

Sta 4 (3)

JUL 29 1996

ENGINEERING DATA TRANSMITTAL

Page 1 of 4  
1. EDT 617507

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-A-102/Waste Management/DAI/TWRS Technical Basis	6. Cog. Engr.: Jaiduk Jo	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
11. Receiver Remarks: For release.		10. System/Bldg./Facility: 241-A-102
		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 07/22/96

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-ER-597	N/A	0	Tank Characterization Report for Single-Shell Tank 241-A-102	N/A	2	1	1

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

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)										(G)	(H)
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
2	1	Cog. Eng. J. Jo	<i>J. Jo</i>	7/29/96							
2	1	Cog. Mgr. J.G. Kristofzski	<i>J.G. Kristofzski</i>	7/29/96							
		QA									
		Safety									
		Env.									
1		R.J. Cash	<i>R.J. Cash</i>	per telecom 7/29/96							

18. A.E. Young <i>A.E. Young</i> Signature of EDT Originator Date 7-29-96	19. N/A Authorized Representative Date for Receiving Organization	20. <i>J.G. Kristofzski</i> J.G. Kristofzski Cognizant Manager Date 7/29/96	21. DOE APPROVAL (if required) Ctrl. No. <input type="checkbox"/> Approved <input type="checkbox"/> Approved w/comments <input type="checkbox"/> Disapproved w/comments
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# Tank Characterization Report for Single-Shell Tank 241-A-102

**Jaiduk Jo**

Westinghouse Hanford Company, Richland, WA 99352  
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: EDT-617507 UC: 2070  
Org Code: 79400 Charge Code: N4G4D  
B&R Code: EW 3120074 Total Pages: 23

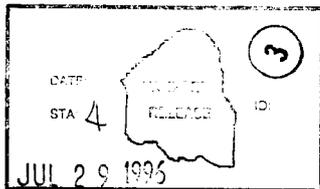
Key Words: Tank Characterization Report, TCR, Single-Shell Tank, Single-Shell, SST, Tank 241-A-102, Tank A-102, A-102, A Farm

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-A-102. This report supports the requirements of Tri-Party Agreement Milestone M-44-09.

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*Jaiduk Jo* 7/29/96  
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# Tank Characterization Report for Single-Shell Tank 241-A-102

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Date Published  
July 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

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## EXECUTIVE SUMMARY

This characterization report summarizes the available information on the historical uses and the current status of Hanford Site single-shell tank 241-A-102, and presents the analytical results of the June 1995 and March 1996 auger sampling and analysis project. This report supports the requirements of *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-09 (Ecology et al. 1996).

Tank 241-A-102 is located in the Hanford Site 200 East Area A Tank Farm.

Tank 241-A-102 went into service in the first quarter of 1956, receiving organic wash water waste from the Plutonium-Uranium Extraction (PUREX) Plant. Later in 1956, the tank began receiving PUREX high-level waste. The transfers of organic wash water waste ceased in 1963, while the receipts of PUREX high-level waste continued until 1980. Over its service life, the tank also received supernatant waste from various tanks, PUREX sludge, B Plant strontium recovery waste, B Plant high-level waste, and evaporator feed waste.

Tank 241-A-102 was sluiced in 1964, 1972-1974, and 1976. Starting in the fourth quarter of 1976, the tank became the primary feed tank for the 242-A Evaporator. It was declared inactive in November 1980, with intrusion prevention completed in 1982 and interim stabilization completed in August 1989 (Agnew et al. 1996b).

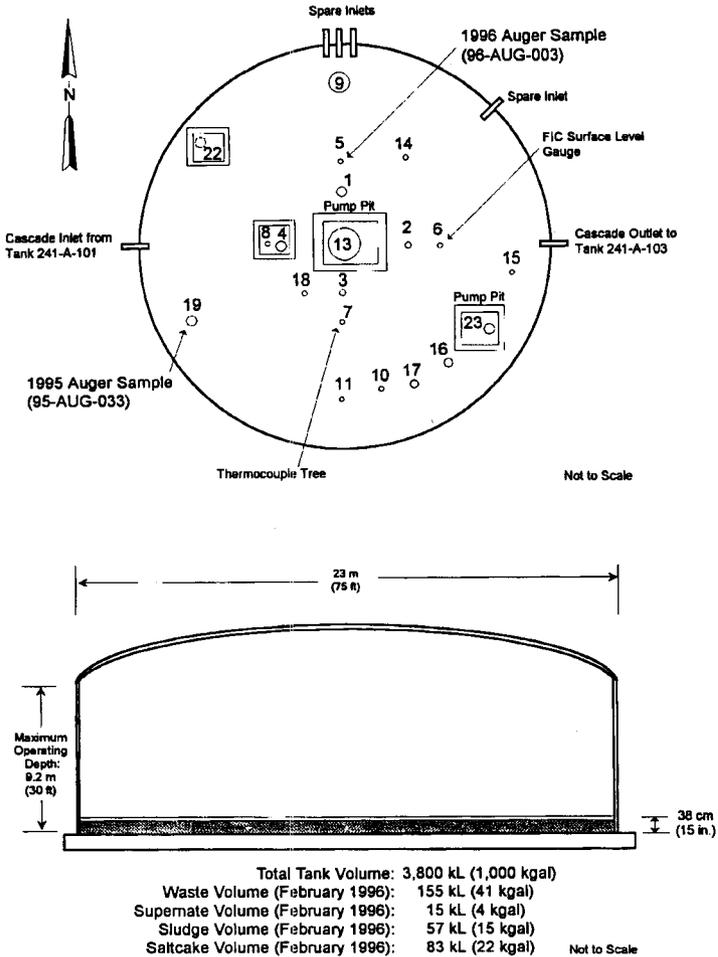
A description of tank 241-A-102 is presented in Table ES-1 and a tank profile is provided in Figure ES-1. The tank has an operating capacity of 3,800 kL (1,000 kgal) and presently contains an estimated 155 kL (41 kgal) of waste. Of this total volume, 83 kL (22 kgal) is

predicted to be saltcake, 57 kL (15 kgal) is estimated to be sludge, and 15 kL (4 kgal) is supernatant (Hanlon 1996). The sludge contains an estimated 8 kL (2 kgal) of drainable interstitial liquid.

Table ES-1. Description and Status of Tank 241-A-102.

<b>TANK DESCRIPTION</b>	
Type	Single-shell
Constructed	1954-1955
In-service	1st quarter 1956
Diameter	23 m (75 ft)
Operating depth	9.2 m (30 ft)
Capacity	3,800 kL (1,000 kgal)
Bottom shape	Flat
Ventilation	Passive
<b>TANK STATUS</b>	
Waste classification	Double-shell slurry feed
Total waste volume	155 kL (41 kgal)
Sludge volume	57 kL (15 kgal)
Saltcake volume	83 kL (22 kgal)
Supernatant volume	15 kL (4 kgal)
Waste surface level (1991 - 1996)	39.4 cm (15.5 in.) to 41.9 cm (16.5 in.)
Temperature (5/77 - 5/96)	17 °C (63 °F) to 55.5 °C (132 °F)
Integrity	Sound
Watch List	None
<b>SAMPLING DATES</b>	
Auger samples	June 1995 & March 1996
<b>SERVICE STATUS</b>	
Declared inactive	November 1980
Intrusion prevention	1982
Interim stabilization	August 1989

Figure ES-1. Profile of Tank 241-A-102.



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This report summarizes the collection and analysis of the auger samples acquired in June 1995 and March 1996. The sampling event was performed to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). The sampling and analyses were performed in accordance with the *Tank 241-A-102 Auger Sampling and Analysis Plan* (Jo 1995b). Sample 95-AUG-033 was taken in June 1995 from riser 19, and sample 96-AUG-003 was taken in March 1996 from riser 5. The safety screening data quality objective (DQO) requires samples from two different risers; however, at the time of the 1995 sampling event, only one riser was available for auger sampling. Once another riser became available, sample 96-AUG-003 was taken to satisfy the DQO. The safety screening DQO requires analyses for fuel content using differential scanning calorimetry (DSC), percent water by thermogravimetric analysis (TGA), total alpha activity through alpha proportional counting, and bulk density by centrifugation. 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 core sampling, and the flammability was measured as a percentage of the lower flammability limit (LFL) using a combustible gas meter.

For the DSC analyses, the highest exothermic reaction measured was -319 J/g (dry weight), which was below the safety screening DQO decision limit of -480 J/g. In addition, all of the 95 percent confidence interval upper limits were below the limit, with the highest value being -354 J/g. Although not required by the sampling and analysis plan (SAP), total organic carbon (TOC) was analyzed as a result of exothermic reactions in the DSC results. All TOC results were less than the decision limit of 30,000  $\mu\text{g C/g}$  (dry weight), with an overall mean

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of 22,500  $\mu\text{g C/g}$  (dry weight). However, the upper limit of the 95 percent confidence interval for sample 96-AUG-003 (32,700  $\mu\text{g C/g}$ ) slightly exceeded the decision limit. According to the organic DQO (Turner et al. 1995), because the weight percent water results were greater than 17 percent, the tank may be considered conditionally safe (Jo 1996b). In addition, monitoring may be required to ensure that the waste will not dry out during interim storage. Sample 96-AUG-003 was analyzed for total cyanide to determine whether or not the ferrocyanide safety program DQO should be applied. All cyanide results were less than the decision limit of 39,000  $\mu\text{g/g}$ , with a mean of 48.2  $\mu\text{g/g}$ . The mean weight percent water, determined by TGA, was 34.3 percent. All total alpha activity results and 95 percent confidence interval upper limits were below the safety screening DQO decision limit of 36  $\mu\text{Ci/g}$ . The density of the solids was 1.7  $\text{g/mL}$ . The flammability of the tank 241-A-102 headspace was measured at zero percent of the LFL, satisfying the safety screening requirement of less than 25 percent of the LFL.

An estimate of the tank heat load could not be calculated from the 1995/1996 analytical data because radionuclides were not evaluated during the sampling and analysis event. Instead, a heat load estimate was derived from radionuclide data from a 1986 core sampling event. The calculated result was 1,130 W (3,860 Btu/hr). The actual value would be less than this, because 10 years have passed since the analysis and the primary heat-producing radionuclides,  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$ , have half-lives of 28.1 and 30.2 years, respectively. The Hanford Defined Waste model (Agnew et al. 1996a) prediction was 750 W (2,560 Btu/hr), while the heat load based on headspace temperature was 3,760 W (12,800 Btu/hr). All heat load estimates were well below the 11,700-W (40,000-Btu/hr) threshold differentiating

high-heat from low-heat tanks (Bergmann 1991). It may be concluded that any heat generated from radioactive sources throughout the year is dissipated because the current tank high temperature is much lower than that observed in the past.

Finally, several conclusions were drawn from the analytical results. The waste currently in tank 241-A-102 may continue to be safely stored in the tank. In addition, no further characterization efforts are needed at this time. Lastly, there were no unexpected findings that could affect the ability to retrieve and dispose of the waste safely.

The average values for major analytes and analytes of concern are presented in Table ES-2.

Table ES-2. Major Analytes and Analytes of Concern.

Analyte	Mean Solids Concentration	Solids RSD (Mean)	Solids Inventory
<b>METALS</b>	$\mu\text{g/g}$	%	kg
Aluminum	31,700	3.3	8,360
Chromium	8,800	2.9	2,320
Iron	19,600	3.1	5,170
Manganese	3,380	3.0	892
Potassium	3,080	2.1	813
Silicon	3,920	2.9	1,030
Sodium	1.29E+05	3.9	34,000
Uranium	35,300	4.0	9,310
<b>ANIONS</b>	$\mu\text{g/g}$	%	kg
Chloride	7,970	41.8	2,100
Nitrate	90,300	3.9	23,800
Nitrite	83,200	4.1	21,900
Oxalate	11,900	5.0	3,140
Phosphate	6,300	5.2	1,660
Sulfate	4,480	13.6	1,180
<b>CARBON</b>	$\mu\text{g C/g}$	%	kg
TIC	4,340	2.9 <sup>1</sup>	1,140
TOC	14,200	2.0 <sup>1</sup>	3,910
<b>PHYSICAL PROPERTIES</b>		%	kg
Water	34.3 wt%	6.2 <sup>1</sup>	90,500
Density	1.7 g/mL	N/A	N/A

Notes:

- RSD (Mean) = relative standard deviation of the mean.
- TIC = total inorganic carbon
- wt% = weight percent

<sup>1</sup>RSD of the mean

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LIST OF TERMS

A1SlCk	242-A Evaporator saltcake
A2SlSlry	242-A Evaporator saltslurry
ANOVA	analysis of variance
Btu/hr	British thermal units per hour
Ci	curies
Ci/L	curies per liter
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
HDW	Hanford Defined Wastes
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
LEL	lower explosive limit
LFL	lower flammability limit
M	moles per liter
m	meters
mg	milligrams
mm	millimeters
mR/hr	milliroentgen per hour
ppm	parts per million
PUREX	Plutonium-Uranium Extraction (Plant)
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
SAP	sampling and analysis plan
SRR	strontium recovery sludge
TLM	Tank Layer Model
TGA	thermogravimetric analysis

**LIST OF TERMS (Continued)**

TIC	total inorganic carbon
TOC	total organic carbon
W	watts
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/L	microcuries per liter
μeq/g	microequivalents per gram
μg C/g	micrograms carbon per gram
μg/g	micrograms per gram
ΔH	change in enthalpy

## 1.0 INTRODUCTION

This tank characterization report contains an overview of single-shell tank 241-A-102 and its waste contents. Estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities are presented, in combination with background tank information. The characterization of tank 241-A-102 is based on the results of auger samples taken in June 1995 and March 1996. For informational purposes, results from a 1986 core sampling event and a 1989 supernatant sampling event are also presented.

