ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635339

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Jaiduk Jo, Data Assessment and Interpretation, R2-12, 373-9322	[] Yes [X] No	08/13/96
	6. Project Title/No./Work Order No. Tank 241-AN-102	7. Bldg./Sys./Fac. No. 241-AN-102	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-545, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

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

13a. Description of Change

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

This ECN is being generated in order to add data from 1996 sampling events.

14a. Justification (mark one)

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

14b. Justification Details

New information was obtained and needed to be included in this document.

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

See attached distribution.

RELEASE STAMP

DATE: AUG 29 1996

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) ECN-635339

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

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

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

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

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

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. J. Jo	Jaiduk Jo	8-29-96	PE		
Cog. Mgr. J.G. Kristofzski	[signature]	8-29-96	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other R.J Cash	[signature] for RJ Cash per telecon	8-29-96	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Double-Shell Tank 241-AN-102

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

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-545	Page 1

(2) Title
Tank Characterization Report for Double-Shell Tank 241-AN-102

CHANGE CONTROL RECORD

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WHC-SD-WM-ER-545
Revision 1

Tank Characterization Report for Double-Shell Tank 241-AN-102

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Date Published
August 1996

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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

EXECUTIVE SUMMARY

This characterization report summarizes the available information on the historical uses, current status, and sampling and analysis results of waste stored in double-shell underground storage tank 241-AN-102. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order*, Milestone M-44-09 (Ecology et al. 1996).

Tank 241-AN-102 is one of seven double-shell tanks located in the AN Tank Farm in the Hanford Site 200 East Area. The tank was hydrotested in 1981, and when the water was removed, a 6-inch heel was left. Tank 241-AN-102 began receiving waste from tank 241-SY-102 beginning in 1982. The tank was nearly emptied in the third quarter of 1983, leaving only 125 kL (33 kgal) of waste. Between the fourth quarter of 1983 and the first quarter of 1984, tank 241-AN-102 received waste from tanks 241-AY-102, 241-SY-102, 241-AW-105, and 241-AN-101. The tank was nearly emptied in the second quarter of 1984, leaving a heel of 129 kL (34 kgal). During the second and third quarters of 1984, the tank was filled with concentrated complexant waste from tank 241-AW-101. Since that time, only minor amounts of Plutonium-Uranium Extraction (PUREX) Plant miscellaneous waste and water have been received; there have been no waste transfer to or from the tank since 1992. Therefore, the waste currently in the tank is considered to be concentrated complexant waste. Tank 241-AN-102 is sound and is not included on any of the Watch Lists.

A description of tank 241-AN-102 and its status are presented in Table ES-1 and Figure ES-1. The tank has an operating capacity of 4,390 kL (1,160 kgal), and presently contains an estimated 4,092 kL (1,081 kgal) of concentrated complexant waste. Of this total volume, 3,755 kL (992 kgal) are estimated to be supernate and 337 kL (89 kgal) are estimated to be sludge (Hanlon 1996).

This report summarizes three grab sampling and analysis events that occurred in October 1994, February 1995, and November/December 1995. The grab samples obtained in October 1994 and February 1995 were both taken from riser 22A for process control purposes. Since two vertical profiles of the tank waste from different risers are needed for a safety screening evaluation, grab samples were taken from riser 21A in November/December 1995. To complete the safety screening evaluation, selected samples from the previous two sampling events were retrieved from archive for safety screening analyses. All analyses performed on the November/December 1995 grab samples, and the grab samples obtained from archive, were done to satisfy requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995).

The purpose of the safety screening data quality objective (DQO) is to identify any unknown safety issues and to evaluate the tank for placement on a Watch List. To accomplish this, the safety screening DQO requires measurements of the total fuel content of the waste by differential scanning calorimetry (DSC), weight percent water by thermogravimetric analysis

Table ES-1. Description and Status of Tank 241-AN-102.[1,2]

TANK DESCRIPTION	
Type	Double-shell
Constructed	1980-1981
In-service	1981
Diameter	22.9 m (75.0 ft)
Maximum operating depth	10.7 m (35.2 ft)
Capacity	4,390 kL (1,160 kgal)
Bottom shape	Flat
Ventilation	Operating exhauster
TANK STATUS	
Waste classification	Concentrated complexant
Total waste volume	4,092 kL (1,081 kgal)
Sludge volume	337 kL (89 kgal)
Drainable interstitial liquid volume	11 kL (3 kgal)
Supernate volume	3,755 kL (992 kgal)
Waste surface level (November 30, 1995)[3]	998 cm (393 in.)
Temperature (1990 - 1996)	25 °C (77 °F) to 39.4 °C (103 °F)
Integrity	Sound
Watch List	None
SAMPLING DATES	
Grab samples	October 1994
Grab samples	February 1995
Grab samples and tank headspace flammability	November/December 1995
SERVICE STATUS	
Active	1981 to present

