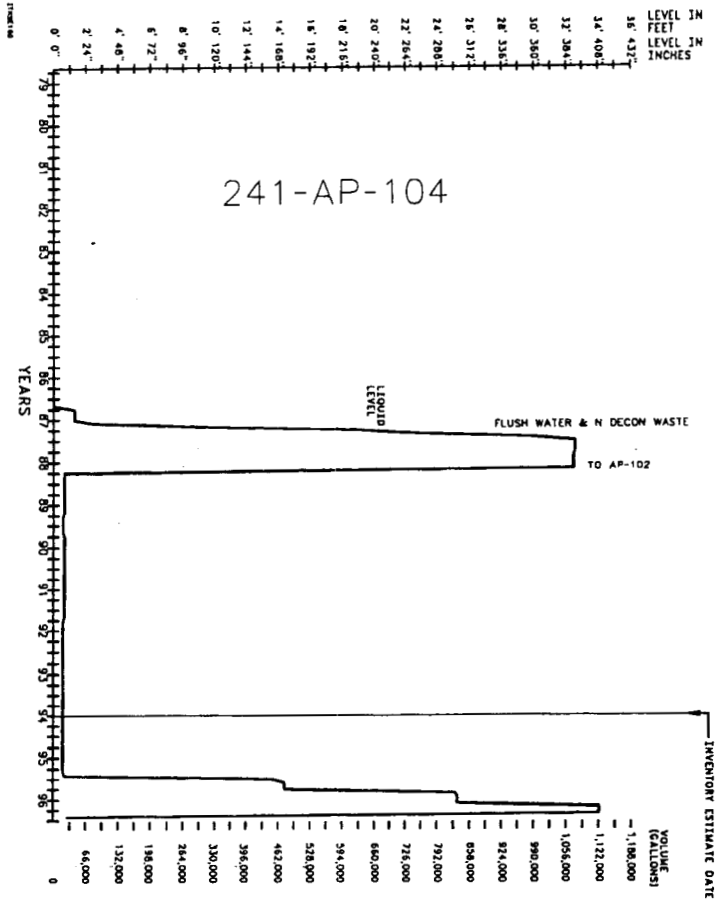
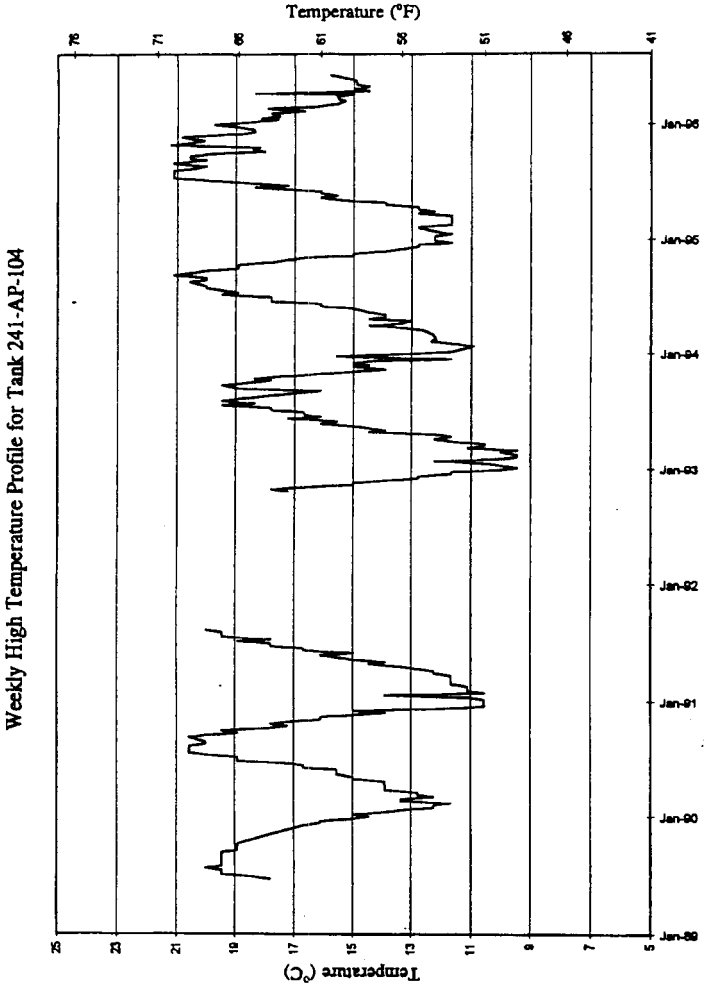


Figure 2-5. Tank 241-AP-104 Weekly Temperature Plot.



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3.0 TANK SAMPLING OVERVIEW

This section describes the January 1996 sampling and analysis events for tank 241-AP-104. Grab samples were taken to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995), and the *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives* (Von Bargen 1995). The sampling and analysis were performed in accordance with the *Tank 241-AP-104 Grab Sampling and Analysis Plan* (Conner 1996). For further discussions of the sampling and analysis procedures, refer to the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

3.1 DESCRIPTION OF SAMPLING EVENT

Thirteen grab samples were taken through riser (1 @ 30°) and riser (1 @ 270°) of tank 241-AP-104 using the bottle-on-a-string method. One grab sample was taken from the waste surface (an elevation of approximately 10 m (33 ft) as measured from the tank bottom to the mouth of the sample bottle), and four samples were taken from each of the three subsurface sampling locations 2.4, 4.9 and 7.6 m (8, 16 and 25 ft from the tank bottom). The surface sample was used for total organic carbon (TOC) and safety screening analyses. The four subsurface samples at each elevation were taken for the following purposes:

- boildown and mixing study analyses
- semivolatiles organics analysis [SVOA]
- volatile organic analysis [VOA]
- safety screening, inorganic and radionuclide analyses.

In addition to the 13 samples, four field blanks and two trip blanks were taken.

Prior to the grab sampling event, the tank headspace vapors were sampled through riser (1@30°) and riser (1@270°) and analyzed for the presence of flammable gases as prescribed by the safety screening DQO. The results of these tests are shown in Table 4-3.

The safety screening DQO notification limit for flammable gas concentration is 25 percent of the lower flammability limit (LFL) (Dukelow et al. 1995). The combustible gas meter used to sample the tank headspace reports results as a percent of the lower explosive limit (LEL). Because the National Fire Protection Association defines the terms LFL and LEL identically, the two terms may be used interchangeably (NFPA 1995).

Volatile organic analyses were performed by the Pacific Northwest National Laboratory Analytical Chemistry Laboratory, and all other analyses were performed at the Westinghouse Hanford Company 222-S Laboratory in accordance with the referenced SAP (Conner 1996). Table 3-1 summarizes the sampling mode, applicable DQOs, and sampling and analytical requirements for the sampling event.

3.2 SAMPLE HANDLING

Samples for VOA analyses were shipped to the Analytical Chemistry Laboratory. All other samples were shipped to the 222-S Laboratory.

Three of the 13 samples, 4AP-2A, -2B, and -2D, were taken on January 18, 1996. The remaining 10 samples were taken on January 23, 1996. All 13 samples were received at the appropriate laboratory the day after they were obtained. Four field blanks were taken on January 18, 1996. Sample 104-AP-IB1 was received at the laboratory the following day, and the other three field blanks were received on January 22, 1996. Two trip blanks were taken on January 23, 1996 and received on January 25.

All samples appeared homogeneous except for a small solid chunk of material in sample 4AP-96-2C. No solids, turbidity, or organic layer were observed. The samples were collected in amber glass bottles, precluding the observation of color. Table 3-2 summarizes additional information on the grab samples.

3.3 SAMPLE ANALYSIS

Table 3-3 describes how the grab samples were analyzed. It includes for each sample, sample and laboratory identification numbers, the analyte used, and the preparation method. Table 3-4 describes the analytical procedures. It identifies the analysis that was performed, the instrument used, the preparation procedure, and the procedure number.analyses were performed in accordance with approved laboratory procedures. No deviations or modifications were noted by the laboratory.

Table 3-1. Data Quality Objective Requirements for Tank 241-AP-104.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
January 1996 grab sampling	Safety screening	Vertical profiles from two widely spaced risers	▸ Energetics ▸ Moisture content ▸ Total alpha activity ▸ Visual check for organic layer ▸ Headspace gas flammability
	Waste compatibility	Grab samples from different depths	▸ Energetics ▸ Moisture content ▸ Visual check for organic layer ▸ Metals by ICP ▸ Anions by IC ▸ Radionuclides ▸ TIC, TOC ▸ Hydroxide ▸ Specific gravity ▸ pH ▸ Percent solids
	Evaporator	Grab samples from different depths	▸ Energetics ▸ Moisture content ▸ Total alpha and beta activities ▸ Visual check for organic layer ▸ Metals by ICP ▸ Anions by IC ▸ Radionuclides ▸ TC, TIC, TOC ▸ Hydroxide ▸ Specific gravity ▸ pH ▸ Ammonia ▸ Uranium ▸ Organics (SVOA), (VOA)

Notes:

IC = Ion chromatography
ICP = Inductively coupled plasma spectrometry
TC = total carbon
TIC = total inorganic carbon

[1]Conner (1996)

Table 3-2. Tank 241-AP-104 Grab Sample Information.[1] (2 sheets)

Riser	Sample Number	Laboratory ID	Sample Elevation (ft)[2]	Sample Type	Dose Rate (mR/hr)
1 @ 30°	4AP-96-1A	PNNL 96-3095	8	Subsurface supernate	35
	4AP-96-1B	S96V000017	8	Subsurface supernate	35
	4AP-96-1C	S96V000006 S96V000009	8	Subsurface supernate	50
	4AP-96-1D	S96V000021	8	Subsurface supernate	45
	4AP-96-2A	PNNL 96-3096	25	Subsurface supernate	15
	4AP-96-2B	S96V000018	25	Subsurface supernate	15
	4AP-96-2C	S96V000007 S96V000010	25	Subsurface supernate	15
	4AP-96-2D	S96V000022	25	Subsurface supernate	15

Table 3-2. Tank 241-AP-104 Grab Sample Information.[1] (2 sheets)

Riser	Sample Number	Laboratory ID	Sample Elevation (ft)[2]	Sample Type	Dose Rate (mR/hr)
1 @ 270°	4AP-96-3A	PNNL 96-3097	16	Subsurface supernate	26
	4AP-96-3B	S96V000019	16	Subsurface supernate	22
	4AP-96-3C	S96V000008 S96V000011 S96V000026	16	Subsurface supernate	26
	4AP-96-3D	S96V000023	16	Subsurface supernate	32
	4AP-96-4	S96V000012 S96V000013	approx. 33	Surface supernate	22
1 @ 30°	4AP-96-IB1	S96V000014 S96V000015	53	Field blank	< 0.5
	4AP-96-IB2	S96V000016	53	Field blank	< 0.5
	4AP-96-OB1	PNNL 96-3093	53	Field blank	< 0.5
	4AP-96-OB2	S96V000020	53	Field blank	< 0.5
N/A	4AP-96-TB1	PNNL 96-3094	N/A	Trip blank	< 0.5
N/A	4AP-96-TB2	S96V000025	N/A	Trip blank	< 0.5

Notes:

[1]Miller (1996)

[2]Sample elevation is defined as the distance from the tank bottom to the mouth of the sample bottle.

Table 3-3. Tank 241-AP-104 Sample Analyses.[1] (2 sheets)

Sample Number	Laboratory ID	Analyte	Preparation Method
4AP-96-1A	PNNL 96-3095	Volatile organic analysis[2]	Direct
4AP-96-1B	S96V000017	Semivolatile organic analysis[3]	Direct
4AP-96-1C	S96V000006 S96V000009	Inorganic[4] and radionuclides[5]	Direct Acid digest
4AP-96-1D	S96V000021	Mixing and boildown[6]	Direct
4AP-96-2A	PNNL 96-3096	Volatile organics	Direct
4AP-96-2B	S96V000018	Semivolatile organics	Direct
4AP-96-2C	S96V000007 S96V000010	Inorganic and radionuclides	Direct Acid digest
4AP-96-2D	S96V000022	Mixing and boildown	Direct
4AP-96-3A	PNNL 96-3097	Volatile organics	Direct
4AP-96-3B	S96V000019	Semivolatile organics	Direct
4AP-96-3C	S96V000008 S96V000011 S96V000026	Inorganic and radionuclides	Direct Acid digest
4AP-96-3D	S96V000023	Mixing and boildown	Direct
4AP-96-4	S96V000012 S96V000013	TOC and safety screen	Direct Acid digest
4AP-96-IB1	S96V000014 S96V000015	Inorganic and radionuclides	Direct Acid digest
4AP-96-IB2	S96V000016	Inorganic and radionuclides	Direct
4AP-96-OB1	PNNL 96-3093	Volatile organics	Direct
4AP-96-OB2	S96V000020	Semivolatile organics	Direct
4AP-96-TB1	PNNL 96-3094	Volatile organics	Direct
4AP-96-TB2	S96V000025	Semivolatile organics	Direct
Tank headspace vapors	N/A	Flammable gas concentration, oxygen, ammonia, and total organic carbon vapor	N/A

Table 3-3. Tank 241-AP-104 Sample Analyses.[1] (2 sheets)

Notes:

[1]Miller (1996)

[2]Volatile organic analyses were required by the SAP for acetone, 1-butanol, 2-butanone, 2-hexanone, methyl isobutyl ketone, 2-pentanone, and tetrahydrofuran. Concentrations of these and other volatile organic compounds are reported in Appendix A.

[3]Semivolatile organic analyses were required by the SAP for 2-butoxyethanol and tri-n-butylphosphate. Concentrations of these and other semivolatile organic compounds are reported in Appendix A.