Tank 241-A-102 was declared inactive in November 1980. Intrusion prevention of the tank was completed in 1982 and interim stabilization was completed in August 1989. Therefore, the composition of the waste should not change appreciably until pretreatment and retrieval activities commence. The analyte concentrations reported in this document reflect the best composition estimates of the waste based on the available analytical data and historical models. 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

The purpose of this report is to summarize the information about the use and contents of tank 241-A-102. Where possible, this information will be used to assess issues associated with safety, operations, environmental, and process development activities. This report also serves as a reference point for more detailed information concerning tank 241-A-102.

### 1.2 SCOPE

The June 1995 and March 1996 auger sampling events for tank 241-A-102 supported the evaluation of the tank waste according to *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). Safety screening analyses were performed on the two auger samples as directed in *Tank 241-A-102 Auger Sampling and Analysis Plan* (Jo 1995b). These analyses were differential scanning calorimetry (to evaluate fuel level and energetics), thermogravimetric analysis (to determine moisture content), total alpha activity analysis (to evaluate criticality potential), and bulk density.

Combustible gas meter readings of the tank headspace vapor were also taken, as required by the safety screening data quality objective (DQO), to address flammability concerns. In addition to the analyses required to satisfy the safety screening DQO, inductively coupled plasma emission spectroscopy (ICP) analyses for metals and ion chromatography (IC) analyses for anions were performed on the March 1996 sample in accordance with the letter on opportunistic analyses by Kristofzski (1995). Total organic carbon was analyzed at the

request of the data review committee (Kirch 1995), and cyanide was measured to determine if the ferrocyanide DQO should be applied. Total inorganic carbon (TIC) was analyzed in the process of obtaining total organic carbon (TOC) data.

## 2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-A-102 based on historical information. The first part details the current condition of the tank. The next part discusses the tank's design, transfer history, and the process sources that contributed to the tank waste, including an estimate of the current contents based on the process history. Conditions that may be related to tank safety issues, such as potentially hazardous tank contents or off-normal operating temperatures, are included. The final part summarizes available surveillance data for the tank. 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 provided to evaluate the heat-generating characteristics of the waste.

### 2.1 TANK STATUS

As of February 29, 1996, tank 241-A-102 contained an estimated 155 kL (41 kgal) of waste classified as double-shell slurry feed (Hanlon 1996). Liquid volume was determined using a photographic evaluation method, and solids volume was last updated on July 27, 1989 using a Food Instrument Corporation (FIC) surface-level gauge and photographic evaluation. However, a recent in-tank video (February 1996) showed that the waste surface is primarily dry and cracked. Some small pools of supernatant did remain, but the overall supernatant volume is probably less than Hanlon's estimate of 15 kL (4 kgal). The amounts of various waste phases existing in the tank are presented in Table 2-1.

Table 2-1. Estimated Tank Contents.<sup>1</sup>

Waste Form	Estimated Volume	
	kL	kgal
Supernatant liquid	15	4
Sludge	57	15
Saltcake	83	22
Total waste	155	41

Note:

<sup>1</sup>Hanlon (1996)

Tank 241-A-102 is identified as sound. The tank was removed from service in November 1980, with intrusion prevention completed in 1982 and interim stabilization completed in August 1989. Tank 241-A-102 is passively ventilated and is not on any Watch List. All monitoring systems were in compliance with documented standards as of February 29, 1996 (Hanlon 1996).

## 2.2 TANK DESIGN AND BACKGROUND

The A Tank Farm was constructed between 1954 and 1955 in the Hanford Site 200 East Area. The A Tank Farm contains six 100-series tanks, each with a 3,800-kL (1,000-kgal) volume, a 23-m (75-ft) diameter, and a 9.2-m (30-ft) operating depth. Tank 241-A-102 began operating in the first quarter of 1956. The A Tank Farm was designed for self-boiling waste with a fluid temperature of 121 °C (250 °F). Tank 241-A-102 is second in the four-tank cascade of 241-A-101, -102, -103, and -106. A 75-mm (3-in.)-diameter cascade overflow line connects four tanks together. Each tank in the cascade series is set 30 cm (1 ft) lower in elevation from the preceding tank. The cascade overflow height is approximately 9.4 m (371 in.) from the tank bottom (Brevick et al. 1995).

These tanks have a flat bottom with no knuckle. Similar to the tanks in all other single-shell tank farms, the tanks in A Tank Farm are designed with a primary mild steel liner (ASTM A283-52T Grade B or C) and a concrete dome with various risers. The tanks are set on a reinforced concrete foundation. A three-ply asphalt waterproofing was applied over the foundation and steel tank. One coat of red lead paint was sprayed on all exposed interior tank surfaces. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the manholes in the tank dome. The tanks were waterproofed on the sides and top with tar and a welded-wire-reinforced mixture of cement, sand and water. Each tank was covered with approximately 2 m (7 ft) of overburden.

Tank 241-A-102 has 20 risers ranging in size from 100 mm (4 in.) in diameter to 1.1 m (42 in.) in diameter. Table 2-2 shows riser numbers, sizes, and descriptions. A plan view that depicts the riser configuration is shown as Figure 2-1. There are four air-lift circulators and a heating coil in this tank. Riser 2, which is 200 mm (8 in.) in diameter, and riser 19, which is 300 mm (12 in.) in diameter, are available for use. A tank cross-section showing the approximate waste level along with a schematic of the tank equipment is shown in Figure 2-2.

Table 2-2. Tank 241-A-102 Risers.<sup>1,2,3,4,5</sup>

Riser Number	Diameter		Description and Comments
	cm	in.	
1	30	12	Air circulator lines
2	20	8	Welded plate
3	20	8	Drywell
4	30	12	Pump, weather covered
5	10	4	Flange, 1996 Sample 96-AUG-003
6	10	4	Food Instrument Corporation level gauge
7	10	4	Thermocouple tree
8	10	4	Pit drain, weather covered
9	51	20	Under ground vent line - below grade
10	10	4	Drain - below grade
11	10	4	Below grade
13	110	42	Pump, weather covered
14	15	6	Drain - below grade
15	15	6	Drain - below grade
16	25	10	Drain - below grade
17	25	10	Drain - below grade
18	10	4	Breather filter
19	30	12	B-222 observation port, bench mark, 95 Sample 95-AUG-033
22	30	12	Weather covered
23	30	12	Weather covered
N1	8	3	Cascade outlet nozzle
N2	8	3	Spare nozzle
N3	8	3	Spare nozzle
N4	8	3	Fill line nozzle
N5	8	3	Fill line nozzle
N6	8	3	Cascade inlet nozzle

Notes:

<sup>1</sup>Alstad (1993)

<sup>2</sup>Tran (1993)

<sup>3</sup>Vitro Engineering (1985)

<sup>4</sup>ARHCO (1971)

<sup>5</sup>General Electric (1970)

Figure 2-1. Riser Configuration for Tank 241-A-102.

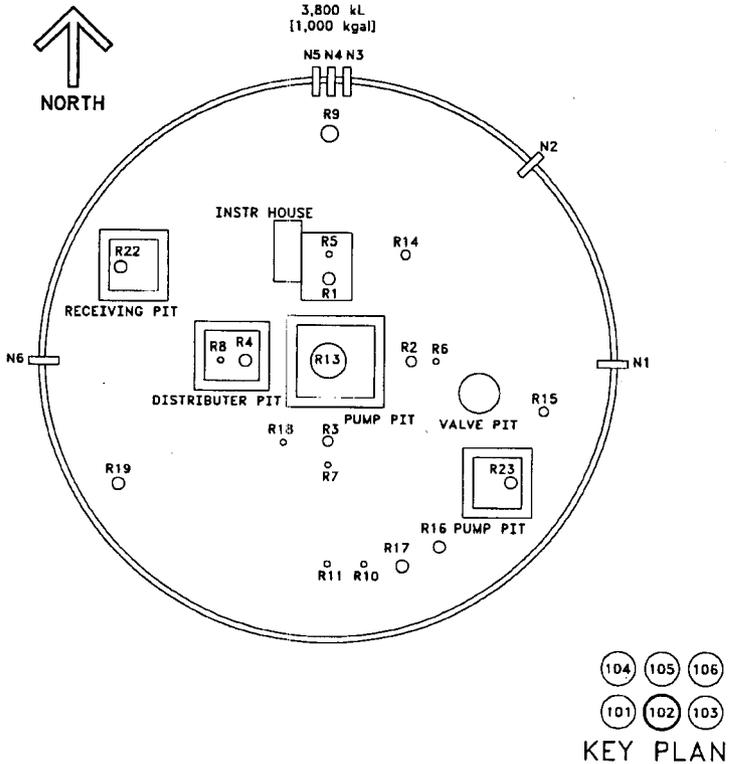
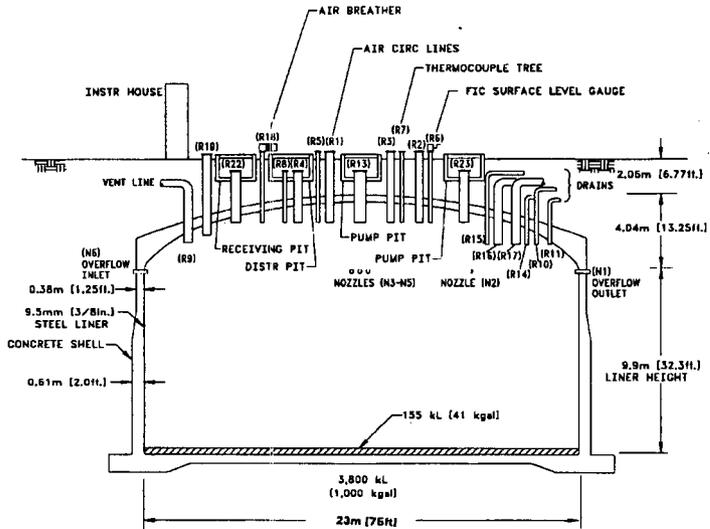


Figure 2-2. Tank 241-A-102 Cross-Section.



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## 2.3 PROCESS KNOWLEDGE

The following sections present the transfer history of waste in tank 241-A-102 and describe the process wastes transferred. This is followed by an estimate of current tank contents based on transfer history.

### 2.3.1 Waste Transfer History

Many types of waste additions and transfers occurred in tank 241-A-102, from the first waste addition of organic wash water waste from the Plutonium-Uranium Extraction (PUREX) Plant on March 22, 1956, through November 1980 when the tank was declared inactive. The tank originally received organic wash and PUREX high-level waste from 1956 to 1963. Various transfers due to sluicing and other operations are apparent from 1963 to 1972. Waste was transferred into and out of this tank for strontium recovery operations in B Plant from 1972 to 1976. Starting in the fourth quarter of 1976, tank 241-A-102 became the primary feed tank for the 242-A Evaporator. The tank was very active as an evaporator feed tank until it was declared inactive in 1980. The last transfer, during the third quarter of 1983, consisted of saltwell pumping 241-A-102 waste to tank 241-AN-101 prior to interim stabilization.

Information concerning concentrates from the tank is not included in the table, but is summarized here. Because tank 241-A-102 was a self-boiling tank, condensate waste was sent to the 216-A-008 crib from the third quarter of 1956 to the second quarter of 1957. Condensate waste was then sent to tank 241-A-106 from the second quarter of 1958 until the second quarter of 1961. It was also sent to both tank 241-A-106 and crib 216-A-024 from the third to the fourth quarter of 1961. In addition, it was sent to crib 216-A-024 from the third quarter of 1962 to the second quarter of 1963. No destination is given in the available transfer records for some of the condensate transferred out of the tank at various dates spanning 1958 to 1980.

The following table, derived from *Waste Status and Transaction Record Summary for the Northeast Quadrant* (Agnew et al. 1996b), covers a yearly account of waste transfers to and from tank 241-A-102.

Table 2-3. Summary of Tank 241-A-102 Waste Transfer History.<sup>1,2</sup> (5 sheets)

Transfer Source		Waste Type	Time Period	Estimated Waste Volume		
From	To			Received	Transferred	Remaining
A Plant (PUREX)	C-103, C-106, condensate	PUREX high level & Organic wash water waste	1956 - 1963	35,640 kL (9,415 kgal)	30,393 kL (8,029 kgal)	5246 kL <sup>3</sup> (1,386 kgal)
A-101, A-105, B-103, B-109, C-101, C-106	C-101, C-105, C-106, condensate	PUREX high-level waste	1963	8,718 kL (2,303 kgal)	12,617 kL (3,333 kgal)	1,347 kL (356 kgal)
A-101, A-104, A-106, BX-109, C-105, C-106	A-103, condensate	PUREX high-level waste	1964	8,335 kL (2,202 kgal)	6163 kL (1,628 kgal)	3,520 kL (930 kgal)
A-101, A-104, A-106, AX-101, AX-102, AX-103, AX-104, B-110, C-102, flush water	A-103, A-105, AX-103, C-102, condensate	PUREX high-level waste	1965	21,471 kL (5,672 kgal)	21,524 kL (5,686 kgal)	3,467 kL (916 kgal)
A-101, A-103, A-104, A-106, AX-101, AX-103, AX-104, B-110, C-105	A-103, AX-104, condensate	PUREX high-level waste	1966	9,653 kL (2,550 kgal)	9,585 kL (2,532 kgal)	3426 kL (905 kgal)
A-101, A-104, A-106, AX-101, AX-102, AX-103, AX-104	A-103, AX-101, AX-102, condensate	Supernatant waste	1967	14,210 kL (3,754 kgal)	14,464 kL (3,821 kgal)	3,263 kL (862 kgal)

Table 2-3. Summary of Tank 241-A-102 Waste Transfer History.<sup>1,2</sup> (5 sheets)