[4]Inorganic analyses include those which are not included in other groups such as organic compounds, radionuclides, physical properties, and total carbon.

[5]Radionuclides are those analytes which are measured in terms of their radioactivity, expressed in μCi/mL.

[6]The mixing and boildown tests were performed to predict waste properties during and after concentration by evaporation.

Table 3-4. Analytical Procedures.[1] (3 sheets)

Analysis	Instrument	Preparation Procedure	Analytical Procedure
Energetics by DSC	Mettler[2]	n/a	LA-514-113, Rev. C-1
Percent water by TGA	Mettler™	n/a	LA-560-112, Rev. B-1
pH	Electrode	n/a	LA-212-106, Rev. A-0
Organic layer	Visual and over-the-top reading	n/a	LA-519-151, Rev. E-2
Mixing and compatibility study	Thermometric/ gravimetric	n/a	LT-519-151
Specific gravity	Gravimetric	n/a	LA-510-112, Rev. C-3
Hydroxide	Metrohm 682 Titroprocessor	n/a	LA-211-102, Rev. C-0
Total carbon	Furnace/coulometer	n/a	LA-344-105, Rev. C-0
Total inorganic carbon	Coulometric autotitration	n/a	LA-622-102, Rev. C-0

Table 3-4. Analytical Procedures.[1] (3 sheets)

Analysis	Instrument	Preparation Procedure	Analytical Procedure
Total organic carbon	Combustion/ coulometry	n/a	LA-344-105, Rev. C-0
Volatile organic compounds	Gas chromatograph mass spectrometer	n/a	PNL-ALO-335
Semivolatile organic compounds	Gas chromatograph mass spectrometer	n/a	LA-523-406, Rev. A-0
Ammonia	Selective ion electrode	n/a	LA-631-001, Rev. B-2
Total alpha activity	Alpha proportional counter	LA-549-141, Rev. D-0	LA-508-101, Rev. D-2
Total beta activity	Beta proportional counter	LA-505-158, Rev. B-0	LA-508-101, Rev. D-2
Radionuclides by GEA	Gamma detector spectrometer	LA-549-141, Rev. D-0	LA-508-162, Rev. B-0
^{99}Tc	Solvent extraction/liquid scintillation	LA-505-158, Rev. B-0	LA-438-101, Rev. D-2
$^{239/240}Pu$	Ion exchange/solvent extraction/alpha energy analysis	LA-505-158, Rev. B-0	LA-943-128, Rev. A-0
^{129}I	Extraction/filtration/gamma energy analysis	LA-519-151, Rev. E-2	LA-378-103, Rev. C-0
^{237}Np	Extraction/alpha count	LA-505-158, Rev. B-0	LA-933-141, Rev.H-1
^{238}Pu	Ion exchange/solvent extraction/alpha energy analysis	LA-505-158, Rev. B-0	LA-943-128, Rev. A-0
^{241}Am ^{244}Cm	Ion exchange/solvent extraction/alpha energy analysis	LA-505-158, Rev. B-0	LA-953-103, Rev. A-4
^{3}H	Micro distillation/ liquid scintillation	n/a	LA-218-114, Rev. A-4

Table 3-4. Analytical Procedures.[1] (3 sheets)

Analysis	Instrument	Preparation Procedure	Analytical Procedure
^{14}C	Persulfate oxidation/liquid scintillation	n/a	LA-348-104, Rev. B-1
^{79}Se	Anion-cation exchange/ distillation/liquid scintillation	LA-505-149, Rev. B-0	LA-365-132, Rev. B-2
^{90}Sr	Separation and beta counting	LA-505-149, Rev. B-0	LA-220-101, Rev. D-1
Metals by ICP	Inductively coupled plasma spectrometer	LA-505-158, Rev. B-0	LA-505-161, Rev. B-0
Total uranium	Laser phosphorimeter	n/a	LA-925-009, Rev. A-1
Anions by IC	Ion chromatograph	LA-504-101, Rev. D-0	LA-533-105, Rev. D-1
Flammable gas/ oxygen	Combustible gas meter	n/a	WHC-IP-0030, IH 1.4 and IH 2.1

Notes:

Rev. = revision n/a = not applicable
Mettler™ is a registered trademark of Mettler Electronics, Anaheim, California.

[1]Miller (1996)

3.4 HISTORICAL SAMPLING EVENTS

Tank 241-AP-104 was sampled in April, July, and December, 1987 (Hanson 1987a, Hanson 1987b, Winters 1988). No details concerning the techniques used to extract the sample, the sample depth, or the riser used to obtain the sample on April or July were available. The April 22, 1987 was a very pale yellow liquid with no solids and no organic materials. The July 9, 1987 sample was noted as a yellow-brown aqueous phase with less than one percent solids. Twelve samples were taken on December 3, 1987 from different depths and risers. The samples were mostly clear, yellow liquid samples with a few dark specks.

Results from all three sampling events are tabulated in Appendix B. However, because the tank is active and its waste is continually changing, the results from the historical sampling events no longer represent the current tank contents.

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4.0 ANALYTICAL RESULTS

Section 4.0 summarizes the analytical results associated with the January 1996 sampling of tank 241-AP-104. The sampling and analysis parameters governing this event were integrated by and described in the SAP (Conner 1996). Analysis of the grab samples was performed at the 222-S Laboratory and the Analytical Chemistry Laboratory.

Table 4-1 shows the data locations for this characterization report. The complete analytical data set is in Appendix A. Section 4.0 reports only analyte overall means.

Table 4-1. Analytical Data Presentation Tables.

Data Type	Location
Chemical data summary	Table 4-2
Headspace flammability screening results	Table 4-3
Comprehensive analytical data	Appendix A

4.1 DATA PRESENTATION

This section summarizes the analytical results from the January 1996 tank 241-AP-104 sampling event. The data were originally reported in *Final Characterization and Safety Screen Report of Double-Shell Tank 241-AP-104 for 242-A Evaporator, Campaign 96-1* (Miller 1996). Section 4.1.1 summarizes the chemical data, Section 4.1.2 summarizes the physical data, and Section 4.1.3 provides the headspace flammability results.

4.1.1 Chemical Data Summary

Data from the grab samples were combined to derive an overall mean for all analytes, except for DSC, which does not require calculation of a mean. All analyte means reported are weighted based on sample location. The overall mean was calculated by averaging the primary and duplicate results for each sample. For those analytes where more than one sample was analyzed from a given sample location (depth and riser), the sample means from that depth and riser were averaged to derive a depth mean. The depth means were averaged to derive a riser mean. Finally, the two riser means were averaged to derive the overall tank mean. When 50 percent or more of the primary and duplicate measurements had detected results, the overall mean was reported as a detected value. Conversely, when more than 50 percent of the individual primary and duplicate measurements had nondetected results, the overall mean was reported as a nondetected value.

The information in Table 4-2 is derived from the Appendix A tables. Table 4-2 summarizes the chemical data except for DSC and any organic compound which was not required by the SAP and was not detected. The first two columns of Table 4-2 lists each analyte and its overall mean. The third column displays the relative standard deviation (RSD) of the mean, defined as the standard deviation (of the mean) divided by the mean, multiplied by 100. The RSDs were estimated using standard analysis of variance techniques. They were computed for analytes having at most 50 percent of the results above the detection limit. For these analytes, the detection limit was used in the computations. This means that for these analytes, the reported mean concentrations and standard deviations of the mean are biased. The magnitude of the bias cannot be estimated. The last column lists projected inventories which were calculated based on a waste volume of 4,258 kL (1,125 kgal), the volume of tank at the time it was sampled.

4.1.2 Physical Data Summary

Thermal analyses and density were performed on tank 241-AP-104 grab samples to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995), the waste compatibility DQO (Fowler 1995), and the evaporator DQO (Von Bargen 1995). The waste compatibility and evaporator DQOs also required a pH measurement.

4.1.2.1 Thermogravimetric Analysis. During a TGA, the mass of a sample is measured while its temperature is increased at a constant rate. Nitrogen is passed over the sample during the heating to remove any released gases. Any decrease in the weight of a sample 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 °C) is caused by water evaporation.

Table A-43 shows the TGA results for tank 241-AP-104. All samples exhibited a large weight loss between the ambient temperature and 100 °C. This was the only transition in all the runs. This weight loss is attributed to the evaporation of water. The overall mean percent water for the tank is 96.6 weight percent.

4.1.2.2 Differential Scanning Calorimetry. During a DSC, heat absorbed or emitted by a substance is measured while the substance is exposed to a linear increase in temperature. While the substance is being heated, nitrogen is passed over the waste material to remove any gases being released. The onset temperature for an endothermic (characterized by or causing the absorption of heat) or an exothermic (characterized by or causing the release of heat) event is determined graphically.

Table 4-2. Chemical Data Summary for Tank 241-AP-104.[1] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
METALS	**µg/mL**	**%**	**kg**
Aluminum	198	82.4	843
Chromium	34.5	52.9	147
Iron	< 1.58	n/a	< 6.73
Manganese	< 0.317	n/a	< 1.35
Nickel	< 0.697	n/a	< 2.97
Silicon	26.1	42.9	111
Sodium	9810	55.2	41,767
Uranium	15.8	56.2	67.3
ANIONS/CATIONS	**µg/mL**	**%**	**kg**
Ammonia	71.6	85.9	305
Fluoride	494	59.6	2,103
Hydroxide	2620	58.3	11,155
Nitrate	14800	63.9	63,013
Nitrite	1820	35.6	7,749
Phosphate	750	42.4	3,193
Sulfate	762	38.1	3,244
RADIONUCLIDES	**µCi/mL**	**%**	**Ci**
^{241}Am	< 1.47E-04	n/a	< 0.626
^{14}C	0.0000619	64.5	0.264
^{144}Ce/Pr	< 0.0258	n/a	< 109.8
^{134}Cs	0.00433	50.5	18.4
^{137}Cs	4.4	17.5	18,734
^{60}Co	< 4.45E-04	n/a	< 1.89
$^{243/244}$Cm	< 1.47E-04	n/a	< 0.626
^{154}Eu	< 0.00115	n/a	< 4.90
^{155}Eu	< 0.00691	n/a	< 29.42
^{129}I	< 5.19E-06	n/a	< 0.0217
^{237}Np	< 2.14E-04	n/a	< 0.911
^{94}Nb	< 5.64E-04	n/a	< 2.40
^{238}Pu	1 3.53E-05	n/a	< 0.150

Table 4-2. Chemical Data Summary for Tank 241-AP-104.[1] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
RADIONUCLIDES (Cont'd)	**μCi/mL**	**%**	**Ci**
$^{239/240}Pu$	< 3.45E-05	n/a	< 0.147
^{226}Ra	< 0.0535	n/a	< 228
$^{106}Ru/Rh$	< 0.0389	n/a	< 166
^{79}Se	< 3.50E-07	n/a	< 0.00128
$^{89/90}Sr$	0.0663	37.9	282
^{99}Tc	0.00289	62.3	12.30
^{3}H	0.00403	84.9	17.16
Total alpha	0.000328	15.2	1.40
Total beta	4.48	15.6	19,074
CARBON	**μg/mL**	**%**	**kg**
Total carbon	944	26.8	4019
Total inorganic carbon	740	38.7	3151
Total organic carbon	154	26	656
ORGANICS	**μg/mL**	**%**	**kg**
Acetone	1.18	27	5.02
1-Butanol	< 29.0	n/a	< 123.5
2-Butanone	< 0.500	n/a	< 2.13
2-Butoxyethanol	0.795	38.6	3.38
2-Hexanone	< 0.500	n/a	< 2.13
4-Methyl-2-pentanone	< 0.500	n/a	< 2.13
2-Pentanone	< 0.500	n/a	< 2.13
Tetrahydrofuran	< 0.500	n/a	< 2.13
Tri-n-butyl phosphate	4.69	87.8	19.97
PHYSICAL PROPERTIES			
pH	12.7	2.72	n/a
Water	96.6 wt%	2.1	4.20 E+06
Specific gravity	1.02	n/a	n/a

Note:

n/a = not applicable

[1]Miller (1996)

Table A-44 shows the DSC results. All reactions were endothermic; therefore, no sample exceeded the safety screening DQO action limit of -480 J/g. Only one transition was observed. The transition represents the endothermic reaction associated with the evaporation of free and interstitial water. Table A-44 also shows the peak temperature for the endothermic reaction and the magnitude of the enthalpy change. The results are on a wet weight basis. Because there were no exothermic reactions, the calculation of a 95 percent confidence interval as required by the safety screening DQO (Dukelow et al. 1995) was not necessary.

4.1.2.3 Specific Gravity. Specific gravity measurements were performed on the samples in duplicate (see Table A-45). The overall tank specific gravity was 1.02.

4.1.2.4 pH Measurements. Measurements for pH were performed on the samples in duplicate (see Table A-42). The overall tank pH was 12.7.

4.1.3 Headspace Flammability Screening Results

As requested in the SAP (Conner 1996), the tank 241-AP-104 headspace was sampled and analyzed for the presence of flammable gases prior to grab sampling. The safety screening DQO notification limit for flammable gas concentration is 25 percent of the LFL (Dukelow et al. 1995). The combustible gas meter used to sample the tank headspace reports results as a percent of the LEL. Because the National Fire Protection Association defines the terms LFL and LEL identically, the two terms may be used interchangeably (NFPA 1995). The reported LEL of 0 percent was well below the safety screening DQO limit of 25 percent of the LFL. In addition, the concentration of oxygen gas, ammonia gas, and total organic carbon vapor were determined. Table 4-3 shows the results of the combustible gas monitoring.

Table 4-3. Headspace Flammability Screening for Tank 241-AP-104.[1]

Vapor Characteristic Measured	Results			
	Riser 1@30° 3 ft. depth	Riser 1@30° 20 ft. depth	Riser 1@270° 3 ft. depth	Riser 1@270° 20 ft. depth
Flammability vapor concentration as percent of the LFL	0%	0%	0%	0%
Volume percent oxygen gas	20.9%	20.9%	20.9%	20.8%
Concentration of ammonia gas	0 ppm	< 5 ppm	0 ppm	0 ppm
Concentration of total organic carbon vapor	0 ppm	0 ppm	0 ppm	0 ppm

Note:
[1]Miller (1996)

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5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

The section discusses the overall quality and consistency of the current sampling results for tank 241-AP-104, and it assesses and compares these results against historical information and program requirements.

5.1 ASSESSMENT OF SAMPLING AND ANALYTICAL RESULTS

This section evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess the overall data quality and consistency and to identify any data limitations.

5.1.1 Field Observations

The safety screening DQO (Dukelow et al. 1995) requirement to sample at least two widely-spaced risers was fulfilled. The waste compatibility DQO (Fowler 1995) and the evaporator DQO (Von Bargen 1995) requirements to take grab samples from different depths were met. A horizontal and vertical comparison of the analytical results therefore was possible and provided an estimate of the distribution of waste constituents. The laboratory analyses were performed promptly. No sampling anomalies were noted.

5.1.2 Quality Control Assessment

The usual quality control assessment includes an evaluation of the appropriate standard recoveries, matrix spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent quality control tests were conducted on the 1996 grab samples, allowing a full assessment regarding the accuracy and precision of the data. The specific criteria for all quality control checks were given in the SAP (Conner 1996). Quality control results outside these criteria are identified by superscripts in Appendix A tables.

The standard and matrix spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion, then the analytical results may be biased high or low, respectively. All standard recoveries were within the defined criteria except for ^{237}Np. Although it was within the internal control limits of the laboratory, the standard recovery for this analyte was 69.4 percent, slightly below the SAP criteria of 70 to 130 percent recovery. Also, the matrix spikes were above the 110 percent upper limit criteria for acetone and 1-butanol, which had recoveries of 124 and 140 percent, respectively. Finally, the analytical precision was within the limits for all analytes, and blank contamination was not noted in any sample (Miller 1996).

In summary, practically all quality control results were within the boundaries specified in the SAP. The few discrepancies noted above should not impact either the validity or the use of the data.

5.1.3 Data Consistency Checks

Comparing different analytical methods can help in assessing data consistency and quality. The quantity of data made it possible to calculate mass and charge balances. Comparing the activities of individual alpha emitters with the total alpha activity was not feasible because all measured alpha emitters exhibited activities less than the detection limit. Comparing the activities of the beta emitters with the total beta activity was possible.

5.1.3.1 Comparison of Results from Different Analytical Methods The following data consistency check compares the results of two analytical methods. A comparison was made between the activities of $^{89/90}Sr$ and ^{137}Cs with the total beta measurement. The sum of the beta emitters was as follows:

$$\text{Sum of beta emitters} = (2 * {}^{89/90}Sr + {}^{137}Cs)$$

Because $^{89/90}Sr$ is in equilibrium with its daughter product ^{90}Y, the $^{89/90}Sr$ activity must be multiplied by 2 to account for all beta emitters (see Table 5-1). The activities from the two methods agree closely.

Table 5-1. Comparison of Total Beta Activity with the Sum of $^{89/90}Sr$ and ^{137}Cs Activities.

Analyte	Overall Mean (µCi/g)	Beta Activities (µCi/g)
$^{89/90}Sr$	0.0663	0.133
^{137}Cs	4.4	4.4
Sum of beta emitters		4.53
Total beta activity		4.48
Relative percent difference		1.11%

5.1.3.2 Mass and Charge Balances. Mass and charge balances were performed to determine whether the measurements were consistent. In calculating the balances, only metals and anions listed in Table 4-2, which were detected at a concentration of 1,000 µg/g or greater, were considered. All analytical results in this section were converted from µg/g (using the specific gravity mean of 1.02) before being used in the following tables.

Sodium was the only cation present in quantities greater than 1,000 μg/g (see Table 5-2). The anions listed in Table 5-3 were assumed present as sodium salts and were expected to balance the positive charge exhibited by sodium. The concentrations of sodium in Table 5-2, the anionic species in Table 5-3, and the percent water were used to calculate the mass balance. The uncertainty estimates (RSDs) associated with each analyte are also given in the tables. The uncertainty estimates for the cation and anion totals and the overall uncertainty Table 5-4 were computed by a statistical technique known as the propagation of errors (Nuclear Regulatory Commission 1988).

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

$$\begin{aligned}\text{Mass balance} &= \text{percent Water} + 0.0001 \times \{\text{Total Analyte Concentration}\} \\ &= \text{percent Water} + 0.0001 \times \{Na^+ + NO_3^- + NO_2^- + OH^-\}\end{aligned}$$

The total of the analyte concentrations calculated from the above equation is 28,500 μg/g. The mean weight percent water obtained from thermogravimetric analysis reported in Table 4-2 is 96.6 percent, or 966,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 995,000 μg/g or 99.5 percent (see Table 5-4).

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of these two values. To derive the results shown in the equations, all concentrations must be converted to a μg/g basis.

<u>Total cations</u> (μeq/g) = $[Na^+]/23.0 = 418$ μeq/g

<u>Total anions</u> (μeq/g) = $[NO_3^-]/62.0 + [NO_2^-]/46.0 + [OH^-]/17.0 = 424$ μeq/g

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge is 0.99.

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

Table 5-2. Cation Mass and Charge Data.

Analyte	Concentration µg/g	Assumed Species	Concentration of Assumed Species µg/g	RSD (Mean) %	Charge µeq/g
Sodium	9,620	Na^+	9,620	55.2	418
Total			9,620	55.2	418

Table 5-3. Anion Mass and Charge Data.

Analyte	Concentration µg/g	Assumed Species	Concentration of Assumed Species µg/g	RSD (Mean) %	Charge µeq/g
Hydroxide	2,570	OH^-	2,570	58.3	151
Nitrate	14,500	NO_3^-	14,500	63.9	234
Nitrite	1,780	NO_2^-	1,780	35.6	39
Total			18,900	49.8	424

Table 5-4. Mass Balance Totals.

Total	Concentration µg/g	RSD (Mean) %
Cations from Table 5-2	9,620	55.2
Anions from Table 5-3	18,900	49.8
Water	966,000	2.1
Grand total	995,000	2.3

5.2 COMPARISON OF HISTORICAL WITH ANALYTICAL RESULTS

No comparison was performed between the historical analytical results and the 1996 sampling event. Because tank 241-AP-104 is active and receives and transfers waste, the historical tank contents information is based on transfers prior to 1996 and does not represent the current tank contents.

5.3 TANK WASTE PROFILE

According to the Surveillance Analysis Computer System database, the tank contained 4,258 kL (1,125 kgal) of supernatant at the time of the January 1996 grab sampling events. The visual descriptions of all samples were the same (uniform with no solids, turbidity, or organic layer observed) except for a small "chunk" of material in sample 4AP-96-2C. Based on this evidence, the tank samples were expected to be similar.

Laboratory analysis, however, showed that many constituents were more concentrated in sample from the bottom half of the tank than in samples from the top half. Examples include the data for nitrate and sodium (see Figure 5-1). Depending on the sample location, both analytes had concentrations that varied by more than a factor of three (for example, nitrate results of 2,900 μg/ml and 19,600 μg/ml).

Waste samples were taken from different depths and two risers. Consequently, ANOVA models with riser and depth terms were fit to the analytical data. The results from these models can be used to test whether mean analyte concentrations vary significantly in the horizontal and vertical directions.

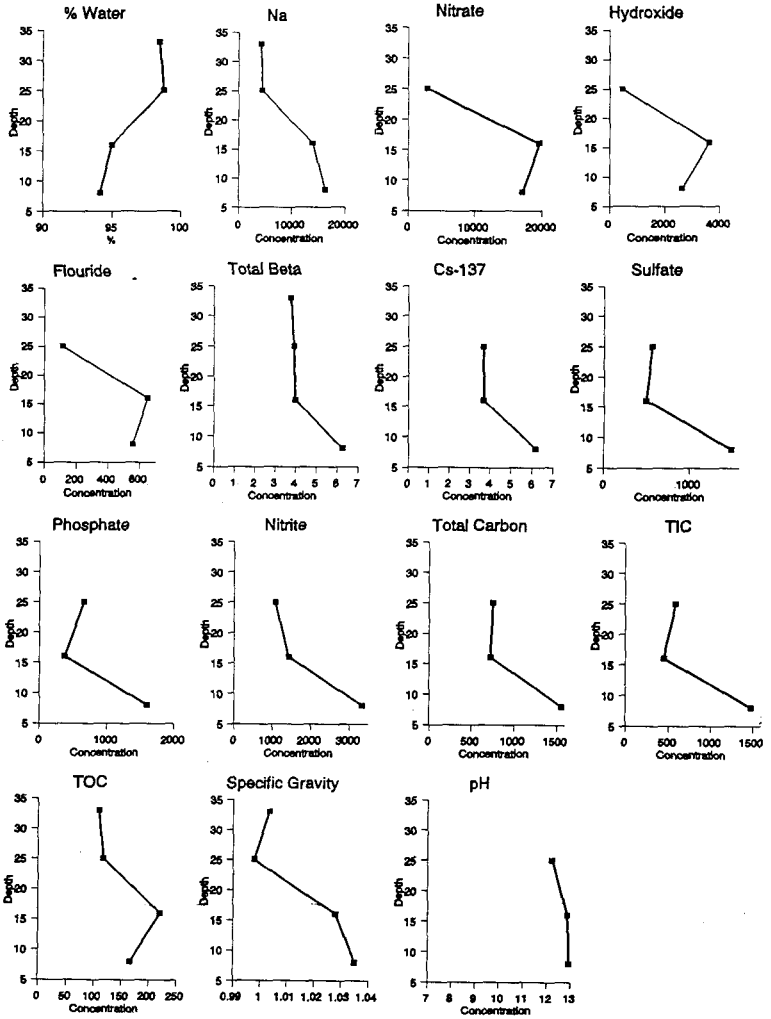
Where analytical data was taken from samples from each riser, a two-way classification (riser and depth) model was used. Where analytical data were available from samples from one riser, a one-way classification (depth) model was used. The models were fit to the analytical data provided that 50 percent or more of the measurements were above the detection limit. For those samples with some measurements below the detection limit, the detection limit was used in the computations. This means that the reported summary statistics are biased. The magnitude of the bias cannot be estimated.

The results from the ANOVA models showed significant differences (at the 0.05 level of significance) in mean concentration between risers (horizontal variability) for only two of 30 analytes (1-butanol and ammonia). Both analytes had small concentrations (less than 200 μg/ml).

There were significant differences in mean concentrations between depths for 13 of 24 analytes (fluoride, hydroxide, nitrate, nitrite, phosphate, sulfate, ^{14}C, ^{134}Cs, ^{137}Cs ^{99}Tc, tritium, total carbon, and pH). Some analytes had large concentrations (more than 1,000 μg/ml); therefore the vertical changes in the waste were more significant than the differences between risers.

Figure 5-1 shows the magnitude of vertical changes. The graphs show analytes with major concentrations plotted with respect to sample depth. Only analytes with tank inventories greater than 1,000 kg or 1,000 Ci are plotted. In almost all cases, analyte concentration increases with depth. Since no samples were taken in the bottom 2.4 m (3 ft), however, it is difficult to predict analyte concentrations in this region. Based on this observation, it is recommended that future grab sampling events include samples taken near the tank bottom.

Figure 5-1. Vertical Profile of Analytes with Tank Inventory of Greater than 1,000 kg or 1,000 Ci.



5.4 COMPARISON OF TRANSFER HISTORY WITH ANALYTICAL RESULTS

The HTCE predictions are based on waste transfers prior to 1994. For this reason, the HTCE estimates of tank contents do not correspond to the present contents of the tank, and a comparison is not appropriate.

5.5 EVALUATION OF PROGRAM REQUIREMENTS

The 1996 grab sampling event was governed by three DQOs: safety screening (Dukelow et al. 1995), waste compatibility (Fowler 1995), and evaporator (Von Bargen 1995). Each DQO contains requirements pertinent to a primary issue regarding tank waste. The safety screening DQO lists requirements for examining the waste in each Hanford underground tank to address the verification of the non-Watch List status of the tank and/or to identify unknown safety issues associated with the tank. The compatibility DQO identifies potential safety and operational problems which may be encountered when combining waste from two sources, for example, the salt well liquor from a single-shell tank with the waste in a receiving double-shell tank. The evaporator DQO details the information needed to safely and efficiently concentrate the waste by evaporation, route the condensate to retention and treatment facilities, and discharge the condensate to the environment.

The primary issues discussed above are integrated by the SAP into a list of required analytical tests and their respective limits. Several issues overlap, for example, the safety screening DQO requirement for the analysis of energetics by DSC is shared by the other two DQOs. The following paragraphs will discuss each issue in the DQOs, the analyses performed to evaluate those issues, and the analytical results from the 1996 grab sampling event. Some issues discussed in the DQOs will not be addressed in this report because they are not pertinent to the waste characterization of the tank.

In addition to the analyses performed in accordance with the DQOs, the tank has previously been screened for high heat conditions. The heat load is modeled by the HTCE (Brevick 1995a) and Kummerer (1994) and has been calculated for this report using the analytical data from the 1996 grab sampling event.