Transfer Source		Waste Type	Time Period	Estimated Waste Volume		
From	To			Received	Transferred	Remaining
A-101, A-103, A-104, A-106, AX-101, AX-103, AX-104	A-103, A-105, AX-102, condensate	Supernatant waste	1968	18,477 kL (4,881 kgal)	20,074 kL (5,303 kgal)	1,666 kL (440 kgal)
A-101, A-103, A-104, A-106, AX-101, AX-103, AX-104	A-106, C-105, condensate	PUREX high-level waste	1969	9,392 kL (2,481 kgal)	8,369 kL (2,211 kgal)	2,688 kL (710 kgal)
A-106, C-106	A-106, C-105	PUREX high-level waste	1970	848 kL (224 kgal)	2,328 kL (615 kgal)	1,268 kL (335 kgal)
A-106, flush water	C-106	PUREX high-level waste	1971	454 kL (120 kgal)	734 kL (194 kgal)	916 kL (242 kgal)
(No transfers in)	B Plant, A-103, A-106	Slurried PUREX sludge	1972 - 1973	0 kL (0 kgal)	851 kL (225 kgal)	113 kL (30 kgal)
B Plant, A-106, AX-103	B Plant	PUREX high-level waste, slurried PUREX sludge, and strontium recovery waste	1974	2,411 kL (637 kgal)	57 kL (15 kgal)	2,468 kL (652 kgal)

Table 2-3. Summary of Tank 241-A-102 Waste Transfer History.<sup>1,2</sup> (5 sheets)

Transfer Source		Waste Type	Time Period	Estimated Waste Volume		
From	To			Received	Transferred	Remaining
B Plant, flush water	A-101	B Plant high-level waste and strontium recovery waste	1975	1,223 kL (323 kgal)	1,045 kL (276 kgal)	2,611 kL (690 kgal)
A-103, AX-102, AY-102, BX-104, BX-105, BX-106, BY-101, BY-104, C-104, C-106, flush water	A-101, A-103, A-106, AX-101, AX-104, AZ-101, AZ-102, BX-103, BX-104, C-103, C-104, condensate	PUREX high-level waste	1976	9,819 kL (2,594 kgal)	10,769 kL (2,845 kgal)	1,623 kL (429 kgal)

Table 2-3. Summary of Tank 241-A-102 Waste Transfer History.<sup>1,2</sup> (5 sheets)

Transfer Source		Waste Type	Time Period	Estimated Waste Volume		
From	To			Received	Transferred	Remaining
A-101, A-103, A-106, AX-102, AX-104, AY-101, AY-102, AZ-102, AZ-102, B-102, B-103, B-108, B-109, B-112, BX-103, BX-104, BX-105, BX-106, BX-107, BX-110, BX-111, BY-101, BY-102, BY-104, BY-106, BY-109, BY-110, BY-111, C-103, C-104, C-106, condensate flush water	A-101, A-103, AX-101, AX-102, AY-102, AZ-101, AZ-102, BX-103, BX-104, BX-105, BX-106, BX-111, BY-106, BY-110, BY-111, C-103, C-104, C-106, condensate	PUREX high-level waste for use as 242-A Evaporator feed	1977	24,094 kL (6,365 kgal)	24,280 kL (6,414 kgal)	1,457 kL (385 kgal)
A-101, A-103, A-106, AX-101, AX-102, AZ-101, BX-104, BX-105, BX-112, BY-107, C-103, C-104, C-106, flush water	A-101, A-103, A-106, AX-102, AY-101, AY-102, AZ-101, BX-104, BY-109, BY-110, C-103, C-104, C-106, SY-102, condensate	PUREX high-level waste for use as 242-A Evaporator feed	1978	22,818 kL (6,028 kgal)	20,880 kL (5,516 kgal)	3,395 kL (897 kgal)

Table 2-3. Summary of Tank 241-A-102 Waste Transfer History.<sup>1,2</sup> (5 sheets)

Transfer Source		Waste Type	Time Period	Estimated Waste Volume		
From	To			Received	Transferred	Remaining
A-101, A-103, A-105, A-106, AX-101, AX-103, BX-104, BY-105, C-104, C-106, flush water	A-101, A-103, A-106, AX-101, AX-102, AX-103, AY-101, BY-110, C-104, C-106, SY-102, condensate water	PUREX high-level waste for use as 242-A Evaporator feed	1979	30,124 kL (7,958 kgal)	33,134 kL (8,753 kgal)	386 kL (102 kgal)
A-101, A-103, AX-101, AX-102, AX-103, AY-101, AY-102, BX-104, BX-105, BX-110, BY-110, C-104, flush water	A-101, A-103, A-106, AW-105, AX-101, AX-102, AX-103, AY-101, AY-102, AZ-101, AY-102, AZ-101, AZ-102, BX-104, SY-102, condensate water	PUREX high-level waste for use as 242-A Evaporator feed	1980	50,111 kL (13,238 kgal)	50,160 kL (13,251 kgal)	337 kL (89 kgal)
(No transfers in)	AN-101	Double Shell Slurry Feed	1983	0 kL (0 kgal)	182 kL (48 kgal)	155 kL (41 kgal)

Notes:

<sup>1</sup>Agnew et al. (1996b)

<sup>2</sup>Waste volumes and types are best estimates based on historical data.

<sup>3</sup>Estimated total waste volume does not include 4th quarter 1963 condensate transferred out.

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### 2.3.2 Historical Estimation of Tank Contents

The following estimates of tank 241-A-102's contents are based on historical transfer data. The estimates have not been validated and thus should be used with caution. The historical data used for the estimates are from the *Waste Status and Transaction Record Summary for the Northeast Quadrant (WSTRS)* (Agnew et al. 1996b), and the *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996a). Agnew et al. (1996a) contains the Hanford Defined Waste (HDW) list, the Tank Layer Model (TLM), and the Historical Tank Content Estimate (HTCE) predictions. TheWSTRS is a compilation of available waste transfer and volume status data. The HDW provides the assumed typical compositions for Hanford Site waste types. In most cases, the available data are incomplete, reducing the reliability of the transfer data and the modeling results derived from them. The TLM takes theWSTRS data, models the waste deposition processes and, using additional data from the HDW (which may introduce more error), generates an estimate of the tank contents. Thus, these model predictions can only be considered estimates that require further evaluation using analytical data.

Based on the TLM, tank 241-A-102 contains a top layer of 15 kL (4 kgal) of supernatant, a middle saltcake and saltslurry layer comprised of 57 kL (15 kgal) of 242-A Evaporator saltslurry (A2SlSlry), 72 kL (19 kgal) of 242-A Evaporator saltcake (A1SlSlck), and a bottom layer of 11 kL (3 kgal) strontium recovery sludge (SRR). Figure 2-3 shows a graphical representation of the estimated waste type and volumes for the tank layers. The SRR (bottom waste layer) should contain large quantities of sodium, iron, organic carbon, nitrite, hydroxide, calcium, carbonate, and silicate. Also present will be a large quantity of cesium and a very large quantity of strontium; therefore, this layer will have an activity that is larger than the other individual waste layers. Also, the TOC concentration is an order of magnitude greater than the A1SlSlck or A2SlSlry layers. The next waste layer, above the SRR layer, is made up of the A1SlSlck. The A1SlSlck will be rich in sodium, aluminum, nitrates, and sulfate. This waste contains slight to moderate quantities of uranium, iron, chromium, calcium, nickel, lead, bismuth, and manganese. Also, some organic carbon will be found. The activity of this layer will be moderate corresponding to the amount of cesium present. The layer above the A1SlSlck is the A2SlSlry, which is very similar to the A1SlSlck. The difference between the A1SlSlck and the A2SlSlry is that the A2SlSlry will have higher quantities of sodium, aluminum, and nitrate, but will have lower concentrations of sulfates. The top waste layer in tank 241-A-102 is supernatant, which has not been formally predicted. Table 2-4 shows an estimate of the expected waste constituents and their concentrations.

Figure 2-3. Tank Layer Model for Tank 241-A-102.

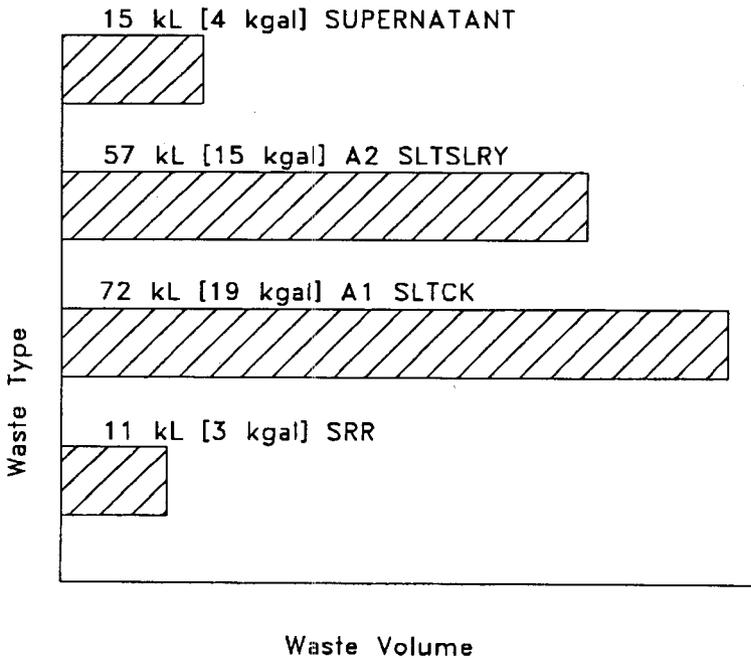


Table 2-4. Tank 241-A-102 Inventory Estimate.<sup>1,2</sup> (2 sheets)

Solids Composite Inventory Estimate			
Physical Properties			
Total solid waste	2.11E+05 kg (37 kgal)		
Heat load	750 W (2,560 Btu/hr)		
Bulk density	1.26 (g/mL)		
Water wt%	66.3		
Total organic carbon wt% carbon (wet)	0.981		
Chemical Constituents	M	ppm	kg <sup>3</sup>
Na <sup>+</sup>	4.82	88,000	17,200
Al <sup>3+</sup>	0.622	13,300	2,600
Fe <sup>3+</sup> (total Fe)	0.112	4,970	971
Cr <sup>3+</sup>	0.0181	746	146
Bi <sup>3+</sup>	4.53E-04	75.0	14.7
La <sup>3+</sup>	8.14E-06	0.897	0.175
Hg <sup>2+</sup>	3.68E-06	0.586	0.115
Zr (as ZrO(OH) <sub>2</sub> )	2.38E-04	17.2	3.37
Pb <sup>2+</sup>	5.06E-04	83.2	16.3
Ni <sup>2+</sup>	0.00185	86.3	16.9
Sr <sup>2+</sup>	2.71E-06	0.189	0.0369
Mn <sup>4+</sup>	0.00173	75.5	14.8
Ca <sup>2+</sup>	0.0202	644	126
K <sup>+</sup>	0.0224	696	136
OH <sup>-</sup>	3.49	47,100	9,200
NO <sub>3</sub> <sup>-</sup>	1.65	81,200	15,900
NO <sub>2</sub> <sup>-</sup>	0.943	34,400	6,730
CO <sub>3</sub> <sup>2-</sup>	0.219	10,400	2,040
PO <sub>4</sub> <sup>3-</sup>	0.0348	2,620	512
SO <sub>4</sub> <sup>2-</sup>	0.113	8,600	1,680
Si (as SiO <sub>3</sub> <sup>2-</sup> )	0.160	3,560	697
F <sup>-</sup>	0.0275	415	81.2
Cl <sup>-</sup>	0.0815	2,290	448

Table 2-4. Tank 241-A-102 Inventory Estimate.<sup>1,2</sup> (2 sheets)

Chemical Constituents (cont'd)	M	ppm	kg <sup>3</sup>
citrate <sup>3-</sup>	0.0126	1,890	370
EDTA <sup>4-</sup>	0.0235	5,370	1,050
HEDTA <sup>3-</sup>	0.0441	9,590	1,880
glycolate <sup>-</sup>	0.0691	4,110	804
acetate <sup>-</sup>	0.00927	434	84.9
oxalate <sup>2-</sup>	6.96E-06	0.486	0.0951
DBP	0.0102	2,150	421
Fe(CN) <sub>6</sub> <sup>4-</sup>	0	0	0
Radiological Constituents	Ci/L	μCi/g	Ci <sup>3</sup>
Pu	---	0.243	0.792
U	0.0773	14,600	2,850
Cs	0.105	83.5	16,300
Sr	0.645	511	1.00E+05

Notes:

<sup>1</sup>Agnew et al. (1996a)

<sup>2</sup>The HTCE predictions have not been validated and should be used with caution.

<sup>3</sup>Small differences appear to exist among the inventories in this column and the inventories calculated from the two sets of concentrations. These differences are being evaluated.

## **2.4 SURVEILLANCE DATA**

Tank 241-A-102 surveillance consists of surface level measurements (liquid and solid), and temperature monitoring inside the tank (waste and headspace). The data provide the basis for determining tank integrity.

Liquid level measurements may indicate if there is a major leak from the tank. Solid surface level measurements provide an indication of physical changes and consistency of the solid layers of a tank. Drywells located around the perimeter of the tank are used to detect increased radioactivity in the event of a leak.

### **2.4.1 Surface Level Readings**

Tank 241-A-102 surface level is monitored with a FIC gauge through riser 6. The FIC gauge is set in the intrusion mode for a 25-mm (1-in.) increase. If the FIC gauge fails, manual field measurements will be conducted quarterly. The baseline measurement is 419 mm (16.5 in.). The maximum allowable increase from the baseline is 75 mm (3 in.). On January 21, 1989, the surface level measurement exceeded the 25-mm (1-in.) decrease criteria. An event fact sheet was issued on January 25, 1989, in response to the decrease. Interior tank photographs, taken on January 27, 1989, showed no evidence of an increase or decrease in the liquid level. An unusual occurrence report was issued in February 1989 (Thurman 1989). A graphical representation of the volume measurements is presented as a level history graph in Figure 2-4. Tank 241-A-102 does not have a liquid observation well. Seven drywells are identified for tank 241-A-102.

### **2.4.2 Internal Tank Temperatures**

The temperature in tank 241-A-102 is monitored through riser 7 with a single thermocouple tree containing 18 thermocouples. Elevations are not available for the individual thermocouples. Temperature readings from the beginning of service to March 1977 are sporadic. Thermocouples 1 through 5 and 7 through 16 have similar temperature data for the years 1977 to 1993. Limited data are available for thermocouples 17 and 18 from 1984 to 1993, and for thermocouple 6 from 1977 to 1989. Plots of the individual thermocouple readings can be found in the HTCE supporting document for A Tank Farm (Brevick et al. 1994). A graph of the highest temperature for the reported temperature readings can be found in Figure 2-5.

Figure 2-4. Tank 241-A-102 Level History.

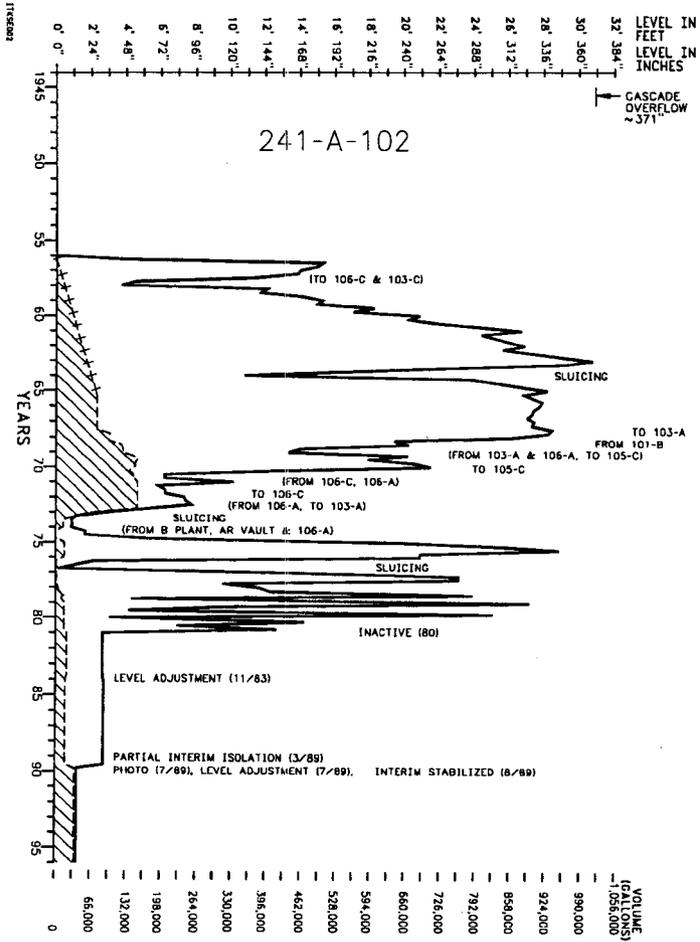
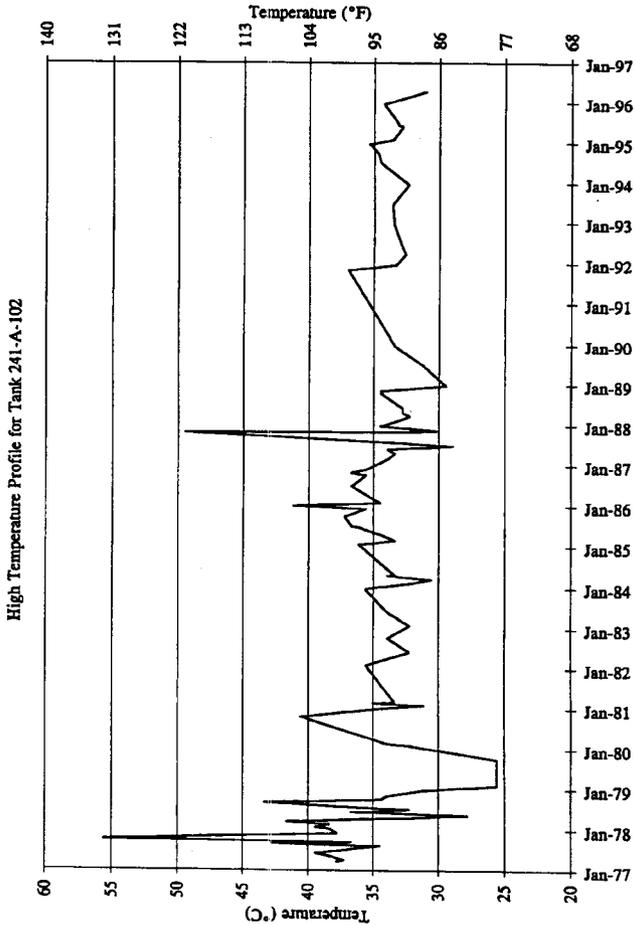


Figure 2-5. Tank 241-A-102 High Temperature Plot.



From March 1977 to May 1996, the tank's median temperature was 31.9 °C (89.5 °F), the minimum temperature was 17 °C (63 °F), and the maximum temperature was 55.6 °C (132 °F). Over the last year, the median temperature was 32 °C (89 °F), the minimum temperature was 29.6 °C (85.3 °F), and the maximum temperature was 34.2 °C (93.6 °F). The maximum temperature on May 3, 1996, was 31.0 °C (87.8 °F) on thermocouple 1. Tank 241-A-102 is a low-heat load tank and has a semiannual (January and July) temperature monitoring requirement.

### **2.4.3 Tank 241-A-102 Photographs**

The 1989 photographic montage of the tank 241-A-102 interior shows a thin, gray saltcake surface layer with patches of supernatant. Equipment visible in the photograph are three air lift circulators, a thermocouple tree, pump, manual tape, overflow inlet nozzle, pit drain, and a few risers. The photographs were taken before the supernatant was pumped from the tank, so the montage does not depict the current status of the tank. However, an in-tank video of the waste surface was taken in February 1996. The video showed the waste surface to be primarily dry and cracked, with intermittent pools of liquid.

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### 3.0 TANK SAMPLING OVERVIEW

This section describes the June 1995 and March 1996 sampling and analysis event for tank 241-A-102. Auger samples were taken to satisfy the requirements of *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). The sampling and analyses were performed in accordance with *Tank 241-A-102 Auger Sampling and Analysis Plan* (Jo 1995b). Further discussion of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

#### 3.1 DESCRIPTION OF SAMPLING EVENT

Auger samples from two risers were collected from tank 241-A-102. Sample 95-AUG-033 was collected from riser 19 on June 7, 1995, using a 20-in. auger with 1-in.-spaced flutes. The DQO required a minimum of two widely spaced vertical profiles to be used to classify the tank; however, a second riser was not found for auger sampling after all the available risers at that time were inspected (Jo 1995a). Sample 96-AUG-003 was later obtained from riser 5 on March 21, 1996, using a 20-in. auger with 0.5-in.-spaced flutes. No problems were noted during acquisition of this auger sample.

Prior to obtaining sample 96-AUG-003, the tank headspace flammability was measured to address the vapor flammability issue as required by the safety screening DQO. Combustible gas meter readings were taken on February 15, 1996, through riser 18 at the breather filter, 90 cm (3 ft) below the riser, and 6 m (20 ft) below the riser. Results for the lower flammability limit (LFL) of the flammable gases were obtained. Other gas reading instruments were used to obtain TOC, oxygen and ammonia.

All analyses were performed by the Westinghouse Hanford Company 222-S Laboratory in accordance with the sampling and analysis plan (SAP) (Jo 1995b) to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995). Table 3-1 summarizes the sampling and analysis requirements of the safety screening DQO.

Table 3-1. Data Quality Objective Requirements for Tank 241-A-102.<sup>1</sup>

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Auger sampling	Safety screening (Dukelow et al. 1995)	Samples from two risers separated radially to the maximum extent possible	<ul style="list-style-type: none"> <li>▶ Energetics</li> <li>▶ Moisture content</li> <li>▶ Total alpha activity</li> <li>▶ Flammable gas</li> <li>▶ Bulk density</li> </ul>

Note:

<sup>1</sup>Jo (1995b)

**3.2 SAMPLE HANDLING**

Sample 95-AUG-033 was received by the Westinghouse Hanford Company 222-S Laboratory on June 9, 1995, and extruded on June 15. A total of 96.5 g of solid material was recovered from the auger. Flutes 1 through 6 contained a small amount of material on the edges. Sample material on flutes 7 through 19 contained hard black pebbles throughout the sample and appeared as a gritty sludge. The sample was runny and fell to the tray upon extrusion. The black pebbles were archived. Sample 96-AUG-003 was received by the 222-S Laboratory on March 21, 1996, and extruded on March 27. The sample had a total of 198.3 g of solid material recovered. Sample material on flutes 1 through 26 consisted of a brown, runny, wet sludge with pebble-like material embedded throughout the sample. The gritty, paste-like waste was similar in appearance to the other auger sample. The black pebbles were hard and did not crumble when pressed. Most of the sample fell on the tray when the auger was removed from the sleeve. The remaining flutes (27 through 38) were clean except for a small amount of waste material on the edges. No drainable or liner liquid was recovered from either of the auger samples.

Table 3-2 presents the extrusion data, dose rates, and visual characteristics. After extrusion, the two auger samples were subsampled to meet the analytical and archive requirements specified in the SAP.

Table 3-2. Tank 241-A-102 Auger Extrusion Data.<sup>1</sup>

Riser	Auger Sample Number	Labcore Number	Mass (g)	Dose Rate (mR/hr)	Flute(s)	Sample Characteristics
19	95-AUG-033	S95T001086	96.5	400	1 - 13	Contained hard small black pebbles throughout the sample; gritty and adhesive
					14 - 19	Clean except the edges
5	96-AUG-003	S96T000343	198.3	1,000	1 - 26	Contained brown, runny, wet sludge with pebble-like material embedded throughout the sample; gritty and adhesive
					27 - 38	Clean except the edges

Note:

<sup>1</sup> Jo (1996a)

### 3.3 SAMPLE ANALYSIS

The analyses performed on both auger samples were those required by the safety screening DQO (Dukelow et al. 1995). These included analyses for energetics by differential scanning calorimetry (DSC), moisture by thermogravimetric analysis (TGA), fissile content by total alpha activity analysis, and bulk density. In addition, the TOC content of both auger samples was measured as requested by the data review committee (Kirch 1995) because moderate exothermic reactions were exhibited during the DSC runs. The 1996 auger sample was further subjected to a cyanide analysis to determine if the ferrocyanide DQO should be applied to the tank. Analyses for metals by ICP and anions by IC were also performed on the 1996 auger sample on an opportunistic basis in accordance with Kristofzski (1995). Prior to auger sampling, the tank headspace flammability was measured using a combustible gas meter.

Analyses were performed on a whole auger basis for both auger samples. All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table 3-3. Table 3-4 displays the analytical procedures by title and number. No deviations or modifications were noted by the laboratory. Quality control (QC) checks include, where appropriate, laboratory control standards, matrix spikes, duplicate analyses, and blanks. Results of the QC tests and the implications for data quality are discussed in Section 5.1.2.

Table 3-3. Tank 241-A-102 Sample Analysis Summary.<sup>1</sup>

Auger Sample	Auger Portion/Type	Sample Number	Analyses
95-AUG-033	Whole auger; Solids	S95T001171	DSC, TGA
		S95T001174	Total alpha activity
		S95T002697	TOC, TIC
96-AUG-003	Whole auger; Solids	S96T001620	DSC, TGA, TOC, TIC, cyanide
		S96T001622	Total alpha activity
		S96T001624	ICP
		S96T001670	IC
Vapor tests	Tank headspace	N/A	Combustible gas meter readings for: flammable gas concentration, oxygen, total organic vapors, ammonia

Note:

<sup>1</sup>Jo (1996b)

Table 3-4. Analytical Procedures.<sup>1</sup>

Analysis	Instrument	Preparation Procedure	Analytical Procedure <sup>2</sup>
Energetics by DSC	Mettler™	All analyses were performed directly on the solid samples.	LA-514-113, Rev. B-1
Percent water by TGA	Perkin-Elmer™		LA-560-112, Rev. A-2
Total alpha activity	Alpha proportional counter		LA-508-101, Rev. D-2
TOC TIC	Furnace oxidation		LA-342-100, Rev. C-0
Cyanide	Distillation		LA-695-103, Rev. A-0
Total metals	Inductively coupled plasma/atomic emission spectrometer	LA-505-159, Rev. D-0 (Acid digestion)	LA-505-161, Rev. B-0
Anions	Ion chromatograph	LA-504-101, Rev. D-0 (Water digestion)	LA-533-105, Rev. D-1
Flammable gas	Combustible gas meter readings	N/A	WHC-IP-0030, IH 1.4 and IH 2.1

Notes:

N/A = not applicable  
 Rev. = revision

Mettler™ is a registered trademark of Mettler Electronics, Anaheim, California.

Perkin-Elmer™ is a registered trademark of Perkins Research and Manufacturing Company, Inc., Canoga Park, California.

<sup>1</sup>Jo (1996b)

<sup>2</sup>Internal procedures of Westinghouse Hanford Company, Richland, Washington.

### 3.4 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

This section presents a discussion of the historical sampling and analysis events for tank 241-A-102. The tank was sampled at least eleven times between 1963 and 1989. However, information regarding many of the sampling events is sparse. Also, because of the active process history of the tank, results from most of the historical sampling events are no

longer representative of the current tank contents. Consequently, only results from the most recent historical sampling for the solids and the supernatant have been tabulated in Appendix B and are discussed in depth in this report.

### **3.4.1 Description of the 1986 Core Sampling Event**

Two core samples of the solids were taken from tank 241-A-102 on March 6 and 8, 1986. Both core samples were taken from riser 4. The data report indicated that 100 percent of the expected sample was recovered during the sampling event. Further detail regarding the sampling event can be found in Weiss and Schull (1988). The analytical results from this sampling event have been included in Appendix B.