5.5.1 Tank 241-AP-104 Heat Load

A factor in assessing tank safety is the heat generation from radioactive decay. The heat load value calculated using the data from the 1996 grab sampling effort (Miller 1996) was 90.5 W (309 Btu/hr). This estimate is well below the design specification limit of 20,500 W (70,000 Btu/hr) for the 241-AP tank farm (Harris 1992). Because this is an active tank, no trend can be established for heat load variations. The calculated heat load is given in Table 5-5.

Table 5-5. Tank 241-AP-104 Projected Heat Load.

Radionuclide	Specific Activity	Projected Inventory	Decay Heat Generation Rate	Heat Load from Radioactive Decay
	μCi/mL	Ci	mW/Ci	W
^{134}Cs	0.00433	18.44	10.2	0.188
^{137}Cs	4.4	18,734	4.72	88.4
$^{89/90}Sr$	0.0663	282	6.69	1.89
^{99}Tc	0.00289	12.30	0.521	0.00641
Total				90.5

Note:
Kirkpatrick and Brown (1984)

5.5.2 Safety Screening Evaluation

Data criteria identified in the safety screening DQO are used to assess the safety of the waste in tank 241-AP-104. The requirement that vertical profiles of the waste be taken from at least two widely-spaced risers was met. The three primary safety analyses required by the safety screening DQO include DSC (to measure the fuel content), a measurement of the total alpha activity (to determine the criticality potential), and a determination of the flammability of the tank headspace vapors. For each required analysis, a decision threshold was established by the DQO which, if exceeded, may warrant further investigation to assure the safety of the tank. Table 5-6 lists the applicable safety issues, decision variables, and thresholds, and the mean analytical results from the 1996 grab sampling event.

The safety screening DQO has established decision criteria threshold of -480 J/g (dry weight basis) for the DSC analyses (Dukelow et al. 1995). Because no exothermic reactions were noted in any sample, the DQO limit was not exceeded, and the calculation of 95 percent confidence interval upper limit per the safety screening DQO was unnecessary.

The potential for criticality can be assessed from the total alpha activity data. The safety screening decision threshold is 1 g/L, or 61.5 μCi/mL. The overall tank mean was 3.28E-04 μCi/mL, well below the decision threshold. The upper limit to a one-sided 95 percent confidence interval on the mean for each sample-duplicate pair were also below the DQO decision threshold. The 95 percent confidence interval upper limits are shown in Appendix C.

The flammability of the gas in the tank headspace is an additional safety screening DQO consideration. The requirement states that any flammable gas present must be ≤ 25 percent of the LFL. The analytical result was 0 percent of the LFL (see Section 4.1.3).

Table 5-6. Decision Variables and Criteria for the Safety Screening Data Quality Objective.

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Ferrocyanide/organics	Total fuel content	-480 J/g	No exotherms
Criticality	Total alpha activity	>61.5 μCi/mL	3.28E-04 μCi/mL
Flammable gas	Flammable gas	25% of the LFL	0 percent of the LFL

5.5.3 Waste Compatibility Evaluation

In accordance with Fowler (1995), tank 241-AP-104 was analyzed to assess the safety and operational implications of combining the wastes in the tank and the double-shell tank system. Safety considerations included criticality, flammable gas generation and accumulation, energetics, corrosion and leakage, and unwanted chemical reactions. Operational considerations included plugged pipelines and equipment, TRU segregation, complexant waste segregation, and heat load limits of the receiving tank. Not all safety and operational considerations are within the scope of this report, notably the potential chemical reactivity of the waste in a variety of different situations and the tendency of waste to plug piping and equipment. Table 5-7 shows the analyses used to evaluate the waste in terms of the safety and operational considerations which are within the scope of this report. The primary decision variable, the out-of-specification decision threshold and the analytical results from the 1996 grab sampling event are listed for each safety or operational issue. All listed analyses and evaluations were well within the out-of-specification decision threshold imposed by the waste compatibility DQO and listed in the SAP (Conner 1996).

The notification limit for criticality in the waste compatibility DQO is .013 g/L. However, because this tank is being processed by the evaporator, the more stringent .005 g/L is used to ensure the slurry feed from the evaporator does not exceed the compatibility limit.

The notification limit for criticality is based on the mean concentration of $^{239/240}$Pu plus 1.077E-10 multiplied by the mean gross uranium result. Because the analytical results for the 1996 grab sampling event were reported in units of μCi/mL, the limit was converted to those units by using the method described in the footnote of Table 5-7. The sum of the analytical mean for $^{239/240}$Pu plus 1.077E-10 multiplied by the mean gross uranium result was well below the notification limit.

Table 5-7. Decision Variables and Criteria for the Waste Compatibility Data Quality Objective. (2 sheets)

Compatibility Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Safety			
Criticality	[$^{239/240}$Pu]	$^{239/240}$Pu + 1.077E-10 * (U-gross) > 0.005 g/L (> 0.3075 μCi/mL)[1]	< 3.45E-05 μCi/mL
Flammable gas	Specific gravity	> 1.41	1.02
Ferrocyanide/ organics	Total fuel content	For exothermic reactions < 177 °C (350 °F), the absolute value of exotherm/endotherm ratio ≥ 1 (No notification required)	No exothermic reactions
Corrosion and leakage	[OH^-] [NO_3^-] [NO_2^-]	< 170 or > 170,000 μg/mL > 341,000 μg/mL < 506 or > 253,000 μg/mL	2,620 μg/mL 14,800 μg/mL 1,820 μg/mL
Operations			
TRU segregation	TRU elements	[$^{239/240}$Pu], [^{238}Pu], [^{241}Am], [U total], [$^{243/244}$Cm], [^{237}Np] total concentration > 0.1 μCi/g	5.63E-04 μCi/g
Complexant segregation (boildown test)	Viscosity change Crystal formation	Observation of rapid viscosity change on crystallization or formation of non-settling crystals would indicate complexed waste.	None observed
Heat load	Heat generation rate from radioactive decay	≥ 20,500 W (70,000 Btu/hr)	90.5 W (309 Btu/hr)

Note:

[1]Although the actual decision criterion listed in Conner (1996) was 0.005 g/L, total alpha was measured in μCi/mL rather than g/L. To convert the notification limit for total alpha into the same units used by the laboratory, it was assumed that all alpha activity originated from ^{239}Pu. Using the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criterion converts to 0.3075 μCi/mL as shown:

$$\left(\frac{0.005\ g}{L}\right)\left(\frac{1\ L}{10^3\ mL}\right)\left(\frac{0.0615\ Ci}{1\ g}\right)\left(\frac{10^6\ \mu Ci}{1\ Ci}\right) = 0.3075\ \frac{\mu Ci}{mL}$$

Flammable gases may accumulate in wastes with high specific gravity (> 1.41). The mean specific gravity for the 1996 grab samples was 1.02, well below the decision threshold. For energetics, the exotherm/endotherm ratio must be below 1 for all reactions below 168 °C (335 °F). Note that this is not a threshold limit as in the case of the evaporator DQO. No exothermic reactions were observed. The concentrations of the corrosion-inhibiting constituents of the waste were all within the limits imposed by the Compatibility DQO.

Operations issues are based on the policy of segregating TRU and complexant wastes, avoiding excess heat in the tanks, and ensuring pumpability of the source waste to the receiving tank. The total concentration of TRU elements was calculated by converting the values to a per-weight basis from the per-volume basis by dividing the analytical result for each radionuclide by the mean tank density and summing the per-weight results. The total was compared to the 0.1 μCi/g standard for segregating TRU waste from non-TRU waste. The waste is non-TRU. The waste from tank 241-AP-104 was classified as noncomplexed. The heat load was calculated as shown in Table 5-5.

5.5.4 Evaporator Evaluation

Tank 241-AP-104 was processed through the evaporator in May 1996. The evaluation and analysis for the processing operations is contained in the *242-A Campaign 96-1 Process Control Plan* (Le 1996). A summary of this finding is included for completeness.

Issues associated with evaporator operation include tank waste compatibility, criticality, presence of a separable organic layer, radioactive source term, ammonia content, waste designation for double-shell tanks, energetics, and organic content. To assess the suitability of the waste for volume reduction and to predict the characteristics of the concentrated product, selected constituents of the waste in tank 241-AP-104 were measured. The analytical results are compared in Table 5-8 to out-of-specification decision thresholds listed in the evaporator DQO (Von Bargen 1995) and the SAP (Conner 1996). The table and the discussion below are divided into three parts to reflect the organization of Table 1.2 in Von Bargen (1995): process control, safety, and compliance. Not all issues appearing in Von Bargen (1995) are within the scope of this report.

5.5.4.1 Process Control Issues. Process control consists of two broad areas: waste compatibility and separable organic layers. Waste compatibility is influenced by the chemical, physical, and radiochemical characteristics of the waste. The waste must be compatible with other waste forms, with tank and piping systems, and with the evaporator itself. Transuranic and complexant wastes must be segregated from non-TRU and noncomplexant wastes. High-phosphate waste can cause crystallization if it is mixed with waste with high-nitrate salt content. High-heat waste must be discharged to a tank which is designed for high heat, and the corrosivity of the waste must be controlled to prolong the life of carbon steel components. The presence of a separable organic layer requires that the minimum level in evaporator feed tank 241-AW-102 be increased from 15.24 cm (6 in.) to 25.3 cm (8.3 ft) to prevent pumping organic material to the evaporator.

Table 5-8. Decision Variables and Criteria for the Evaporator Operation Data Quality Objective. (4 sheets)

Evaporator Issues	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Process Control			
Mixing and compatibility study	Samples from the candidate feed wastes are combined in the laboratory; the resultant mixture is observed for changes in temperature, color, clarity, or other visually determinable characteristic. (Le 1996)		No changes observed.
High-phosphate waste	$[PO_4^{3-}]$	$[PO_4^{3-}] > 0.1$ M (9,500 μg/mL)	0.00790 M (750 μg/mL)
Complexed waste segregation	TOC content, wt % water	if > 3% TOC (dry basis), then waste must be stored in a tank with > 50 wt % water	0.444 % TOC (dry basis), 96.6 wt % water
Ferrocyanide/ organics	Total fuel content	For exothermic reactions < 177 °C (350 °F), absolute value of exotherm/endotherm ratio ≥ 1	No exothermic reactions
Flammable gas accumulation	Specific gravity	Specific gravity > 1.41	1.02 specific gravity
TRU segregation	TRU elements	[$^{239/240}$Pu], [^{238}Pu], [^{241}Am], [U total], [$^{243/244}$Cm], [^{237}Np] total concentration > 0.1 μCi/g	5.63E-04 μCi/g
Heat generation	Design limits of evaporator feed and slurry tanks	Heat production from radioactive decay >70,000 Btu/hr	309 Btu/hr (based on [^{137}Cs] and [$^{89/90}$Sr])
Corrosion	$[OH^-]$ $[NO_3^-]$ $[NO_2^-]$	< 170 or > 170,000 μg/mL > 341,000 μg/mL < 506 or > 253,000 μg/mL	2,620 μg/mL 14,800 μg/mL 1,820 μg/mL
Operational level of evaporator feed tank	Separable organic layer	Visual detection of separable organic layer	No separable organic layer detected

Table 5-8. Decision Variables and Criteria for the Evaporator Operation Data Quality Objective. (4 sheets)

Evaporator Issues	Primary Decision Variable	Decision Criteria Threshold		Mean Analytical Result
Safety				
Criticality	$^{239/240}Pu$	> 0.005 g/L (> 0.3075 μCi/mL)[1]		< 3.45E-05 μCi/mL
Radioactive source term	Activity of selected radionuclides	Radionuclide	Limit (μCi/mL)	Mean radioactivity (μCi/mL)
		^{14}C	0.26	0.00006
		^{60}Co	1.2	< 4.45E-04
		^{79}Se	0.078	< 3.35E-07
		^{90}Sr	220	0.0663
		^{94}Nb	0.098	< 5.64E-04
		^{99}Tc	2	0.00289
		^{106}Ru	53	< 0.0389
		^{129}I	0.0026	< 5.19E-06
		^{134}Cs	15	0.00433
		^{137}Cs	800	4.4
		^{154}Eu	5	< 0.00115
		^{155}Eu	7	< 0.00691
		^{226}Ra	0.033	< 0.0535
		^{238}Pu	0.0013	< 3.53E-05
		$^{239/240}Pu$	0.16	< 3.45E-05
		^{241}Pu	15 (based on total beta activity)	4.48
		^{241}Am	1	< 1.47E-04
		^{244}Cm	0.013	< 1.47E-04
Ferrocyanide/ organics	Total fuel content	Exotherm/endotherm ratio > 1; Presence of organic layer		No exothermic reactions; no organic layer

Table 5-8. Decision Variables and Criteria for the Evaporator Operation Data Quality Objective. (4 sheets)

Evaporator Issues	Primary Decision Variable	Decision Criteria Threshold		Mean Analytical Result
Safety (Cont'd)				
Corrosion and leakage	[OH^-] [NO^3] [NO^2]	< 170 or > 170,000 μg/mL > 341,000 μg/mL < 506 or > 253,000 μg/mL		2,620 μg/mL 14,800 μg/mL 1,820 μg/mL
Ferrocyanide/organic	Total fuel content	For exothermic reactions < 177 °C (350 °F), the absolute value of exotherm/endotherm ratio ≥ 1		No exothermic reactions
Compliance				
CERCLA[2] reportable quantity of ammonia	Feed tank ammonia content	No specific limit. Results are used to develop process controls to ensure reportable quantity is not exceeded.		71.6 μg/mL
Vessel vent organic discharge	Feed tank organic compound content	Organic compound	Limit[3] μg/mL	Mean analytical result (μg/mL)
		Acetone	174.4 (R-1)/R	1.18
		1-Butanol	452 (R-1)/R	< 29.0
		2-Butoxyethanol	190.4 (R-1)/R	0.795
		2-Butanone	116 (R-1)/R	< 0.5
		Tributyl phosphate	20,300 (R-1)/R	4.69
		TOC (TC-TIC)	174.4 (R-1)/R (as acetone)	204
Compliance with WAC 173-303-100	Ammonia content of feed tank	No specific limit. Evaporator feed stock is blended so that the process condensate contains < 5,000 μg/mL ammonia.		

Table 5-8. Decision Variables and Criteria for the Evaporator Operation Data Quality Objective. (4 sheets)

Evaporator Issues	Primary Decision Variable	Decision Criteria Threshold		Mean Analytical Result
Compliance (Cont'd)				
Liquid effluent retention facility liner compatibility	Organic content of feed tank	Organic compound	Limit[3] (μg/mL)	Mean analytical result (μg/mL)
		1-Butanol	500,000	< 29.0
		Sum of: Acetone 2-Butanone, 2-Hexanone, Methyl isobutyl ketone, 2-Pentanone	200,000 (R-1)/R	1.18 (all but acetone were undetected)
		Tetrahydrofuran	2,000	< 0.5
		2-Butoxyethanol	2,000	0.795
		Tributyl phosphate	2,000	4.69
		Ammonia	100,000	71.6
		TOC (TC-TIC)	< 1,240 (R-1)/R	204

Notes:

[1]Although the actual decision criterion listed in Conner (1996) was 0.005 g/L, total alpha was measured in μCi/mL rather than g/L. To convert the notification limit for total alpha into the same units as the laboratory, it was assumed that all alpha activity originated from ^{239}Pu. Using the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criterion converts to 0.3075 μCi/mL as shown:

$$\left(\frac{0.005\ g}{L}\right)\left(\frac{1\ L}{10^3\ mL}\right)\left(\frac{0.0615\ Ci}{1\ g}\right)\left(\frac{10^6\ \mu Ci}{1\ Ci}\right) = 0.3075\ \frac{\mu Ci}{mL}$$

[2]*Comprehensive Environmental Response Compensation and Liability Act*

[3]R is the ratio of the evaporator feed flow rate to the slurry flow rate. R is equal to 2 for AP-104.

Tank waste compatibility for evaporator operations is assured by a documented assessment of the waste by the compatibility program (Fowler 1995). Results from sampling and analysis events and boildown studies, are used to predict the behavior of the waste when it is mixed with waste from other tanks or in the double-shell tank system. Results from the mixing compatibility study and boildown test are documented in *242-A Campaign 96-1 Process Control Plan* (Le 1996, Appendix J). The boildown and mixing tests indicated the behavior of noncomplexed waste; no visible changes in the waste were evident when mixed.

When high-phosphate waste is mixed with high-salt waste or neutralized cladding removal waste, crystals could result that could plug pumps and equipment and make future waste handling difficult. The phosphate concentration in the tank was well within limits.

The waste was analyzed for TOC content to determine its capability of sustaining an exothermic reaction and to evaluate whether the waste could be classified as complexant. The TOC limit is three weight percent. Waste in tanks exceeding this value must be stored in tanks with greater than 50 percent water. The waste in tank 241-AP-104 contains less than one tenth of a percent TOC and is composed of 96.6 weight percent water.

The same energetics limit that applies to the waste compatibility DQO also applies to the evaporator DQO and the tests are the same. All results were well within the decision thresholds.

Flammable gas can accumulate in waste with a high specific gravity. Consequently, the evaporator is operated so that the specific gravity of the slurry does not exceed 1.41. The specific gravity of the waste was 1.02.

Transuranic wastes are routinely segregated from non-TRU wastes to avoid increasing TRU waste unnecessarily. The total concentration, in μCi/mL, of six transuranic elements listed in Table 5-8 was compared to the limit for designating TRU waste (100 nCi/g, or 0.1 μCi/g). The waste in tank 241-AP-104 is well below the limit for TRU waste.

The heat generation caused by radioactive decay is calculated and modeled to ensure that high-heat waste is not discharged to a tank not designed for high heat. The slurry tanks used in conjunction with the evaporator (241-AW Tank Farm) are designed for 20,500 W (70,000 Btu/hr). The heat load in tank 241-AP-104 was determined to be 90.5 W (309 Btu/hr), well below the high-heat limit.

Uniform and stress corrosion processes are sometimes controlled in tank waste by adding sodium hydroxide and salts of nitrate and nitrite. The concentrations of corrosion-preventing chemicals are maintained within boundaries which are determined by their relative concentrations and by the temperature of the tank waste. For tank 241-AP-104, the waste temperature is < 75 °C (167°F), and the Table 5-8 limits apply. For additional information, refer to Section 6.1.4 in Fowler (1995).

High concentration organic material must be kept out of the evaporator because it may carry over in the evaporator and contaminate the liquid effluent retention facility or the effluent treatment facility, causing deterioration of the liquid effluent retention facility liner or discharge of listed compounds at quantities which are above permit levels. For this reason, the operating level of the feed tank must be kept higher (100 in. rather than 6 in.) to prevent introduction of the organic material into the evaporator, thereby reducing the waste volume reduction rate. No separable organic layer was found.

5.5.4.2 Safety Issues. Safety issues relate to personnel, the public, and the prevention of damage to equipment or the release of hazardous materials to the environment. Criticality, the release of radioactive materials, large energy releases, and maintenance of plant integrity are dealt with in the evaporator DQO.

Criticality is prevented by controlling the concentration of fissile materials. The SAP for tank 241-AP-104 requires the analysis of $^{239/240}Pu$ and sets the limit at 0.005 g/L. The conversion of the units g/L to μCi/mL is discussed in footnote 1 of Table 5-8; the conversion yielded a limit of 0.3075 μCi/mL. The fissile content of the waste is < 3.45E-05 μCi/mL, well below the limit.

Radionuclides in candidate waste are measured to ensure that the concentrations of selected radionuclides will not be increased by waste volume reduction in excess of the boundary limits set by the Evaporator 242-A safety analysis report (Lavender 1993). The concentrations of most radionuclides listed in Table 5-8 are below the detection level or are present at a level well below the DQO limit.

The reasons for measuring fuel content, the limits, and the analytical results are the same as for the process control issue.

As discussed in the process control section, control of corrosion is directly related to plant integrity and thereby safety. The same analyses were performed, and they have the same limits and analytical results.

5.5.4.3. Compliance Issues. Compliance issues are primarily pertinent to obtaining permits to discharge listed materials to the environment. The feed tank must be characterized adequately, and the evaporator must be operated correctly before compliance with permit requirements can be accomplished. The following is a discussion of each compliance issue, its limits, and its analytical results. Total fuel content has been discussed adequately in preceding sections and will not be discussed here.

The ammonia content of the feed tank is measured to develop process controls so that the CERCLA reportable amount of ammonia of 100 pounds in any 24 hour period is not exceeded. An evaluation based on past data determined that the mean analytical result of 71.6 μg/mL would not exceed this limit when processed through the evaporator.

Vessel vent organic discharge levels are limited to three pounds per hour or 3.1 tons per year. In order to meet this standard, the concentrations of organic materials are measured in the feed tank. The limits are adjusted according to the ratio between the feed flow rate and slurry flow rate (R), according to the modifier (R-1)/R. At high boildown levels, the modifier is relatively large, allowing the presence of larger amounts of organic compounds in the feed tank. Conversely smaller amounts of organic compounds are allowed in the feed tank when the boildown rate is low. A TC-TIC screen is also performed to monitor for any major organic compounds which may have been missed. For further discussion, refer to Von Bargen (1995).

The R value used for AP-104 was 2. This gives an effective limit to TC-TIC of 87.2. The measured value of TC-TIC for AP-104 was 204 thus exceeding the limit. In this case a technical evaluation (Le 1996, Appendix J) was performed as called for in the evaporator DQO. Based on this evaluation it was determined that additional organics identified in the TC-TIC calculation would not cause the emissions limit to be exceeded.

Ammonia levels have no specific limit but are controlled so that the process condensate contains $< 5{,}000\ \mu g/mL$ of ammonia. This limit is derived from the "Dangerous Waste Regulations" (WAC-173-303) limit for extremely hazardous waste of one weight percent, or $10{,}000\ \mu g/mL$. Assuming a 50 percent volume reduction and 100 percent carryover of ammonia through the evaporator, the ammonia concentration is controlled to $5{,}000\ \mu g/mL$ or less in the feed tank. The mean analytical result for ammonia was $71.6\ \mu g/mL$.

In addition to complying with permit requirements for discharging organic compounds to the environment, organic compounds are also controlled to prevent the degrading of the high-density polyethylene liner in the Liquid Effluent Retention Facility. The limits for the organic compound were established by the manufacturer. The limits are higher than the concentrations typically seen and are adjusted by the (R-1)/R modifier to compensate for condensate flow rate. The analytes on the list are chosen because they have been seen in the process condensate. The TC-TIC screen is performed to monitor for any major organic compounds which may have been missed. All required organic compounds exhibited mean analytical concentrations much lower than their respective limits.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The waste in tank 241-AP-104 was grab sampled in January of 1996. Three DQOs were used to guide the process: the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995), and the *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives* (Von Bargen 1995). The requirements of the three DQOs were integrated into the *Tank 241-AP-104 Grab Sampling and Analysis Plan* (Conner 1996).

Thirteen grab samples of tank waste were taken from riser (1@30°) and riser (1@270°). The safety screening DQO requires measuring the total fuel content of the waste by DSC, weight percent water by TGA, specific gravity, total alpha activity by alpha proportional counting, and a visual examination of the waste samples for an organic layer. The safety screening DQO also requires a determination of the flammability of the tank headspace gases. The waste compatibility DQO contains requirements which assist tank farm operators in performing waste transfers. The waste compatibility DQO required the same analyses as the safety screening DQO and, in addition, required analyses for selected metals, anions, radionuclides, and carbon. The data acquired in accordance with the evaporator DQO assist the evaporator operators in the safe and efficient operation of the evaporator. The data also enable evaporator and liquid retention facility operators to ensure that downstream facilities are not damaged and to fulfill all requirements of discharge permits. The evaporator DQO required the same analyses as the safety screening DQO and selected metals, anions, radionuclides, carbon, and physical properties. A boildown test was also performed to predict the behavior of the waste during and after concentration by evaporation.

All analyses exhibited results well within the limits imposed by the safety screening, waste compatibility, and evaporator DQOs. The mean total alpha activity was 3.28E-04 μCi/mL, well below the safety screening DQO decision threshold of 41 μCi/mL; the DSC scans exhibited only endothermic reactions; no organic layer was detected; and the weight percent water results were 96.6 percent by TGA. The flammability of the tank vapor headspace was measured at 0 percent of the LFL. The analyses performed in accordance with the waste compatibility DQO exhibited no results which would preclude waste transfers. The waste is non-TRU and not complexant; therefore it does not require segregation. The analyses performed to satisfy the evaporator DQO revealed that the waste is suitable for concentration by evaporation.

The degree of vertical homogeneity suggests that the analyte concentrations will continue to increase below the 8 ft sample depth. Because no samples were taken in the bottom 8 ft, however, it is difficult to predict analyte concentrations in this region. For this reason, it is recommended that future sampling events include samples from near the tank bottom.

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7.0 REFERENCES

Agnew, S. F., 1995, *Hanford Defined Wastes: Chemical and Radionuclide Compositions*, LA-UR-94-2657, Rev. 2, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., P. Baca, R. Corbin, K. Jurgensen, and B. Young, 1995, *Tank Layer Model (TLM)*, LA-UR-94-4269, Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1996, *Waste Status and Transaction Record Summary for the Southeast Quadrant*, WHC-SD-WM-TI-689, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, and W. W. Pickett, 1995a, *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 Areas*, WHC-SD-WM-ER-350, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, and S. D. Consort, 1995b, *Supporting Document for the Historical Tank Content Estimate for AP Tank Farm*, WHC-SD-WM-ER-315, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601 et seq.

Conner, J. M., 1996, *Tank 241-AP-104 Grab Sampling and Analysis Plan*, WHC-SD-WM-TSAP-069, Rev. 0C, Westinghouse Hanford Company, Richland, Washington.

DeLorenzo, D. S., A. T. DiCenso, D. B. Hiller, K. W. Johnson, J. H. Rutherford, D. J. Smith, and B. C. Simpson, 1994, *Tank Characterization Reference Guide*, WHC-SD-WM-TI-648, Rev. 0, Westinghouse Hanford Company, 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.

Ecology, EPA, and DOE, 1996, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Fowler, K. D., 1995, *Data Quality Objectives for Tank Farms Waste Compatibility Program*, WHC-SD-WM-DQO-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending March 31, 1996*, WHC-EP-0182-96, Westinghouse Hanford Company, Richland, Washington.

Hanson, G. N., 1987a, "104AP Sample Results," (Internal memorandum [DSI] to distribution, dated May 14), Westinghouse Hanford Company, Richland, Washington.

Hanson, G. N., 1987b, "104AP Sample Results," (Internal memorandum [DSI] to distribution, dated August 11), Westinghouse Hanford Company, Richland, Washington.

Harris, J. P., 1992, *Operating Specifications for the 241-AN, AP, AW, AY, AZ, & SY Tank Farms*, OSD-T-151-00029, Rev./Mod. H-5, Westinghouse Hanford Company, Richland, Washington.