After the samples were received by the Westinghouse Hanford Company 222-S Laboratory, they were centrifuged and separated for analysis. Composites of each core were made. The solids were water leached, acid leached, and treated for dissolution in a HNO<sub>3</sub>-HF-HCl solution (fusion). The HNO<sub>3</sub>-HF-HCl and acid leach fractions were combined for analysis. Consequently, only two analytical values were generated for each core, one from the water digestion and one from the fusion/acid digestion combination. The two values were summed, as directed by Weiss and Schull (1988), to calculate a core mean, and an overall mean was derived by averaging the two core means.

An extensive set of analyses was performed on the core composites. Twenty-three metals, nine radionuclides, nitrate, TOC, pH, density, and particle size were measured on the samples. A viscosity test could not be performed because the waste was too solid (Weiss and Schull 1988).

### **3.4.2 Description of the 1989 Supernatant Sampling Event**

A supernatant sample was removed from tank 241-A-102 on March 14, 1989 (Weiss 1989). The sample was received by the Process Chemistry Laboratories on March 15. No information concerning the sampling method, sampling riser, or sampling depth was available. An aliquot of the liquid sample was removed and submitted for analysis. No further details were available regarding the sample preparation or analysis procedures. Results from this sampling event have been tabulated in Appendix B.

The results from this sampling event may no longer be representative of the supernatant presently in the tank. This sample was taken before the tank was pumped in July 1989 during interim stabilization efforts.

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## 4.0 ANALYTICAL RESULTS

### 4.1 OVERVIEW

This section presents a summary of the analytical results associated with the June 1995 and March 1996 auger sampling of tank 241-A-102. The sampling and analysis were performed as directed in the SAP (Jo 1995b). This plan integrated all documents related to sampling and analytical requirements, including applicable DQOs. All analyses were performed at the Westinghouse Hanford Company 222-S Laboratory.

Locations of the analytical results are given in Table 4-1. Comprehensive analytical data are in Appendix A. Only analyte overall means are reported in Section 4.0.

Table 4-1. Analytical Data Presentation Tables.

Analysis	Tabulated Location
Chemical data summary	Table 4-2
Differential scanning calorimetry	Table 4-3
Headspace flammability screening results	Table 4-4
1995 comprehensive analytical data	Appendix A
1986 and 1989 historical sampling data	Appendix B

### 4.2 DATA PRESENTATION

This section summarizes the analytical results from the 1995 and 1996 sampling of tank 241-A-102. The subsections below provide information about the chemical, physical, and vapor data. Data from the analysis of samples 95-AUG-033 and 96-AUG-003 were originally reported in *45-Day Safety Screen Results and Final Report for Tank 241-A-102, Auger Sample 95-AUG-033* (Jo 1995a), *45-Day Safety Screening Results for Tank 241-A-102, Auger Sample 96-AUG-003* (Jo 1996a), and *Final Report for Tank 241-A-102, Auger Sample 96-AUG-003* (Jo 1996b).

When 50 percent or more of the individual primary/duplicate measurements had detected results, the overall mean was reported as a detected value. Conversely, when results for more than half of the individual primary/duplicate results were nondetected, the overall mean was reported as a less than (<) value. The incorporation of nondetected results provides the most conservative concentration estimates. Using nondetected results in the mean calculation also requires the use of nondetected results in the relative standard deviation (RSD) of the mean estimates and the analysis of variance (ANOVA) calculations (see Section 5.3).

The use of nondetected results in mean calculations produces bias, so using these values in statistical calculations creates bias. Thus, the RSD of the mean estimates and the ANOVA results should be used with caution.

Overall means were calculated for constituents of the solids portion of the tank waste. The overall means for total alpha activity, TIC, TOC, and weight percent water were derived by taking an average of the primary and duplicate pair results from each auger, and then averaging the two auger means. For the remaining analytes, data were only available from one sample (96-AUG-003), and the overall mean was simply the average of the primary/duplicate pair values.

Relative standard deviations of the mean were calculated for those analytes with results from both augers. The RSD is defined as the standard deviation of the mean divided by the overall mean, times 100. The four QC parameters assessed on the tank 241-A-102 samples were standard recoveries, spike recoveries, duplicate analyses, and blanks. The QC results are summarized in Section 5.1.2. More specific QC information is provided in each of the analyte data tables in Appendix A. Sample and duplicate pairs in which any of the QC parameters were outside their specified limits have been denoted with a superscript in accordance with the directions provided in the Appendix A introduction.

#### 4.2.1 Chemical Data Summary

Chemical data from sample 96-AUG-003 are presented in Table 4-2. Chemical analyses were not performed on sample 95-AUG-033, with the exception of TIC, TOC, and total alpha activity because the sample was analyzed before the directive regarding opportunistic analyses was issued (Kristofzski 1995). The projected inventory was calculated by multiplying the overall mean by the solids density (1.7 g/mL) and the total waste volume (155 kL [41 kgal]), and then dividing by a unit conversion factor of  $1E+06$ . The original analytical data are listed in Appendix A.

Table 4-2. Chemical Data Summary for Tank 241-A-102.<sup>1</sup> (2 sheets)

Analyte	Mean Solids Concentration	Solids RSD (Mean)	Projected Inventory
METALS	µg/g	%	kg
Aluminum	31,700	3.3	8,360
Antimony	< 23.5	N/A	< 6.20
Arsenic	< 39.1	N/A	< 10.3
Barium	139	4.0	36.7
Beryllium	< 1.95	N/A	< 0.514
Bismuth	336	3.9	88.6
Boron	52.3	4.8	13.8
Cadmium	76.5	2.8	20.2
Calcium	690	2.9	182
Cerium	158	2.9	41.7
Chromium	8,800	2.9	2,320
Cobalt	11.9	0.4	3.14
Copper	36.1	3.3	9.52
Iron	19,600	3.1	5,170
Lanthanum	103	4.1	27.2
Lead	1,410	2.5	372
Lithium	< 3.91	N/A	< 1.03
Magnesium	468	2.7	123
Manganese	3,380	3.0	892
Molybdenum	58.6	2.9	15.5
Neodymium	230	3.7	60.7
Nickel	413	3.3	109
Phosphorous	1,600	3.1	422
Potassium	3,080	2.1	813
Samarium	40.4	0.2	10.7
Selenium	< 39.1	N/A	< 10.3
Silicon	3,920	2.9	1,030
Silver	371	3.2	97.9
Sodium	1.29E+05	3.9	34,000

Table 4-2. Chemical Data Summary for Tank 241-A-102.<sup>1</sup> (2 sheets)

Analyte	Mean Solids Concentration	Solids RSD (Mean)	Projected Inventory
Strontium	31.5	3.7	8.31
Sulfur	554	3.8	146
Thallium	< 78.2	N/A	< 20.6
Titanium	34.1	5.0	9.00
Uranium	35,300	4.0	9,310
Vanadium	< 19.5	N/A	< 5.14
Zinc	124	2.8	32.7
Zirconium	484	1.7	128
<b>ANIONS</b>	<b>µg/g</b>	<b>%</b>	<b>kg</b>
Bromide	< 2,690	NA	< 710
Chloride	7,970	46.8	2,100
Fluoride	< 277	N/A	< 73.1
Nitrate	90,300	3.9	23,800
Nitrite	83,200	4.1	21,900
Oxalate	11,900	5.0	3,140
Phosphate	6,300	5.2	1,660
Sulfate	4,480	13.6	1,180
Cyanide	30.7	1.8	8.10
<b>RADIONUCLIDES</b>	<b>µCi/g</b>	<b>%</b>	<b>Ci</b>
Total alpha activity	4.68	11.9	1,230
<b>CARBON</b>	<b>µg C/g</b>	<b>%</b>	<b>kg</b>
TIC	4,340	2.9	1,140
TOC	14,200	2.0	3,910
<b>PHYSICAL PROPERTIES</b>		<b>%</b>	<b>kg</b>
Water	34.3 wt%	6.2	90,500
Density	1.7 g/mL	N/A	N/A

Notes:

RSD (Mean) = relative standard deviation of the mean from both augers

<sup>1</sup>Jo (1996b)

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## 4.2.2 Physical Data Summary

Thermal analyses were performed on the tank 241-A-102 auger samples to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995). The DQO also required density measurements.

**4.2.2.1 Thermogravimetric Analysis.** In 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 heating to remove any gaseous matter. Any decrease in the weight of a sample represents a loss of gaseous matter from the sample either through evaporation or through 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 [302 °F]) is from water evaporation. Weight percent water by TGA was performed by the 222-S Laboratory on a Perkin-Elmer™ instrument using procedure LA-560-112, Rev. A-2.

The TGA percent water data for tank 241-A-102 are presented in Table A-50 in Appendix A. Both the primary and duplicate runs from sample S96T001620 and the duplicate run from sample S95T001171 showed two transitions. The TGA scan for the primary run for sample S95T001171 was similar to the others, but was interpreted as having three transitions. In all cases, the first transition occurred between ambient temperature and approximately 175 °C (350 °F). Again, the weight loss during this transition is attributed to evaporation of water. The results ranged between 30.66 and 36.63 percent, with a mean of 34.3 percent. The second transition began at around 180 °C (360 °F), and for the three samples with only two transitions, it ended in the vicinity of 425 °C (800 °F). The second transition was consistent with the DSC analyses, which showed an exothermic reaction in approximately the same temperature range. For the sample with three transitions, the second ended at 310 °C (590 °F), and the range of the third was 310 to 470 °C (590 to 880 °F).

**4.2.2.2 Differential Scanning Calorimetry.** In a DSC analysis, 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, a gas such as nitrogen is passed over the waste material to remove any gases being released. The onset temperature for an endothermic event (characterized by or causing the absorption of heat) or an exothermic event (characterized by or causing the release of heat) is determined graphically. Analyses by DSC were performed by the 222-S Laboratory using procedure LA-514-113, Rev. B-1.

The DSC results are presented in Table A-51 in Appendix A; peak temperatures and magnitudes of the enthalpy changes are provided for each transition. All samples exhibited two transitions. The first transition represents the endothermic reaction associated with the evaporation of free and interstitial water. For all samples, the second transition was exothermic. By convention, exothermic reactions are denoted in Table A-51 with a negative sign. All results reported in the table are on a wet weight basis.

For a comparison of the exothermic enthalpy changes with the -480-J/g safety screening decision limit, the exothermic values had to be converted to a dry weight basis using the respective sample weight percent water. After conversion to a dry weight basis, it was determined that none of the samples exceeded the -480-J/g limit. The upper limits of a one-sided 95 percent confidence interval ranged from -177 to -354 J/g (dry weight basis) (Jo 1996b).

Table 4-3 presents the sample results, along with the weight percent water for conversion to a dry weight, the converted exothermic value, and the upper limits of the 95 percent confidence interval.

Table 4-3. DSC Exothermic Results and 95 Percent Confidence Interval Upper Limits.<sup>1</sup>

Sample Number	Auger Sample	Run	Wet Weight	Weight	Dry Weight	95% Confidence
			$\Delta H$	% Water	$\Delta H$	Interval Upper Limits
			J/g	%	J/g	J/g
S95T001171	95-AUG-033	1	-216.4	32.13	-319	-354
		2	-207.4		-306	
S96T001620	96-AUG-003	1	-64.2	36.38	-101	-177
		2	-77.4		-122	

Notes:

$\Delta H$  = change in enthalpy (negative sign denotes exothermic reaction)

<sup>1</sup>Jo (1996a)

**4.2.2.3 Density.** Bulk density measurements were performed on sample 96-AUG-003 as required by the safety screening DQO (Dukelow et al. 1995). The density data are provided in Table A-52 of Appendix A. The density of the solids was 1.7 g/mL.

#### 4.2.3 Headspace Flammability Screening Results

As requested in the SAP (Jo 1995b), the tank headspace was sampled and analyzed for the presence of flammable gases. 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 percentage 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). Also measured were the volume percent oxygen gas, total organic vapor, and ammonia gas. Prior to the 1996

auger sampling, all gases were monitored at the breather filter, 90 cm (3 ft) into the riser, and 6 m (20 ft) into the riser (headspace). The results of the combustible gas monitoring are presented in Table 4-4, and indicate that the flammable vapor concentration in the tank headspace is 0 percent of the LFL.

Table 4-4. Headspace Flammability Screening for Tank 241-A-102.<sup>1</sup>

Location	Flammable Vapor Concentration as a Percent of LFL	Volume Percent Oxygen Gas	Total Organic Vapor (ppm)	Ammonia Gas (ppm)
Riser 18/ breather filter	0%	20.9%	0	< 5
Riser 18/ 90 cm (3 ft) into riser	0%	20.9%	1.2	< 5
Riser 18/ 6 m (20 ft) into riser	0%	20.9%	12.4	300

Note:

<sup>1</sup>Jo (1996b)

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## 5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

The purpose of this chapter is to discuss the overall quality and consistency of the current sampling results for tank 241-A-102, and to assess and compare 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 interpretation of the data. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data.

#### 5.1.1 Field Observations

The sampling event in 1995 was to include two auger samples, but the second sample could not be taken until March 1996 when a second riser became available. Once two auger samples were obtained, the safety screening DQO (Dukelow et al. 1995) requirement that vertical profiles be obtained from at least two widely spaced risers was fulfilled. Between 30 and 38 cm (12 and 15 in.) of sample were expected to be recovered from the auger samples. Waste material was found on the bottom 33 cm (13 in., or 96.5 g) of sample 95-AUG-033 and the bottom 34 cm (13.5 in., or 198.3 g) of sample 96-AUG-003. The remaining lengths of each auger were clean except for a small amount of material on the edges. The auger samples contained small black pebble-like material. A sample of this material was collected from sample 95-AUG-003 and archived. No anomalies during sampling or extrusion 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 1995 and 1996 auger samples, allowing a full assessment regarding the accuracy and precision of the data. The specific QC criteria for all primary and secondary analytes were given in the SAP (Jo 1995b), whereas the opportunistic analytes were governed by the *Hanford Analytical Services Quality Assurance Plan* (DOE 1995). Quality control results outside these criteria are identified by superscripts in the Appendix A tables for all analytes. The QC results for the primary and secondary analytes identified in the safety screening DQO are discussed below.

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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. One of two matrix spike recoveries was slightly below the 90 to 110 percent range specified in the SAP for total alpha activity and TOC, and the only spike recovery for cyanide was also outside this limit. The low recovery for total alpha activity may have been due to high solids content on the sample mount, resulting in self-shielding. The analytical precision is estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred. One of two RPDs were outside the SAP limit for total alpha activity, DSC, and TOC. Finally, sample blank contamination was not noted in any of the samples (Jo 1995a, 1996a, and 1996b).

In summary, the majority of the QC results for the primary and secondary safety screening analytes 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

Comparisons of different analytical methods can help to assess the consistency and quality of the data. Due to the lack of chemical data for sample 95-AUG-033, data consistency checks were only performed on sample 96-AUG-003. The quantity of data available for sample 96-AUG-003 enabled calculations of mass and charge balances, along with comparisons of the ICP phosphorus and sulfur results with the IC phosphate and sulfate results, respectively.

**5.1.3.1 Comparison of Results from Different Analytical Methods.** The following data consistency check compares the results from two different analytical methods. A close correlation between the two methods strengthens the credibility of both results, whereas a poor correlation brings the reliability of the data into question. All analytical mean results were taken from Table 4-2.

The analytical phosphorous mean result as determined by ICP was 1,600  $\mu\text{g/g}$ , which converts to 4,900  $\mu\text{g/g}$  of phosphate. This compared well with the IC phosphate mean result of 6,300  $\mu\text{g/g}$ . The RPD between these two phosphate results was 25.0 percent.

The ICP sulfur value of 554  $\mu\text{g/g}$  converts to 1,660  $\mu\text{g/g}$  of sulfate. This compares poorly with the IC sulfate result of 4,480  $\mu\text{g/g}$ . The RPD between these two sulfate results was 91.9 percent. These results are contradictory to expected behavior. Because ICP measures total sulfur, its result is usually larger than or equal to the IC sulfate value, which is a measurement of the soluble sulfur. There are two possible explanations for the unexpected results. At low concentrations, the sulfur results by ICP can be unreliable. Also, some metal sulfates are insoluble in acid and soluble in basic media. It is possible that the water leach performed prior to the IC analysis solubilized some of these compounds better than the acid digestion done before the ICP analysis.

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**5.1.3.2 Mass and Charge Balances.** The principle objective in performing mass and charge balances is to determine if the measurements were self-consistent. In calculating the balances, only analytes listed in Table 4-2 detected at a concentration of 2,000  $\mu\text{g/g}$  or greater were considered.

Except sodium and potassium, all cations listed in Table 5-1 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Because precipitates are neutral species, all positive charge was attributed to the sodium and potassium cations. The anionic analytes listed in Table 5-2 were assumed to be present as sodium/potassium salts and were expected to balance the positive charge exhibited by the cations. Phosphorous and sulfur were assumed to be present as soluble phosphate and sulfate ions. The concentrations of cationic species in Table 5-1, the anionic species in Table 5-2, and the percent water were ultimately 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, as well as the overall uncertainty given in Table 5-3, 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  $\mu\text{g/g}$  to weight percent.

$$\begin{aligned} \text{Mass balance} &= \text{percent water} + 0.0001 \times \{\text{total analyte concentration}\} \\ &= \text{percent water} + 0.0001 \times \{ \text{AlO(OH)} + \text{Cr(OH)}_3 + \text{FeO(OH)} \\ &\quad + \text{MnO(OH)} + \text{UO}_3 + \text{Na}^+ + \text{K}^+ + \text{Br}^- + \text{Cl}^- + \text{NO}_3^- + \text{NO}_2^- + \text{CO}_3^{2-} \\ &\quad + \text{C}_2\text{O}_4^{2-} + \text{C}_2\text{H}_3\text{O}_2^- + \text{PO}_4^{3-} + \text{SO}_4^{2-} + \text{SiO}_4^{4-} \} \end{aligned}$$

The total analyte concentration calculated from the above equation is 574,000  $\mu\text{g/g}$  (wet weight). The mean weight percent water obtained from thermogravimetric analysis reported in Table 4-2 is 34.3 percent, or 343,000  $\mu\text{g/g}$ . The mass balance resulting from adding the percent water to the total analyte concentration is 91.7 percent (Table 5-3).

The following equations demonstrate the derivation of total cations and total anions, and the charge balance is the ratio of these two values. To derive the results as shown in the equations, all concentrations must first be converted to a  $\mu\text{g/g}$  basis.

$$\begin{aligned} \text{Total cations} \\ (\mu\text{eq/g}) &= [\text{Na}^+]/23.0 + [\text{K}^+]/39.1 = 5,690 \mu\text{eq/g} \end{aligned}$$

$$\begin{aligned} \text{Total anions} \\ (\mu\text{eq/g}) &= [\text{Br}^-]/79.9 + [\text{Cl}^-]/35.5 + [\text{CO}_3^{2-}]/30.0 + [\text{C}_2\text{O}_4^{2-}]/44.0 + [\text{C}_2\text{H}_3\text{O}_2^-]/59.0 \\ &\quad + [\text{NO}_3^-]/62.0 + [\text{NO}_2^-]/46.0 + [\text{PO}_4^{3-}]/31.7 + [\text{SO}_4^{2-}]/48.0 + \\ &\quad [\text{SiO}_4^{4-}]/23.0 = 6,000 \mu\text{eq/g} \end{aligned}$$

Table 5-1. Cation Mass and Charge Data.

Analyte	Concentration (wet weight)	Assumed Species	Concentration of Assumed Species	RSD (Mean)	Charge
	$\mu\text{g/g}$		$\mu\text{g/g}$	%	
Aluminum	31,700	$\text{AlO(OH)}$	70,400	3.3	0
Chromium	8,800	$\text{Cr(OH)}_3$	17,400	2.9	0
Iron	19,600	$\text{FeO(OH)}$	31,200	3.1	0
Manganese	3,380	$\text{MnO(OH)}$	5,410	2.7	0
Uranium	35,300	$\text{UO}_3$	42,400	4.0	0
Potassium	3,080	$\text{K}^+$	3,080	2.1	79
Sodium	129,000	$\text{Na}^+$	129,000	3.9	5,610
Total			299,000	2.8	5,690

Table 5-2. Anion Mass and Charge Data.

Analyte	Concentration (wet weight)	Assumed Species	Concentration of Assumed Species	RSD (Mean)	Charge
	$\mu\text{g/g}$		$\mu\text{g/g}$	%	
Chloride	7,970	$\text{Cl}^-$	7,970	46.8	225
Nitrate	90,300	$\text{NO}_3^-$	90,300	3.9	1,460
Nitrite	83,200	$\text{NO}_2^-$	83,200	4.1	1,810
Oxalate	11,900	$\text{C}_2\text{O}_4^{2-}$	11,900	5.0	270
Phosphate	6,300	$\text{PO}_4^{3-}$	6,300	5.2	199
Silicon	3,920	$\text{SiO}_4^{4-}$	12,900	2.9	561
Sulfate	4,480	$\text{SO}_4^{2-}$	4,480	13.6	93
TIC	4,400	$\text{CO}_3^{2-}$	22,000	2.9	733
TOC	14,800	$\text{C}_2\text{H}_3\text{O}_2^-$	36,400	2.0	617
Total			275,000	3.2	5,970

Table 5-3. Mass Balance Totals.

Totals	Concentrations	RSD (Mean)
	$\mu\text{g/g}$	%
Total from Table 5-1	299,000	2.8
Total from Table 5-2	275,000	3.2
Water %	343,000	6.2
Grand Total	917,000	2.7

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.95.

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

## 5.2 COMPARISON OF HISTORICAL WITH ANALYTICAL RESULTS

Although the tank supernatant was pumped during interim stabilization in August 1989, no significant changes in the solid layer are expected. Therefore, a comparison is possible between the results of the latest sampling event and a historical solids sampling from 1986. In March 1986, two core samples were removed from riser 4 of tank 241-A-102. An extensive set of analyses were performed on the core samples. More information regarding these core samples can be found in Section 3.4.

Table 5-4 presents the comparisons between the two data sets. For a majority of the analytes in the table, the result from the latest sampling event is actually from the auger obtained in 1996. This is because a limited set of analyses were performed on the 1995 auger sample. Only TOC and total alpha activity had results from both the 1995 and 1996 auger samples. In order to make a comparison with the 1995/1996 total alpha activity result, the 1986 activities of  $^{241}\text{Am}$  and  $^{239/240}\text{Pu}$  were summed.

As can be seen in Table 5-4, several of the analytes displayed good agreement, while others agreed poorly. Nearly half of the analytes had RPDs below 50 percent. The poor agreement is likely due to heterogeneity of the waste (the waste contains both sludge and saltcake according to Hanlon [1996]), and may be influenced by the fact that most of the results from each sampling event were based on waste recovered from a single riser.

Table 5-4. Comparisons of Solids Data from the 1986 and 1996 Sampling Events for Tank 241-A-102. (2 sheets)

Analyte	1986 Analytical Result <sup>1,2</sup>	1996 Analytical Result <sup>3</sup>	Relative Percent Difference
<b>METALS</b>	<b>µg/g</b>	<b>µg/g</b>	<b>%</b>
Aluminum	23,300	31,700	30.5
Barium	880	139	145
Bismuth	1,740	336	135
Boron	14.2	52.3	115
Cadmium	64.9	76.5	16.4
Calcium	2,590	690	116
Chromium	5,800	8,800	41.1
Cobalt	24.2	11.9	68.1
Copper	81.8	36.1	77.5
Iron	14,000	19,600	33.3
Lead	1,180	1,410	17.8
Magnesium	1,390	468	99.2
Manganese	2,150	3,380	44.5
Nickel	526	413	24.1
Phosphorous	5,240	1,600	106
Potassium	2,820	3,080	8.8
Silicon	16,600	3,920	124
Silver	247	371	40.1
Sodium	1.87E+05	1.29E+05	36.7
Strontium	97.6	31.5	102
Uranium	9,540	35,300	115
Zirconium	1,440	484	99.4
<b>CARBON</b>	<b>µg C/g</b>	<b>µg C/g</b>	<b>%</b>
TOC	7,570	14,850 <sup>5</sup>	64.9
<b>RADIONUCLIDES</b>	<b>µCi/g</b>	<b>µCi/g</b>	<b>%</b>
Total alpha activity	3.22 <sup>4</sup>	4.68 <sup>5</sup>	37.0
<b>ANIONS</b>	<b>µg/g</b>	<b>µg/g</b>	<b>%</b>
Nitrate	1.79E+05	90,300	65.9

Table 5-4. Comparisons of Solids Data from the 1986 and 1996 Sampling Events for Tank 241-A-102. (2 sheets)

Analyte	1986 Analytical Result <sup>1,2</sup>	1996 Analytical Result <sup>3</sup>	Relative Percent Difference
<b>PHYSICAL PROPERTIES</b>			<b>%</b>
Bulk Density	1.59 g/mL	1.7 g/mL	6.7

## Notes:

<sup>1</sup>Weiss and Schull (1988)

<sup>2</sup>The reliability of these data is questionable due to the lack of proper QC documentation. The data are not validated and should be used with caution.

<sup>3</sup>Jo (1996b)

<sup>4</sup>Based on the <sup>241</sup>Am and <sup>239/240</sup>Pu activities.

<sup>5</sup>Overall mean from the 1995 and 1996 sampling events.

### 5.3 TANK WASTE PROFILE

According to the estimate of Hanlon (1996), the tank contents consist of 15 kL (4 kgal) of supernatant, 57 kL (15 kgal) of sludge, and 83 kL (22 kgal) of saltcake. The visual descriptions of both samples were similar (pebble-like material, gritty, runny, paste-like composition). The TLM indicated a supernatant layer above the solids, with the solids layered in three portions from top to bottom as follows: saltcake slurry, saltcake, and strontium recovery sludge. However, the in-tank video does not show the supernatant as a thin liquid layer, but as intermittent pools of liquid.

Auger samples were obtained from two different risers. Consequently, a one-way random effects ANOVA model was fit to the total alpha, TOC, and TIC data. These models can be used to test whether mean analyte concentrations vary significantly in the horizontal direction. The results showed that there were no significant (0.05 level of significance) differences in the mean concentrations for total alpha, TOC, and TIC between risers (horizontal variability).

In summary, the visual descriptions of the samples and the statistical results suggest horizontal homogeneity. The Hanlon (1996) estimates and the TLM implied that the tank contents were expected to be vertically heterogeneous in that a thin layer of supernatant was expected to override the solids. However, the in-tank video and photographs taken during auger extrusion suggest that the waste may be homogeneous.

#### **5.4 COMPARISON OF TRANSFER HISTORY WITH ANALYTICAL RESULTS**

Because only a few analytes were evaluated on the 1995 auger sample, the HTCE predictions in *Hanford Tank Chemical and Radionuclide Inventories HDW Model Rev. 3* (Agnew et al. 1996a) were compared to the analytical results from the 1996 auger sample. This comparison is shown in Table 5-5, and is presented for informational purposes only. The HTCE values have not been validated and thus should be used with caution.

Comparing the HTCE with the analytical values produced varied results. A total of 22 analytes were compared. Five analytes (calcium, dry TOC, nitrate, sodium, and density) exhibited RPDs less than 50 percent. Of these, the calcium and dry TOC RPDs were less than 10 percent. Low RPD for dry TOC suggests that dry TOC can be used to evaluate Agnew's HDW model for dry TOC. However, more dry TOC should be evaluated from many different tanks. Five analytes (chromium, lead, manganese, bromium and acetate) exhibited RPDs greater than 150 percent. The RPDs for the remaining analytes were between these two extremes.