Kaiser Engineers Hanford Company, date unknown, *Plan Tank Penetrations 241 AP-102-104*, H-2-90539, Rev. 1, ICF Kaiser Hanford Company, Richland, Washington.

Kirkpatrick, T. D., and R. C. Brown, 1984, *Basis and Values for Specific Activity and Decay Heat Generation Rates for Selected Radionuclides*, SD-RE-TI-131, Rockwell Hanford Operations, Richland, Washington.

Kummerer, M., 1994, *Topical Report on Heat Removal Characteristics of Waste Storage Tanks*, WHC-SD-WM-SARR-010, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lavender, 1993, *Final Safety Analysis Report, 242-A Evaporator Liquid Effluent Retention Facility*, WHC-SD-W105-SAR-001, Rev. 0-C, Westinghouse Hanford Company, Richland, Washington.

Le, E. Q., and M. D. Guthrie, April 29, 1996, *242-A Campaign 96-1 Process Control Plan*, WHC-SD-WM-PCP-011, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Leach, C. E., and S. M. Stahl, 1993, *Hanford Site Tank Farm Facilities Interim Safety Basis*, WHC-SD-WM-ISB-001, Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1996, *Final Characterization and Safety Screen Report of Double-Shell Tank 241-AP-104 for 242-A Evaporator, Campaign 96-1*, WHC-SD-WM-DP-142, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

NFPA, 1995, *National Fire Codes*, Vol. 10, Section 115, "Laser Fire Protection," National Fire Prevention Association, Quincy, Massachusetts.

Nuclear Regulatory Commission, 1988, *Statistical Methods for Nuclear Materials Management*, NUREG-CR-4604, PNL-5849, (C. A. Bennett and W. M. Bowen eds.), U.S. Government Printing Office, Washington, D.C.

Public Law 101-510, Section 3.37, 1990, *Safety Measures for Waste Tanks at the Hanford Nuclear Reservation*, U.S. Congress, Washington, D.C. (also referred to as the Wyden Amendmemt).

Salazar, B. E., 1994, *Double-Shell Underground Waste Storage Tanks Riser Survey*, WHC-SD-RE-TI-093, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

Von Bargen, B. H., 1995, *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives*, WHC-SD-WM-DQO-014, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WAC 173-303, 1990, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WHC, 1994, *Piping Plan Tank 104*, H-2-90556, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

Winters, W. I., 1988, *Analytical Results for Tank 241-AP-104 Phosphate/Sulfate Wastes*, WHC-SD-RE-TI-212, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

ANALYTICAL RESULTS
DOUBLE-SHELL TANK 241-AP-104

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A.0 ANALYTICAL RESULTS DOUBLE-SHELL TANK 241-AP-104

A.1 INTRODUCTION

Appendix A provides the chemical and radiological characteristics of tank 241-AP-104 in table form and includes specific concentrations of metals, ions, radionuclides, total carbon, physical properties, volatile organic compounds, and semi-volatile organic compounds.

The data table for each analyte lists the sample number, sample location, an original and duplicate result for each sample, a sample mean, an overall mean for the tank in which all samples are weighted equally, and a relative standard deviation. The data are listed in standard notation for values greater than .001 and less than 100,000. Values outside these limits are listed in scientific notation.

A.2 ANALYTE TABLE DESCRIPTION

The "Sample Number" column lists the grab sample number for which the analyte was measured. For sampling rationale, locations, and descriptions of sampling events, see Section 3.0.

The "Sample Location" column lists the Labcore sample location.

The "Result" and "Duplicate" columns are self-explanatory. The "Mean" column is the average of result and duplicate values. All values, including those below the detection level (<), were averaged. If both sample values were non-detected, the mean is expressed as a non-detected value. If one or both values were above the detection limit, the mean is expressed as a detected value. Superscript letters on the Mean values, for which the corresponding quality control violations are listed below, are quality control flags.

"a" indicates a standard recovery below the quality control limit.

"b" indicates a standard recovery above the quality control limit.

"c" indicates a spike recovery below the quality control limit.

"d" indicates a spike recovery above the quality control limit.

"e" indicates that the RPD was outside the quality control limits.

"f" indicates the presence of blank contamination.

The "Overall Mean" column was calculated by averaging the primary and duplicate results for each sample. For analytes having more than one sample analyzed from a given sample

location (depth and riser), the sample means from that depth and riser were averaged to derive a depth mean. The depth means were averaged to derive a riser mean. Finally, the riser means were averaged to derive the overall tank mean. When 50 percent or more of the primary and duplicate measurements had detected results, the overall mean was reported as a detected value. Conversely, when greater than 50 percent of the individual primary and duplicate measurements had nondetected results, the overall mean was reported as a nondetected value. For those samples with some (but less than half) measurements below the detection limit, the detection limit was used in the computation. This means that the reported summary statistics are biased. The magnitude of the bias cannot be estimated. As discussed earlier, means were assigned a detect or non-detect status depending on the relative number of non-detected values in the data set. Means for data sets having greater than 50 percent non-detected values were assigned a status of non-detect.

The "Relative Standard Deviation" (RSD) column, is a measure of variance defined as the standard deviation divided by the mean. This number is expressed as a percent.

The "Projected Inventory" column is the inventory estimate based on the overall mean for each analyte and the waste volume at the time of sampling, 4,258 kL (1,125 kgal), and the appropriate conversion factors.

In the tables n/a means not applicable.

Table A-1. Tank 241-AP-104 Analytical Results: Aluminum.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	164	165	164.5	198	82.4	843
S96V000013		33.2	32.9	33.05			
S96V000026		168	172	170			
S96V000009	Riser 1, 30°N	548	549	548.5			
S96V000010		41.1	41.6	41.35			

Table A-2. Tank 241-AP-104 Analytical Results: Chromium.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	19.3	19.3	19.3	34.5	52.9	147
S96V000013		16.1	16.3	16.2			
S96V000026		19.4	19.3	19.35			
S96V000009	Riser 1, 30°N	85.1	85.4	85.25			
S96V000010		16.9	17.3	17.1			

Table A-3. Tank 241-AP-104 Analytical Results: Iron.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	< 1.66	< 1.66	< 1.66	< 1.58	n/a	< 6.73
S96V000013		< 0.5	< 0.5	< 0.5			
S96V000026		< 4	< 4	< 4			
S96V000009	Riser 1, 30°N	< 2.5	< 2.5	< 2.5			
S96V000010		< 0.5	< 0.5	< 0.5			

Table A-4. Tank 241-AP-104 Analytical Results: Manganese.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	< 0.333	< 0.333	< 0.333	< 0.317	n/a	< 1.35
S96V000013		< 0.1	< 0.1	< 0.1			
S96V000026		< 0.8	< 0.8	< 0.8			
S96V000009	Riser 1, 30°N	< 0.5	< 0.5	< 0.5			
S96V000010		< 0.1	< 0.1	< 0.1			

Table A-5. Tank 241-AP-104 Analytical Results: Nickel.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	< 0.666	< 0.666	< 0.666	< 0.697	n/a	< 2.97
S96V000013		0.342	0.32	0.331			
S96V000026		< 1.6	< 1.6	< 1.6			
S96V000009	Riser 1, 30°N	< 1	< 1	< 1			
S96V000010		0.338	0.313	0.3255			

Table A-6. Tank 241-AP-104 Analytical Results: Silicon.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	90.1	81.8	85.95	26.1	42.9	111
S96V000013		18.2	8.06	13.13			
S96V000026		31.9	29.3	30.6			
S96V000009	Riser 1, 30°N	11.8	14.1	12.95			
S96V000010		19.8	20.4	20.1			

Table A-7. Tank 241-AP-104 Analytical Results: Sodium.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	13900	14100	14000	9810	55.2	41,767
S96V000013		4270	4300	4285			
S96V000026		13900	14100	14000			
S96V000009	Riser 1, 30°N	16400	16400	16400			
S96V000010		4490	4580	4535			

Table A-8. Tank 241-AP-104 Analytical Results: Total Uranium (ICP).

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000011	Riser 1, 270°N	< 16.6	< 16.6	< 16.6	< 30.0	n/a	< 127.7
S96V000013		34.3	34.6	34.45			
S96V000026		< 40	< 40	< 40			
S96V000009	Riser 1, 30°N	< 25	< 25	< 25			
S96V000010		31.6	32.8	32.2			

Table A-9. Tank 241-AP-104 Analytical Results: Total Uranium (Kinetic Phosphorescence).

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	9.76	n/a	9.76	15.8	56.2	67.3
S96V000006	Riser 1, 30°N	9.41	n/a	9.41			
S96V000007		34.2	n/a	34.2			

Table A-10. Tank 241-AP-104 Analytical Results: Fluoride.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	655.7	649	652.35	494	59.6	2,103
S96V000006	Riser 1, 30°N	561.2	558	559.6			
S96V000007		113.9	112	112.95			

Table A-11. Tank 241-AP-104 Analytical Results: Nitrate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	19560	19600	19580	14800	63.9	63,013
S96V000006	Riser 1, 30°N	17170	17100	17135			
S96V000007		2928	2960	2944			

Table A-12. Tank 241-AP-104 Analytical Results: Nitrite.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	1437	1450	1443.5	1820	35.6	7,749
S96V000006	Riser 1, 30°N	3344	3310	3327			
S96V000007		1090	1080	1085			

Table A-13. Tank 241-AP-104 Analytical Results: Phosphate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	367.4	376	371.7	750	42.4	3,193
S96V000006	Riser 1, 30°N	1582	1620	1601			
S96V000007		659.5	655	657.25			

Table A-14. Tank 241-AP-104 Analytical Results: Sulfate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	495	494	494.5	762	38.1	3,244
S96V000006	Riser 1, 30°N	1485	1510	1497.5			
S96V000007		557.3	562	559.65			

Table A-15. Tank 241-AP-104 Analytical Results: Hydroxide.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	3720	3650	3685	2620	58.3	11,155
S96V000006	Riser 1, 30°N	2640	2640	2640			
S96V000007		464	460	462			

Table A-16. Tank 241-AP-104 Analytical Results: Ammonia.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	133	n/a	133	71.6	85.9	305
S96V000006	Riser 1, 30°N	< 5	n/a	< 5			
S96V000007		15.4	n/a	15.4			

Table A-17. Tank 241-AP-104 Analytical Results: Americium-241.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 1.460E-04	n/a	< 1.460E-04	< 1.47E-04	n/a	< 0.626
S96V000009	Riser 1, 30°N	< 1.500E-04	n/a	< 1.500E-04			
S96V000010		< 1.470E-04	< 1.410E-04	< 1.440E-04			

Table A-18. Tank 241-AP-104 Analytical Results: Carbon-14.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000008	Riser 1, 270°N	1.850E-05	1.990E-05	1.920E-05	6.19E-05	64.5	0.264
S96V000006	Riser 1, 30°N	4.790E-05	5.010E-05	4.900E-05			
S96V000007		1.450E-04	1.750E-04	1.600E-04			

Table A-19. Tank 241-AP-104 Analytical Results: Cerium/Praseodymium-144.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 0.02448	n/a	< 0.02448	< 0.0258	n/a	< 109.8
S96V000009	Riser 1, 30°N	< 0.03046	< 0.0307	< 0.03058			
S96V000010		< 0.0238	n/a	< 0.0238			

Table A-20. Tank 241-AP-104 Analytical Results: Cesium-134.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	0.00658	n/a	0.00658	0.00433	50.5	18.44
S96V000009	Riser 1, 30°N	< 0.002361	< 0.00237	< 0.0023655			
S96V000010		0.00183	n/a	0.00183			

Table A-21. Tank 241-AP-104 Analytical Results: Cesium-137.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	3.88	n/a	3.88	4.4	17.5	18,734
S96V000009	Riser 1, 30°N	6.15	6.19	6.17			
S96V000010		3.67	n/a	3.67			

Table A-22. Tank 241-AP-104 Analytical Results: Cobalt-60.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 4.987E-04	n/a	< 4.987E-04	< 4.45E-04	n/a	< 1.89
S96V000009	Riser 1, 30°N	< 4.883E-04	< 4.460E-04	< 4.672E-04			
S96V000010		< 3.152E-04	n/a	< 3.152E-04			

Table A-23. Tank 241-AP-104 Analytical Results: Curium-243/244.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 1.460E-04	n/a	< 1.460E-04	< 1.47E-04	n/a	< 0.626
S96V000009	Riser 1, 30°N	< 1.500E-04	n/a	< 1.500E-04			
S96V000010		< 1.470E-04	< 1.410E-04	< 1.440E-04			

Table A-24. Tank 241-AP-104 Analytical Results: Europium-154.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 0.001152	n/a	< 0.001152	< 0.00115	n/a	< 4.90
S96V000009	Riser 1, 30°N	< 0.001305	< 0.00133	< 0.0013175			
S96V000010		< 9.614E-04	n/a	< 9.614E-04			

Table A-25. Tank 241-AP-104 Analytical Results: Europium-155.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 0.006518	n/a	< 0.006518	< 0.00691	n/a	< 29.4
S96V000009	Riser 1, 30°N	< 0.008243	< 0.0082	< 0.0082215			
S96V000010		< 0.00637	n/a	< 0.00637			

Table A-26. Tank 241-AP-104 Analytical Results: Iodine-129.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000008	Riser 1, 270°N	< 6.330E-06	< 6.210E-06	< 6.270E-06	< 5.19E-06	n/a	< 0.0217
S96V000006	Riser 1, 30°N	< 1.540E-06	2.930E-06	2.235E-06			
S96V000007		< 6.410E-06	< 5.590E-06	< 6.000E-06			

Table A-27. Tank 241-AP-104 Analytical Results: Neptunium-237.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	1.870E-04	n/a	1.870E-04[QC:a]	< 2.14E-04	n/a	< 0.911
S96V000009	Riser 1, 30°N	2.020E-04	n/a	2.020E-04[QC:a]			
S96V000010		< 3.050E-04	< 2.510E-04	< 2.780E-04[QC:a]			

Table A-28. Tank 241-AP-104 Analytical Results: Niobium-94.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 5.113E-04	n/a	< 5.113E-04	< 5.64E-04	n/a	< 2.40
S96V000009	Riser 1, 30°N	< 7.395E-04	< 7.180E-04	< 7.288E-04			
S96V000010		< 5.060E-04	n/a	< 5.060E-04			

Table A-29. Tank 241-AP-104 Analytical Results: Plutonium-238.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 3.270E-05	n/a	< 3.270E-05	< 3.53E-05	n/a	< 0.150
S96V000009	Riser 1, 30°N	< 3.680E-05	n/a	< 3.680E-05			
S96V000010		4.260E-05	< 3.560E-05	< 3.910E-05			

Table A-30. Tank 241-AP-104 Analytical Results: Plutonium-239/240.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 3.270E-05	n/a	< 3.270E-05	< 3.45E-05	n/a	< 0.147
S96V000009	Riser 1, 30°N	< 3.680E-05	n/a	< 3.680E-05			
S96V000010		< 3.600E-05	< 3.560E-05	< 3.580E-05			

Table A-31. Tank 241-AP-104 Analytical Results: Radium-226.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 0.05063	n/a	< 0.05063	< 0.0535	n/a	< 228
S96V000009	Riser 1, 30°N	< 0.06375	< 0.0639	< 0.063825			
S96V000010		< 0.04887	n/a	< 0.04887			

Table A-32. Tank 241-AP-104 Analytical Results: Ruthenium/Rhodium-106.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 0.03681	n/a	< 0.03681	< 0.0389	n/a	< 166
S96V000009	Riser 1, 30°N	< 0.04644	< 0.0464	< 0.04642			
S96V000010		< 0.03574	n/a	< 0.03574			

Table A-33. Tank 241-AP-104 Analytical Results: Selenium-79.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	< 2.83E-07	n/a	< 2.83E-07	< 3.50E-07	n/a	< 0.00128
S96V000009	Riser 1, 30°N	< 4.230E-07	5.730E-07	4.980E-07			
S96V000010		< 4.230E-07	n/a	< 3.37E-07			

Table A-34. Tank 241-AP-104 Analytical Results: Strontium-89/90.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	0.0405	n/a	0.0405	0.0663	37.9	282
S96V000009	Riser 1, 30°N	0.113	0.0994	0.1062			
S96V000010		0.0781	n/a	0.0781			

Table A-35. Tank 241-AP-104 Analytical Results: Technetium-99.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	0.00276	n/a	0.00276	0.00289	62.3	12.30
S96V000009	Riser 1, 30°N	0.00521	0.00546	0.005335			
S96V000010		0.000724	n/a	0.000724			

Table A-36. Tank 241-AP-104 Analytical Results: Tritium.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000008	Riser 1, 270°N	0.00166	0.00177	0.001715	0.00403	84.9	17.16
S96V000006	Riser 1, 30°N	0.000327	n/a	0.000327			
S96V000007		0.0125	0.0122	0.01235			

Table A-37. Tank 241-AP-104 Analytical Results: Total Alpha.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	0.000361	0.00034	0.000351	0.000328	15.2	1.40
S96V000013		0.000305	0.000236	0.000271			
S96V000009	Riser 1, 30°N	0.000236	0.000229	0.000233			
S96V000010		0.000451	0.000465	0.000458			

Table A-38. Tank 241-AP-104 Analytical Results: Total Beta.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: acid digest		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96V000011	Riser 1, 270°N	4	3.97	3.985	4.48	15.6	19,074
S96V000013		3.75	3.79	3.77			
S96V000009	Riser 1, 30°N	6.25	6.23	6.24			
S96V000010		3.86	3.98	3.92			

Table A-39. Tank 241-AP-104 Analytical Results: Total Carbon.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	711	747	729	944	26.8	4,019
S96V000006	Riser 1, 30°N	1550	1570	1560			
S96V000007		741	777	759			

Table A-40. Tank 241-AP-104 Analytical Results: Total inorganic carbon.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	446	n/a	446	740	38.7	3,151
S96V000006	Riser 1, 30°N	1480	n/a	1480			
S96V000007		586	n/a	586			

Table A-41. Tank 241-AP-104 Analytical Results: Total organic carbon.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: Direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000008	Riser 1, 270°N	221	n/a	221	154	26.0	656
S96V000012		110	n/a	110			
S96V000006	Riser 1, 30°N	167	n/a	167			
S96V000007		118	n/a	118			

Table A-42. Tank 241-AP-104 Analytical Results: pH.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: Direct		unitless	unitless	unitless	unitless	%	
S96V000008	Riser 1, 270°N	12.88	n/a	12.88	12.7	2.72	n/a
S96V000006	Riser 1, 30°N	12.94	12.95	12.945			
S96V000007		12.23	n/a	12.23			

Table A-43. Tank 241-AP-104 Analytical Results: Percent Water.

Sample Number	Sample Location	Result		Duplicate		Sample Mean	Overall Mean	RSD (Mean)
Liquids: direct		% H_2O	Temperature Range °C	% H_2O	Temperature Range °C	% H_2O	Weight Percent	%
S96V000008	Riser 1, 270°N	95.17	35 - 100	94.78	35 - 100	94.975	96.6	2.10
S96V000012		98.83	35 - 95	98.09	35 - 95	98.46		
S96V000006	Riser 1, 30°N	94.43	30 - 95	93.87	35 - 95	94.15		
S96V000007		98.71	30 - 90	96.86	35 - 90	98.785		

Table A-44. Tank 241-AP-104 Analytical Results: Energetics by DSC.

Sample Number	Sample Location	Run	Sample Weight	Transition 1	
Liquids: direct			mg	Peak Temp. (°C)	ΔH (J/g)
S96V000008	Riser 1, 270°N	1	9.900	109.8	2,049
		2	10.198	103.0	1,760
S96V000012		1	9.952	107.8	1,841
		2	10.011	107.8	1,945
S96V000006	Riser 1, 30°N	1	10.126	109.8	1,799
		2	10.830	107.8	2,091
S96V000007		1	9.840	107.8	2,123
		2	9.500	107.8	2,067

Note:

ΔH = change in enthalpy (negative sign denotes exothermic reaction).

Table A-45. Tank 241-AP-104 Analytical Results: Specific gravity.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		unitless	unitless	unitless	unitless	%	
S96V000008	Riser 1, 270°N	1.021	1.035	1.028	1.02	n/a	n/a
S96V000012		0.996	1.011	1.0035			
S96V000006	Riser 1, 30°N	1.039	1.031	1.035			
S96V000007		1.001	0.995	0.998			

Table A-46. Tank 241-AP-104 Analytical Results: 2-Butoxyethanol.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000019	Riser 1, 270°N	1.1	n/a	1.1	0.795	38.6	3.38
S96V000017	Riser 1, 30°N	0.57	n/a	0.57			
S96V000018		0.41	n/a	0.41			

Table A-47. Tank 241-AP-104 Analytical Results: Tri-n-butyl Phosphate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96V000019	Riser 1, 270°N	8.8	n/a	8.8	4.69	87.8	19.97
S96V000017	Riser 1, 30°N	0.19	n/a	0.19			
S96V000018		0.97	n/a	0.97			

Table A-48. Tank 241-AP-104 Analytical Results: 1,1,1-Trichloroethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-49. Tank 241-AP-104 Analytical Results: 1,1,2,2-Tetrachloroethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-50. Tank 241-AP-104 Analytical Results: 1,1,2-Trichloroethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-51. Tank 241-AP-104 Analytical Results: 1,1-Dichloroethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-52. Tank 241-AP-104 Analytical Results: 1,1-Dichloroethene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3096	Riser 1, 30°N	< 0.5	n/a	< 0.5			

Table A-53. Tank 241-AP-104 Analytical Results: 1,2,3-Trimethylbenzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-54. Tank 241-AP-104 Analytical Results: 1,2,4-Trimethylbenzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-55. Tank 241-AP-104 Analytical Results: 1,2-Dichloroethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-56. Tank 241-AP-104 Analytical Results: 1,2-Dichloroethylene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3096	Riser 1, 30°N	< 0.5	n/a	< 0.5			

Table A-57. Tank 241-AP-104 Analytical Results: 1,2-Dichloropropane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-58. Tank 241-AP-104 Analytical Results: 1,3,5-Trimethylbenzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-59. Tank 241-AP-104 Analytical Results: 1-Butanol.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	37	39	38[QC:d]	< 29.0	n/a	< 123.5
96-3095	Riser 1, 30°N	< 20	n/a	< 20			
96-3096		< 20	n/a	< 20			

Table A-60. Tank 241-AP-104 Analytical Results: 2-Hexanone.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-61. Tank 241-AP-104 Analytical Results: 2-Pentanone.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-62. Tank 241-AP-104 Analytical Results: 2-Butanone.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-63. Tank 241-AP-104 Analytical Results: 4-Methyl-2-Pentanone.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-64. Tank 241-AP-104 Analytical Results: Acetone.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	1.5	1.3	1.4[QC:d]	1.18	27	5.02
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		1.4	n/a	1.4			

Table A-65. Tank 241-AP-104 Analytical Results: Benzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-66. Tank 241-AP-104 Analytical Results: Bromodichloromethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-67. Tank 241-AP-104 Analytical Results: Bromoform.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	n/a	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-68. Tank 241-AP-104 Analytical Results: Bromomethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-69. Tank 241-AP-104 Analytical Results: Carbon disulfide.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-70. Tank 241-AP-104 Analytical Results: Carbon tetrachloride.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-71. Tank 241-AP-104 Analytical Results: Chlorobenzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-72. Tank 241-AP-104 Analytical Results: Chloroethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-73. Tank 241-AP-104 Analytical Results: Chloroform.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-74. Tank 241-AP-104 Analytical Results: Chloromethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-75. Tank 241-AP-104 Analytical Results: Dibromochloromethane.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5		< 0.5			
96-3096		< 0.5		< 0.5			

Table A-76. Tank 241-AP-104 Analytical Results: Ethylbenzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-77. Tank 241-AP-104 Analytical Results: Isopropylbenzene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-78. Tank 241-AP-104 Analytical Results: Methylene Chloride.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-79. Tank 241-AP-104 Analytical Results: Styrene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-80. Tank 241-AP-104 Analytical Results: Tetrachloroethene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-81. Tank 241-AP-104 Analytical Results: Tetrahydrofuran.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-82. Tank 241-AP-104 Analytical Results: Toluene

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-83. Tank 241-AP-104 Analytical Results: Trichloroethene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-84. Tank 241-AP-104 Analytical Results: Vinyl acetate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-85. Tank 241-AP-104 Analytical Results: Vinyl chloride.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-86. Tank 241-AP-104 Analytical Results: Xylenes (total).

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

Table A-87. Tank 241-AP-104 Analytical Results: cis-1,3-Dichloropropene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5	< 0.5	n/a	< 2.13

Table A-88. Tank 241-AP-104 Analytical Results: trans-1,3-Dichloropropene.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
96-3097	Riser 1, 270°N	< 0.5	< 0.5	< 0.5	< 0.5	n/a	< 2.13
96-3095	Riser 1, 30°N	< 0.5	n/a	< 0.5			
96-3096		< 0.5	n/a	< 0.5			

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APPENDIX B

HISTORICAL SAMPLING EVENTS
DOUBLE-SHELL TANK 241-AP-104

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B.0 HISTORICAL SAMPLING EVENTS

B.1 INTRODUCTION

Historical data have been located for four tank 241-AP-104 samples analyzed from May 12, 1987 through March 1, 1988. The data, which were taken from Westinghouse Laboratory Sample Analysis Reports and a supporting document (Winters 1988) are summarized in the following sections.

B.2 DESCRIPTION OF THE APRIL 1987 SAMPLING EVENT

One sample (T-8530) from tank 241-AP-104 was taken on April 22, 1987 and analyzed on May 12, 1987 (see Table B-1). No details about the techniques used to extract the sample were available. The sample was a very pale, yellow liquid with no solids and no organic materials. The sample was collected at a depth of 4.76 m (15.62 ft). The composition of the tank's contents was noted as approximately 70 percent phosphate waste and 30 percent sulfate waste (Hanson 1987a).

B.2.1 Sample Handling and Analysis

No data were available about sample handling. The referenced data were obtained from a report analysis and referenced DSI (Don't Say It-Write It, informal internal memorandum) from G. N. Hanson to distribution dated May 14, 1987. The sample analysis results are shown in Table B-1.

B.3 DESCRIPTION OF THE JULY 1987 SAMPLING EVENT

One sample (T-513) was taken from tank 241-AP-104 on July 9, 1987, and analyzed on August 5, 1987 (see Table B-2). No details about the techniques used to extract sample, or the riser used to obtain the samples were available. The physical appearance of the sample was a yellow-brown aqueous phase with less than one percent solids. The sample was collected at a depth of 9.52 m (31.23 ft). The composition of the tank's contents was noted as approximately 85 percent phosphate waste and 15 percent sulfate waste (Hanson 1987b).

B.3.1 Sample Handling and Analysis

No data were available about sample handling. The referenced data were obtained from a report analysis and referenced DSI from G. N. Hanson to distribution dated August 11, 1987. The sample results are shown in Table B-2.