#### **5.5 EVALUATION OF PROGRAM REQUIREMENTS**

The two tank 241-A-102 auger samples analyzed at the 222-S Laboratory were acquired to meet the requirements of the safety screening DQO (Dukelow et al. 1995). This section discusses the requirements of the DQO and compares the analytical data to defined concentration limits.

##### **5.5.1 Safety Evaluation**

Data criteria identified in the safety screening DQO (Dukelow et al. 1995) are used to assess the waste safety and to check for unidentified safety issues. The DQO requires at least two vertical profiles of the tank waste. An assessment was made of the analytical results from the 1995 and 1996 sampling events, and it was decided that further sampling was not needed. Of the five primary analyses required by the DQO, three have decision criteria thresholds which, if exceeded, could warrant further investigation to ensure tank safety. These three analyses include DSC (to measure the fuel content), a determination of total alpha activity (to evaluate the criticality potential), and a measurement of the flammability of the tank headspace vapors.

Table 5-5. Comparison of Historical Estimates with the 1996 Analytical Results for Tank 241-A-102. (2 Sheets)

Analyte	HTCE Estimate <sup>1,2</sup>	1996 Analytical Result <sup>3</sup>	Relative Percent Difference
<b>METALS</b>	<b>µg/g</b>	<b>µg/g</b>	<b>%</b>
Aluminum	13,300	31,700	81.8
Bismuth	75.0	336	127
Calcium	644	690	6.9
Chromium	746	8,800	169
Iron	4,970	19,600	119
Lead	83.2	1,410	178
Manganese	75.5	3,380	191
Nickel	86.3	413	131
Potassium	696	3,080	126
Sodium	88,000	1.29E+05	37.8
Uranium	14,600	35,300	83.0
Zirconium	17.2	484	186
<b>ANIONS</b>	<b>µg/g</b>	<b>µg/g</b>	<b>%</b>
Chloride	2,290	7,970	111
Nitrate	81,200	90,300	10.6
Nitrite	34,400	83,200	83.0
Phosphate	2,620	6,300	82.5
Sulfate	8,600	4,480	63.0
Acetate	434	36,400 <sup>4,5</sup>	195
Carbonate	10,400	22,000 <sup>4,6</sup>	71.6
<b>PHYSICAL PROPERTIES</b>			<b>%</b>
Bulk Density	1.26 g/mL	1.7 g/mL	29.7
Water	66.3 wt%	34.3 wt% <sup>4</sup>	63.6

Table 5-5. Comparison of Historical Estimates with the 1996 Analytical Results for Tank 241-A-102. (2 Sheets)

Analyte	HTCE Estimate <sup>1,2</sup>	1996 Analytical Result <sup>3</sup>	Relative Percent Difference
<b>CARBON</b>			
TOC (wet)	0.754 wt%	1.49 wt%	65.6
TOC (dry)	2.24 wt%	2.27 wt%	1.33

Notes:

<sup>1</sup>Agnew et al. (1996a)

<sup>2</sup>The reliability of these data is questionable due to the lack of proper QC documentation. The data are not validated and should be used with caution.

<sup>3</sup>Jo (1996b)

<sup>4</sup>Overall mean from the 1995 and 1996 sampling events.

<sup>5</sup>Calculated from TOC.

<sup>6</sup>Calculated from TIC.

The safety screening DQO has established a decision limit of -480 J/g (dry weight basis) for exothermic reactions detected during the DSC analysis. Exothermic reactions were observed in both auger samples; however, all results were below the decision limit, with the highest exothermic reaction measured being -319 J/g (dry weight basis). In addition, all the 95 percent confidence interval upper limits were below the threshold, with the highest value being -354 J/g.

The potential for criticality can be assessed from the total alpha activity data. The safety screening DQO decision threshold is 36.2  $\mu\text{Ci/g}$ . All results from samples 95-AUG-033 and 96-AUG-003 were well below the limit, with an overall mean of 4.68  $\mu\text{Ci/g}$ . The highest 95 percent confidence interval upper limit was 5.30  $\mu\text{Ci/g}$ , also well below the threshold.

The DQO limit for flammable gas concentration is 25 percent of the LFL. Combustible gas meter readings taken at the time of the 1996 sampling revealed the concentration of flammable gases to be 0 percent of the LFL.

Although not required by the SAP, TOC was analyzed on a discretionary basis because of exothermic reactions in the DSC scans. All TOC results were less than the decision limit of 30,000  $\mu\text{g C/g}$  (dry weight). However, the 95 percent confidence interval upper limit for sample 96-AUG-003 slightly exceeded the decision limit, with a result of 32,700  $\mu\text{g C/g}$ . Because the weight percent water results were greater than 17 percent, the tank may be

considered conditionally safe according to the organic DQO (Turner et al. 1995). However, monitoring may be required to ensure that the waste will not dry out during interim storage (Jo 1996b). A cyanide analysis was run on sample 96-AUG-003 to determine whether or not the ferrocyanide DQO should be applied. The cyanide mean (dry weight) was 48.2  $\mu\text{g/g}$ , far below the ferrocyanide DQO decision limit of 39,000  $\mu\text{g/g}$ .

Table 5-6 lists the safety issues, the analytes of concern along with their threshold limits, and the corresponding analytical results.

Another factor in assessing tank waste safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. A tank heat load could not be calculated from the analytical data because radionuclides were not determined. However, the analytical results of the 1986 historical sampling event included several radionuclides (see Appendix B). The heat load estimate based on these results was 1,130 W (3,860 Btu/hr). The HTCE prediction was 750 W (2,560 Btu/hr), while the heat load based on headspace temperature was 3,760 W (12,800 Btu/hr) (Kummerer 1994). Because an upper temperature limit has been exhibited (Section 2.4.3), it may be concluded that any heat generated from radioactive sources throughout the year is dissipated.

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

Issue	Primary Decision Variable	Decision Criteria Threshold	Analytical Result
Ferrocyanide/Organics	Total fuel content	-480 J/g (dry weight)	-319 J/g <sup>1</sup> (dry weight)
Organics	Total organic carbon	30,000 $\mu\text{g C/g}$ (dry weight)	22,500 $\mu\text{g C/g}^2$ (dry weight)
Ferrocyanide	Total cyanide	39,000 $\mu\text{g/g}$ (dry weight)	48.2 $\mu\text{g/g}$ (dry weight)
Criticality	Total alpha	36 $\mu\text{Ci/g}$	4.68 $\mu\text{Ci/g}$
Flammability	Flammable gas	25% of the LFL	0% of the LFL

Notes:

<sup>1</sup>Largest exothermic value

<sup>2</sup>Largest TOC value.

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## 6.0 CONCLUSIONS AND RECOMMENDATIONS

The waste in tank 241-A-102 has been sampled and analyzed for the purposes of safety screening according to the requirements listed in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). The tank was auger sampled in June 1995 and March 1996. To assess tank safety, the safety screening DQO required analyses for energetics, total alpha activity, weight percent water, density, and the flammable gas concentration in the tank headspace. In addition, for sample 96-AUG-003, an internal letter (Kristofzski 1995) directed the laboratory to perform all feasible analyses of the waste samples on an opportunistic basis, according to the work load in the laboratory. Consequently, ICP and IC analyses were run. All samples were analyzed at the Westinghouse Hanford Company 222-S Laboratory.

All exothermic results from the DSC scans were below the decision limit of -480 J/g, with the highest exothermic reaction observed being -319 J/g (dry weight basis). The highest 95 percent confidence interval upper limit was -354 J/g. The data review committee requested TOC analyses due to the results from the DSC scans, even though the decision limit was not exceeded (Kirch 1995). The mean TOC result was 22,500  $\mu\text{g C/g}$  (dry weight), below the limit of 30,000  $\mu\text{g C/g}$ . However, the 95 percent confidence interval upper limit for sample 96-AUG-003 slightly exceeded the decision limit, with a result of 32,700  $\mu\text{g C/g}$ . Because the weight percent water results were greater than 17 percent, the tank may be considered conditionally safe according to the organic DQO (Turner et al. 1995). However, monitoring may be required to ensure that the waste will not dry out during interim storage (Jo 1996b). A cyanide analysis was run on sample 96-AUG-003 to determine whether or not the ferrocyanide DQO should be applied. The cyanide mean (dry weight) was 48.2  $\mu\text{g/g}$ , far below the ferrocyanide DQO decision threshold of 39,000  $\mu\text{g/g}$ . The overall mean for total alpha activity was 4.68  $\mu\text{Ci/g}$ , well below the DQO limit of 36  $\mu\text{Ci/g}$ . Finally, the concentration of flammable gas in the tank headspace was 0 percent of the LFL.

A tank heat load could not be calculated from the 1995/1996 analytical data because radionuclides were not determined. However, the analytical results of the 1986 historical sampling event included several radionuclides (see Appendix B). The heat load estimate based on these results was 1,130 W (3,860 Btu/hr). The HTCE prediction was 750 W (2,560 Btu/hr), while the heat load based on headspace temperature was 3,760 W (12,800 Btu/hr). Because the tank exhibits an upper temperature limit, it may be concluded that any heat generated from radioactive sources throughout the year is dissipated.

Finally, several conclusions were drawn from the analytical results. The waste currently in tank 241-A-102 may continue to be safely stored in the tank without special action. In addition, no further characterization efforts are needed at this time. Lastly, there were no unexpected findings that could affect the ability to retrieve and dispose of the waste safely.

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**APPENDIX A**

**ANALYTICAL RESULTS FROM 1995  
AND 1996 AUGER SAMPLINGS**

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## **A.0 ANALYTICAL RESULTS FROM 1995 AND 1996 AUGER SAMPLINGS**

### **A.1 INTRODUCTION**

Appendix A reports the chemical, radiochemical, and physical characteristics of tank 241-A-102 in table form and in terms of the specific concentrations of metals, ions, radionuclides, and physical properties.

Each data table lists the laboratory sample identification, sample origin, an original and duplicate result for each sample, a sample mean, a mean for the tank in which the augers results are weighted equally, a relative standard deviation of the mean (RSD [mean]), and a projected tank inventory for the particular analyte using the weighted mean and the appropriate conversion factors. The data are listed in standard notation for values greater than 0.001 and less than 100,000. Values outside these limits are listed in scientific notation.

The tables are numbered A-1 through A-52. The units and symbols used in the analyte tables, and the sources used in compiling the analytical data (Jo 1996b), are found in the List of Terms and Section 7.0, respectively. For more information on sampling rationale, locations, and descriptions of sampling events, see Section 3.0.

### **A.2 ANALYTE TABLE DESCRIPTION**

The "Sample Number" column lists the laboratory sample for which the analyte was measured.

Column two specifies the "Sample Location" from where the sample was derived.

Column three contains the name of the segment portion from which the sample was taken. All auger samples were analyzed on a whole auger basis.

The "Sample Mean" column is the average of the result and duplicate values. When 50 percent or more of the individual primary/duplicate measurements had detected results, the overall mean was reported as a detected value. Conversely, when results for more than half of the individual primary/duplicate results were nondetected, the overall mean was reported as a less than (<) value. The incorporation of nondetected results provides the most conservative concentration estimates. Using nondetected results in the mean calculation also requires the use of nondetected results in the relative standard deviation (RSD) of the mean estimates and the ANOVA calculations. Whereas the use of nondetected results in mean calculations produces a known high bias, using these values in statistical calculations creates an unknown bias. Thus, the RSD of the mean estimates and the ANOVA results should be used with caution. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the original laboratory data package. The means may appear to have been rounded up in some cases and rounded down in others.

This is because the analytical results given in the tables may have fewer significant figures than originally reported, not because the means were incorrectly calculated.

All overall means for the waste in tank 241-A-102 were calculated the same as the sample means, with the exception of TOC, TIC, total alpha, and percent water. For these analytes, the overall mean is an average of the two auger means.

The RSD (mean) is 100 times the standard deviation of the mean divided by the overall tank mean. The standard deviation of the mean was estimated using standard ANOVA techniques. For analytes with at most 50 percent detected results, the RSD (mean) and overall mean were computed using all the data. That is, the detected results were used as quantitative values. In such cases, the overall tank mean and standard deviation of the mean are biased. The magnitude of the bias is unknown. The RSD (mean) was not computed for analytes with at least 50 percent detected results.

The projected inventory is the product of the overall analyte concentration mean, the solids waste volume (140 kL), the bulk density of the waste (1.7 g/mL), and the appropriate conversion factors.