Table B-1. Supernatant Sample T-8530[1] from Tank 241-AP-104.[2]

Component	Lab Value	Lab Unit
Physical Data		
Vis-OTR	Very pale yellow in color, no solids, no organic, < 1 mRad/hr	
pH	9.64	---
Chemical Analysis		
Cl	2.59E-04	M
F	<6.48E-04	M
Ca	9.86E-05	M
K	1.05E-04	M
Na	4.02E-01	M
NO_2	Nondetectible	M
NO_3	<8.81E-05	M
OH	pH too low	M
PO_4	1.41E-01	M
SO_4	2.90E-02	M
U	2.44E-04	g/l
TOC	1.48E-01	g/L Carbon
C/R	1.50E-01	lb NaOH/gal
Radiological Analysis		
^{241}Am	<9.77E-01	μCi/L
Total Beta	5.575	μCi/L
Total Alpha	<4.50E-02	μCi/L
^{60}Co	2.56E+00	μCi/L
^{103}Ru	3.10E-01	μCi/L
^{129}I	Incomplete	μCi/L
$^{239/240}Pu$	1.94E-02	μCi/L
^{99}Tc	4.24E-02	μCi/L
^{137}Cs	5.79E-01	μCi/L

Note:

[1]Hanson (1987a)

[2]Data contained in this table no longer represent the current tank contents.

Table B-2. Supernatant Sample T-513[1] from Tank 241-AP-104.[2]

Component	Lab Value	Lab Unit
Physical Data		
Vis-OTR	Yellow brown aqueous phase, <1% solids, <1 mRad/hr	
pH	11.46	---
Chemical Analysis		
Cl	2.39E-03	M
F	<6.80E-04	M
Ca	9.86E-05	M
Cr	4.74E-05	M
Fe	5.23E-05	M
Na	2.21E-01	M
P	8.04E-02	M
Mg	4.57E-04	M
NO_3	<8.16E-03	M
NO_2	2.27E-05	M
PO_4	1.65E-01	M
SO_4	1.53E-02	M
U	2.09E-04	g/L
TOC	2.48E-02	g/L Carbon
Radiological Analysis		
^{241}Am	<9.28E-01	μCi/L
Total Beta	9.03E+00	μCi/L
Total Alpha	4.58E-02	μCi/L
^{60}Co	3.62E+00	μCi/L
^{54}Mn	2.36E-01	μCi/L
^{129}I	<1.64E-02	μCi/L
$^{239/240}Pu$	6.67E-02	μCi/L
^{137}Cs	6.28E-01	μCi/L

Note:

[1]Hanson (1987b)

[2]Data contained in this table no longer represent the current tank contents.

B.4 DESCRIPTION OF THE 1988 SAMPLING EVENT

Twelve samples were taken from tank 241-AP-104 on December 3, 1987. The following text is derived from Winters (1988). The samples were taken from different depths and angles from the 10 cm (4 in.) riser 1. The Analytical System Laboratories characterized the 12 waste samples for chemical and radiological constituents, and evaluated the homogeneity of the waste in the tank. The samples were joined into two composite samples (WI-549 and WI-550) and analyzed. The 12 samples were mostly clear yellow liquid samples with a few dark specks. The 12 500 mL samples were received in plastic bottles. Each sample was sealed in an ice cream carton with tamper-indicating tape. No seal had been disturbed upon arrival. Table B-3 contains the information for the 12 samples. No further details about the techniques used to extract samples from tank 241-AP-104 were available.

Table B-3. Results from Composite Sample Analyses.[1,2] (3 Sheets)

Waste Tank 241-AP-104					
March 1, 1988					
Component	WI-549 (#1)	WI-549 (#2)	WI-550 (#1)	WI-550 (#2)	Units
Physical Analysis					
SpG	1.019	1.022	1.001	1.008	---
Total solids	3.15	3.22	---	---	wt%
Centrifuged solids	0.13	0.14	---	---	wt%
H_2O	96.80	96.80	---	---	wt%
pH	11.71	11.7	---	---	---
Chemical Analysis					
Ag	< 6.300E-01	< 6.300E-01	< 6.30E-01	< 6.30E-01	ppm
Al	< 2.520E+00	< 2.720E+00	< 2.52E+00	< 2.52E+00	ppm
Ba	< 1.743E+00	< 1.740E+00	< 1.74E+00	< 1.74E+00	ppm
Be	---	---	---	---	ppm
Bi	2.730E+01	2.860E+01	2.73E+01	2.86E+01	ppm
Ca	1.111E+00	1.753E+00	1.28E+00	1.66E+00	ppm
Cd	< 5.250E+00	< 5.250E+00	< 5.25E+00	< 5.25E+00	ppm
Cr	1.795E+00	1.580E+00	1.94E+00	1.51E+00	ppm
Cu	< 6.720E-01	< 7.040E-01	< 6.72E-01	< 6.72E-01	ppm
Fe	2.069E+00	2.403E+00	2.36E+00	2.42E+00	ppm
K	< 6.090E+01	< 6.380E+01	< 6.09E+01	< 3.09E+01	ppm
Mg	1.607E+00	1.688E+00	1.62E+00	1.57E+00	ppm
Mn	< 1.218E+01	< 1.276E+01	< 1.22E+01	< 1.22E+01	ppm
Mo	< 1.239E+01	< 1.298E+01	< 1.24E+01	< 1.24E+01	ppm
Na	1.182E+04	1.140E+04	1.17E+04	1.23E+04	ppm
Ni	< 7.980E+00	< 8.360E+00	< 7.98E+00	< 7.98E+00	ppm
Pb	8.610E+01	9.020E+01	8.61E+01	8.61E+01	ppm
P	5.402E+03	5.330E+03	5.05E+03	5.40E+03	ppm
Si	< 2.100E+01	< 2.200E+01	< 2.10E+01	< 2.10E+01	ppm
Sn	< 1.008E+01	< 1.056E+01	< 1.01E+01	< 1.01E+01	ppm
Ti	< 1.764E+00	< 1.848E+00	< 1.78E+00	< 1.76E+00	ppm
V	---	---	---	---	ppm

Table B-3. Results from Composite Sample Analyses.[1,2] (3 Sheets)

Waste Tank 241-AP-104					
March 1, 1988					
Component	WI-549 (#1)	WI-549 (#2)	WI-550 (#1)	WI-550 (#2)	Units
W	---	---	---	---	ppm
Zr	< 3.780E+00	< 3.960E+00	< 3.78E+00	< 3.78E+00	ppm
Zn	---	---	---	---	ppm
As	< 50	< 50	< 50	< 50	ppb
Se	---	---	---	---	ppb
Hg	---	---	---	---	ppb
U	< 2.260E-03	< 2.260E-03	< 2.260E-03	< 2.260E-03	g/L
Th	---	---	---	---	g/L
Cl	2.250E-03	2.150E-03	2.28E-03	2.25E-03	M
F	< 6.720E-04	< 6.720E-04	< 6.720E-04	< 6.720E-04	M
SO_4	1.440E-02	1.390E-02	1.960E-02	2.210E-02	M
PO_4	1.590E-01	1.530E-01	1.850E-01	1.880E-01	M
NO_3	2.020E-03	2.020E-03	2.020E-03	2.020E-03	M
NO_2	1.860E-05	1.810E-05	1.470E-05	1.640E-05	M
OH	Too Low	Too Low	Too Low	Too Low	---
CO_3	2.850E-02	2.870E-02	2.780E-02	2.780E-02	M
S	No Method	No Method	No Method	No Method	---
CN	< 1	< 1	< 1	< 1	μg/mL
TOC	0.213	0.221	---	---	g/L

Table B-3. Results from Composite Sample Analyses.[1,2] (3 Sheets)

Waste Tank 241-AP-104					
March 1, 1988					
Component	WI-549 (#1)	WI-549 (#2)	WI-550 (#1)	WI-550 (#2)	Units
Radiological Analysis					
Total Beta	9.76	9.76	8.66	8.84	μCi/L
^{3}H	---	---	---	---	μCi/L
^{14}C	9.20E-04	1.26E-03	---	---	μCi/L
^{79}Se	No Method	No Method	No Method	No Method	μCi/L
^{90}Sr	2.98E-02	3.54E-02	3.48E-02	3.74E-02	μCi/L
^{99}Tc	5.82E-02	4.28E-02	4.80E-02	4.39E-02	μCi/L
^{129}I	< 2.51E-02	< 3.09E-02	< 4.82E-02	< 3.07E-02	μCi/L
Total Alpha	8.83E-03	6.59E-03	7.970E-03	7.760E-03	μCi/L
$^{239/240}Pu$	1.59E-03	7.45E-05	1.08E-03	1.02E-03	μCi/L
^{241}Am	8.25E-04	7.42E-04	9.54E-03	8.70E-04	μCi/L
^{237}Np	< 2.700E-01	< 2.700E-01	< 2.700E-01	< 2.700E-01	μCi/L
^{244}Cm	1.26E-03	9.62E-04	1.26E-03	9.35E-04	μCi/L
^{137}Cs	4.96E-01	6.68E-01	4.62E-01	4.84E-01	μCi/L
^{134}Cs	---	---	---	---	μCi/L
^{60}Co	6.71E+00	6.59E+00	6.90E+00	6.67E+00	μCi/L
^{54}Mn	1.56E-01	6.20E-02	1.59E-01	1.88E-01	μCi/L
$^{106}RuRh$	< 4.70E-01	1.04E+00	9.98E-01	1.10e+00	μCi/L

Note:

[1]Winters (1988)

[2]Data contained in this table no longer represent the current tank contents.

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APPENDIX C

UPPER LIMITS TO ONE-SIDED 95 PERCENT CONFIDENCE INTERVALS ON THE MEAN FOR DOUBLE-SHELL TANK 241-AP-104

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C.0 UPPER LIMITS TO ONE-SIDED 95 PERCENT CONFIDENCE INTERVALS ON THE MEAN FOR DOUBLE-SHELL TANK 241-AP-104

C.1 INTRODUCTION

Table C-1 shows the upper 95 percent confidence interval limits for the total alpha activity analyses. The limits were calculated for each sample-duplicate pair and are compared with the DQO limit for total alpha activity (61.5 μCi/mL). If the upper 95 percent confidence limit is less than 61.5 μCi/mL, the total alpha activity is also less than 61.5 μCi/mL .

Table C-1. 95 Percent Upper Confidence Limits for Total Alpha Activity Sample-Duplicate Pairs.[1]

Sample Number	Sample Location	Result	Duplicate	Sample Mean	95% Upper Confidence Level
		μCi/mL	μCi/mL	μCi/mL	μCi/mL
S96V000011	Riser 1, 270°N	3.610E-04	3.400E-04	3.505E-04	4.88E-04
S96V000013		3.050E-04	2.360E-04	2.705E-04	4.17E-04
S96V000009	Riser 1, 30° N	4.510E-04	4.650E-04	4.580E-04	5.02E-04
S96V000010		2.360E-04	2.290E-04	2.3250E-04	2.55E-04

Notes:

The 95 percent upper confidence limits were calculated by Los Alamos Technical Associates .

[1]Miller (1996)

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Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
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Department of Energy - Richland Operations					
J. F. Thompson	S7-54	X			
W. S. Liou	S7-54	X			
N. W. Willis	S7-54	X			
ICF-Kaiser Hanford Company					
R. L. Newell	S3-09	X			
Pacific Northwest Laboratory					
N. G. Colton	K3-75	X			
*J. R. Gormsen	K7-28				X
S. A. Hartley	K5-12	X			
J. G. Hill	K7-94	X			
G. J. Lumetta	P7-25	X			
A. F. Noonan	K9-81	X			
Westinghouse Hanford Company					
H. Babad	S7-14	X			
D. A. Barnes	R1-80	X			
G. R. Bloom	H5-61	X			
W. L. Cowley	A3-37	X			
L. A. Diaz	T6-06	X			
G. L. Dunford	S7-81	X			
*E. J. Eberlein	R2-12				X
D. B. Engelman	R1-49	X			
J. S. Garfield	H5-49	X			
*J. D. Guberski	R1-51				X
D. L. Herting	T6-09	X			
D. C. Hetzer	S6-31	X			
G. Jansen	H6-33	X			
G. D. Johnson	S7-15	X			
T. J. Kelley	S7-21	X			
N. W. Kirch	R2-11	X			
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H. Sutter		X			
555 Quince Orchard Rd., Suite 500 Gaithersburg, MD 20878					
P. Szerszen		X			
Los Alamos Laboratory CST-14 MS-J586 P. O. Box 1663 Los Alamos, NM 87545					
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T. T. Tran	B1-44	X			
Ogden Environmental 101 East Wellsian Way Richland, WA 99352					
R. J. Anema		X			
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D. Powers		X			
Nuclear Consulting Services Inc. P. O. Box 29151 Columbus, OH 43229-01051					
J. L. Kovach		X			
Chemical Reaction Sub-TAP P.O. Box 271 Lindsborg, KS 67456					
B. C. Hudson		X			
Tank Characterization Panel Senior Technical Consultant Contech 7309 Indian School Road Albuquerque, NM 87110					
J. Arvisu		X			
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C. T. Narquis	T6-16	X			
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L. M. Sasaki (2)	R2-12	X			
L. W. Shelton, Jr.	H5-49	X			
B. C. Simpson	R2-12	X			
G. L. Troyer	T6-50	X			
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K. A. White	S5-13	X			
W. D. Winkelman	R2-12	X			
~~TFIC (Tank Farm Information Center)~~	~~R1-20~~	~~X~~ No Longer			
Central Files	A3-88	X			
EDMC	H6-08	X			
ERC (Environmental Resource Center)	R1-51	X			
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TCRC (10)	R2-12	X			