The four QC parameters assessed on the tank 241-A-102 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. These results are summarized in Section 5.1.2, and more specific information is provided in the following appendix tables. Sample and duplicate pairs in which any of the QC parameters were outside their specified limits are footnoted in column 6 with a QC:a, QC:b, QC:c, QC:d, QC:e, or QC:f as follows:

QC Footnotes:

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

Table A-1. Tank 241-A-102 Analytical Results: Aluminum.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	32,700	30,600	31,650 <sup>Ca</sup>	31,700	3.3	8,360

Table A-2. Tank 241-A-102 Analytical Results: Antimony.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 24.2	< 22.7	< 23.45	< 23.5	N/A	< 6.20

Table A-3. Tank 241-A-102 Analytical Results: Arsenic.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 40.3	< 37.9	< 39.1	< 39.1	N/A	< 10.3

Table A-4. Tank 241-A-102 Analytical Results: Barium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	144	133	138.5	139	4.0	36.7

Table A-5. Tank 241-A-102 Analytical Results: Beryllium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 2.01	< 1.89	< 1.95	< 1.95	N/A	< 0.514

Table A-6. Tank 241-A-102 Analytical Results: Bismuth.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	349	323	336	336	5.6	88.6

Table A-7. Tank 241-A-102 Analytical Results: Boron.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	54.8	49.8	52.3	52.3	6.8	13.8

Table A-8. Tank 241-A-102 Analytical Results: Cadmium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	78.6	74.3	76.45	76.5	4.0	20.2

Table A-9. Tank 241-A-102 Analytical Results: Calcium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	710	670	690	690	4.1	182

Table A-10. Tank 241-A-102 Analytical Results: Cerium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	162	153	157.5	158	4.0	41.7

Table A-11. Tank 241-A-102 Analytical Results: Chromium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	9,050	8,540	8,795 <sup>cc-a</sup>	8,800	4.1	2,320

Table A-12. Tank 241-A-102 Analytical Results: Cobalt.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	11.9	11.8	11.85	11.9	0.6	3.14

Table A-13. Tank 241-A-102 Analytical Results: Copper.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	37.3	34.9	36.1	36.1	4.7	9.52

Table A-14. Tank 241-A-102 Analytical Results: Iron.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	20,200	19,000	19,600	19,600 <sup>±0.5</sup>	4.3	5,170

Table A-15. Tank 241-A-102 Analytical Results: Lanthanum.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	107	98.5	102.75	103	5.8	27.2

Table A-16. Tank 241-A-102 Analytical Results: Lead.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	1,440	1,370	1,405	1,410	3.5	372

Table A-17. Tank 241-A-102 Analytical Results: Lithium.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 4.03	< 3.79	< 3.91	< 3.91	N/A	< 1.03

Table A-18. Tank 241-A-102 Analytical Results: Magnesium.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	480	455	467.5	468	3.8	123

Table A-19. Tank 241-A-102 Analytical Results: Manganese.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	3,480	3,280	3,380 <sup>cc-a</sup>	3,380	4.2	892

Table A-20. Tank 241-A-102 Analytical Results: Molybdenum.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	60.3	56.9	58.6	58.6	4.1	15.5

Table A-21. Tank 241-A-102 Analytical Results: Neodymium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	238	221	229.5	230	5.2	60.7

Table A-22. Tank 241-A-102 Analytical Results: Nickel.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	426	399	412.5	413	4.6	109

Table A-23. Tank 241-A-102 Analytical Results: Phosphorus.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	1,650	1,550	1,600 <sup>c,a</sup>	1,600	4.4	422

Table A-24. Tank 241-A-102 Analytical Results: Potassium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	3,140	3,010	3,075 <sup>c,a</sup>	3,080	3.0	813

Table A-25. Tank 241-A-102 Analytical Results: Samarium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 40.3	40.5	40.4	40.4	0.4	10.7

Table A-26. Tank 241-A-102 Analytical Results: Selenium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 40.3	< 37.9	< 39.1	< 39.1	N/A	< 10.3

Table A-27. Tank 241-A-102 Analytical Results: Silicon.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	4,030	3,800	3,915	3,920	4.2	1,030

Table A-28. Tank 241-A-102 Analytical Results: Silver.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	383	359	371 <sup>(c,d)</sup>	371	4.6	97.9

Table A-29. Tank 241-A-102 Analytical Results: Sodium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	1.340E+05	1.240E+05	1.290E+05 <sup>Q=3</sup>	1.29E+05	5.6	34,000

Table A-30. Tank 241-A-102 Analytical Results: Strontium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	32.6	30.3	31.45	31.5	5.2	8.31

Table A-31. Tank 241-A-102 Analytical Results: Sulfur.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	575	533	554	554	5.4	146

Table A-32. Tank 241-A-102 Analytical Results: Thallium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 80.5	< 75.8	< 78.15	< 78.2	N/A	< 20.6

Table A-33. Tank 241-A-102 Analytical Results: Titanium.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	35.8	32.4	34.1	34.1	7.1	9.00

Table A-34. Tank 241-A-102 Analytical Results: Uranium.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	36,700	33,900	35,300 <sup>0.3d</sup>	35,300	5.6	9,310

Table A-35. Tank 241-A-102 Analytical Results: Vanadium.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	< 20.1	< 18.9	< 19.5	< 19.5	N/A	< 5.14

Table A-36. Tank 241-A-102 Analytical Results: Zinc.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	127	120	123.5	124	4.0	32.7

Table A-37. Tank 241-A-102 Analytical Results: Zirconium.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001624	Riser 5	Whole	492	476	484 <sup>0.0-1</sup>	484	2.3	128

Table A-38. Tank 241-A-102 Analytical Results: Bromide.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	< 2,756	< 2,620	< 2,688	< 2,690	3.6	< 710

Table A-39. Tank 241-A-102 Analytical Results: Chloride.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	4,245	11,700	7,972.5 <sup>0.0-0</sup>	7,970	66.1	2,100

Table A-40. Tank 241-A-102 Analytical Results: Fluoride.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	< 284.3	< 270	< 277.15	< 277	N/A	< 73.1

Table A-41. Tank 241-A-102 Analytical Results: Nitrate.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	86,820	93,800	90,310	90,300	5.6	23,800

Table A-42. Tank 241-A-102 Analytical Results: Nitrite.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	79,790	86,600	83,195	83,200	5.8	21,900

Table A-43. Tank 241-A-102 Analytical Results: Oxalate.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	11,320	12,500	11,910	11,900	7.0	3,140

Table A-44. Tank 241-A-102 Analytical Results: Phosphate.

Sample Number	Sample Location	Segment Portion	Result $\mu\text{g/g}$	Duplicate $\mu\text{g/g}$	Sample Mean $\mu\text{g/g}$	Overall Mean $\mu\text{g/g}$	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	6,620	5,970	6,295	6,300	7.3	1,660

Table A-45. Tank 241-A-102 Analytical Results: Sulfate.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T002170	Riser 5	Whole	3,873	5,090	4,481.5 <sup>QC-c</sup>	4,480	19.2	1,180

Table A-46. Tank 241-A-102 Analytical Results: Cyanide.

Sample Number	Sample Location	Segment Portion	Result µg/g	Duplicate µg/g	Sample Mean µg/g	Overall Mean µg/g	RSD (Mean) %	Projected Inventory kg
S96T001620	Riser 5	Whole	30.1	31.2	30.65 <sup>QC-c</sup>	30.7	2.5	8.10

Table A-47. Tank 241-A-102 Analytical Results: Total Alpha Activity.

Sample Number	Sample Location	Segment Portion	Result µCi/g	Duplicate µCi/g	Sample Mean µCi/g	Overall Mean µCi/g	RSD (Mean) %	Projected Inventory Ci
S95T001174	Riser 19	Whole	4.55	3.7	4.125 <sup>QC-c</sup>	4.68	11.9	1,230
S96T001622	Riser 5	Whole	5.23	5.25	5.24 <sup>QC-c</sup>			

Table A-48. Tank 241-A-102 Analytical Results: Total Inorganic Carbon.

Sample Number	Sample Location	Segment Portion	Result		Duplicate	TriPLICATE	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
			µg C/g	µg C/g						
S95T002697	Riser 19	Whole	4,800	4,250		4,520	4,340	2.9	1,140	
S96T001620	Riser 5	Whole	5,360	3,180	3,940	4,160 <sup>RSE</sup>				

Table A-49. Tank 241-A-102 Analytical Results: Total Organic Carbon.

Sample Number	Sample Location	Segment Portion	Result		Duplicate	TriPLICATE	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
			µg C/g	µg C/g						
S95T002697	Riser 19	Whole	15,500	15,500		15,500	14,850	2.0	3,910	
S96T001620	Riser 5	Whole	17,900	10,100	14,600	14,200 <sup>RSE</sup>				

Table A-50. Tank 241-A-102 Analytical Results: Thermogravimetric Analysis.

Sample Number	Sample Location	Result		Duplicate		Sample Mean	Overall Mean	RSD
		Temp. Range	% H <sub>2</sub> O	Temp. Range	% H <sub>2</sub> O			
S95T001171	Riser 19	35-170	30.66	35-165	33.59	32.13	34.3	6.2
S96T001620	Riser 5	35-175	36.13	35-182	36.63	36.38		

Note:

Temp. = temperature

Table A-51. Tank 241-A-102 Analytical Results: Differential Scanning Calorimetry.

Sample Number	Sample Location	Run	Sample Weight		Transition 1		Transition 2	
			mg	g	Peak Temp. (°C)	$\Delta H$ (J/g)	Peak Temp. (°C)	$\Delta H$ (J/g)
S95T001171	Riser 19	1	20.21	133.3	825.9	375.8	-216.4	
		2	23.225	131.1	921.0	375.9	-207.4	
S96T001620	Riser 5	1	29.179	129.3	1,075.3 <sup>exo</sup>	352.9	-64.2	
		2	44.61	121.3	954.7 <sup>exo</sup>	361.1	-77.4	

Note:

$\Delta H$  = change in enthalpy (negative sign denotes exothermic reaction)

Table A-52. Tank 241-A-102 Analytical Results: Bulk Density

Sample Number	Sample Location	Segment Portion	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			g/mL	g/mL	g/mL	g/mL	%	kg
S96T001620	Riser 5	Whole	1.7	N/A	1.7	1.7	N/A	N/A

**APPENDIX B**

**HISTORICAL SAMPLING RESULTS**

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**B.0 HISTORICAL SAMPLING RESULTS**

**B.1 INTRODUCTION**

Appendix B presents results from selected historical sampling events for tank 241-A-102. Table B-1 lists the analytical results from a core sampling event performed in 1986. The samples, referenced as 91XCOOXX and 92XCOOXX, were reported as being dark brown in color. No additional specifics were available from historical records. Table B-2 lists the results from a supernatant sample analyzed in 1989. No details concerning sampling and analysis were available.

Table B-1. Core Composite Analysis of Tank 241-A-102 From 1986.<sup>1,2</sup> (2 sheets)

Component	Sample Number 91XCOOXX	Sample Number 92XCOOXX	Overall Mean
	µg/g	µg/g	µg/g
<b>CHEMICAL ANALYSIS</b>			
Aluminum	20,700	25,800	23,300
Barium	730	1,030	880
Bismuth	1,180	2,290	1,740
Boron	13.2	15.2	14.2
Cadmium	44.9	84.9	64.9
Calcium	2,010	3,170	2,590
Chromium	5,270	6,320	5,800
Cobalt	17.3	31.1	24.2
Copper	52.6	111	81.8
Iron	5,670	22,300	14,000
Lead	559	1,810	1,180
Magnesium	1,090	1,680	1,390
Manganese	1,060	3,240	2,150
Nickel	532	520	526
Phosphorous	5,590	4,890	5,240
Potassium	2,720	2,910	2,820
Silicon	13,400	19,700	16,600
Silver	124	370	247
Sodium	1.94E+05	1.80E+05	1.87E+05

Table B-1. Core Composite Analysis of Tank 241-A-102 From 1986.<sup>1,2</sup> (2 sheets)

Component	Sample Number 91XCOOX	Sample Number 92XCOOX	Overall Mean
	µg/g	µg/g	µg/g
<b>CHEMICAL ANALYSIS (cont'd)</b>			
Strontium	148	47.1	97.6
Uranium	17,000	2,080	9,540
Zinc	105	---	105
Zirconium	813	2,070	1,440
Nitrate	2.20E+05	1.37E+05	1.79E+05
TOC	7,200	7,940	7,570
<b>RADIOLOGICAL ANALYSIS</b>			
Component	µCi/g	µCi/g	µCi/g
<sup>241</sup> Am	0.0826	2.34	1.21
<sup>14</sup> C	0.00168	6.23E-04	0.00115
<sup>60</sup> Co	1.07	0.590	0.83
<sup>137</sup> Cs	167	112	140
<sup>129</sup> I	< 4.30E-05	< 3.50E-05	< 3.90E-05
<sup>239/240</sup> Pu	1.76	2.25	2.01
<sup>90</sup> Sr	138	1,070	604
<sup>99</sup> Tc	0.113	0.0874	0.100
Total gamma	185	153	169
<b>PHYSICAL DATA</b>			
Bulk Density	1.52 g/mL	1.66 g/mL	1.59 g/mL
Visual	w/yellow dark brown	dark brown	N/A
pH	13.0	13.0	13.0

Notes:

<sup>1</sup>Weiss and Schull (1988)

<sup>2</sup>The reliability of these data is questionable due to the lack of proper QC documentation. The data are not validated and should be used with caution.

Table B-2: 1989 Analysis of 241-A-102 Liquid.<sup>1,2</sup> (2 sheets)

Component	Result	Lab Unit
<b>CHEMICAL ANALYSIS</b>		
Cl <sup>-</sup>	0.0055	M
F <sup>-</sup>	< 0.068	M
PO <sub>4</sub> <sup>3-</sup>	< 0.055	M
SO <sub>4</sub> <sup>2-</sup>	1.01	M
NO <sub>3</sub> <sup>-</sup>	2.08	M
NO <sub>2</sub> <sup>-</sup>	0.043	M
OH <sup>-</sup>	1.02	M
Al	1.52	M
B	0.0029	M
Ca	7.4E-04	M
Cr	8.2E-04	M
Fe	1.2E-04	M
K	0.146	M
Mo	0.001	M
Na	8.72	M
Ni	5.4E-04	M
P	0.0033	M
U	0.00124	g/L
TOC	12.5	g/L
<b>RADIONUCLIDES</b>		
<sup>137</sup> Cs	6.96E+05	μCi/L
<sup>89/90</sup> Sr	1,580	μCi/L
<sup>99</sup> Tc	369	μCi/L
<sup>239/240</sup> Pu	4.53	μCi/L
<sup>241</sup> Am	0.87	μCi/L
Total alpha	16.8	μCi/L
Total beta	4.24E+05	μCi/L

Table B-2: 1989 Analysis of 241-A-102 Liquid.<sup>1,2</sup> (2 sheets)

Component	Result	Lab Unit
<b>PHYSICAL DATA</b>		
Density	1.57	g/mL
%H <sub>2</sub> O	46.2	%
pH	13.6	N/A

Notes:

<sup>1</sup>Weiss (1989)

<sup>2</sup>The reliability of these data is questionable due to the lack of proper QC documentation. The data are not validated and should be used with caution.

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