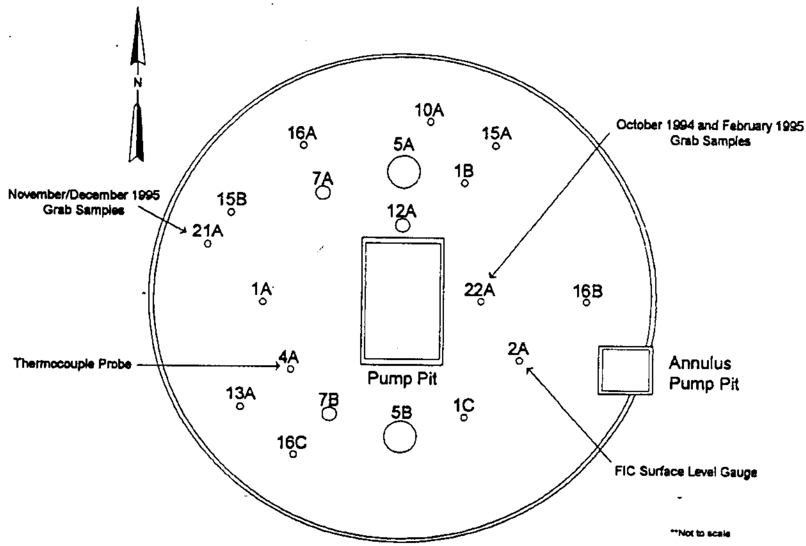
Notes:

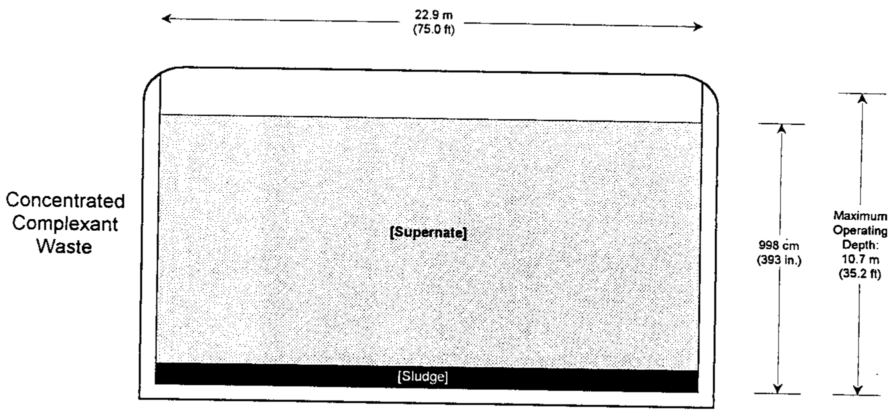
[1]Tank status as of April 30, 1996.

[2]This is an active tank and the tank status will be changed when transfers occur.

[3]Waste surface level when the November/December sample was taken.

Figure ES-1. Description and Status of Tank 241-AN-102.





Total Tank Volume: 4,390 kL (1,160 kgal)
Current Waste Volume (April 1996): 4,092 kL (1,081 kgal)
Sludge Volume (April 1996): 337 kL (89 kgal)
Supernate Volume (April 1996): 3,755 kL (992 kgal)

**Not to scale

(TGA), density (solids) or specific gravity (liquids) by displacement, total alpha activity by alpha proportional counting, and a visual examination of the waste samples for an organic layer (liquids only). The safety screening DQO also requires a determination of the flammability of the tank headspace gases. To satisfy this requirement, monitoring within the tank headspace using a combustible gas meter was performed before sampling, and the flammability was measured as a percentage of the lower flammability limit (LFL).

The waste compatibility DQO governs the acquisition of analytical data that assist the tank farm operators in performing non-routine transfers. The waste compatibility DQO requires some of the same analyses as the safety screening DQO, as well as those for selected metals, anions, radionuclides, pH, and total inorganic carbon (TIC) and total organic carbon (TOC).

The DSC was performed on the supernate samples and on centrifuged fractions of the sludge samples. Twelve of the 14 samples exhibited exothermic reactions, with the majority (8) exhibiting exothermic reactions with changes in enthalpy exceeding the safety screening decision threshold of -480 J/g (dry weight). All but one of the 12 samples exceeded upper limit to one-sided 95 percent confidence interval on the mean. Exothermic behavior is not surprising due to the properties of the concentrated complexant waste stored in the tank. Concentrated complexant waste contains high levels of organic carbon, nitrate, and nitrite. It should be noted that the mean water contents of both the sludge and supernate samples, as performed by TGA, were 44.6 weight percent and 49.7 weight percent, respectively. The lowest individual value was 35.60 percent. Consequently, all weight percent water results were above 17 weight percent, the minimum amount required to prevent a propagating exothermic reaction according to the organic DQO (Turner et al. 1995). The TOC analysis was performed on any sample that exhibited a change in enthalpy greater than -480 J/g. A comparison was made between the TOC results and the TOC limit of 30,000 μg C/g presented in the organic DQO (Turner et al. 1995). On a dry-weight basis, the sludge was found to contain a mean concentration of 44,000 μg C/g of TOC, and the supernate was found to contain a mean of 37,000 μg C/g of TOC. Again, although these values exceeded the threshold, this was expected due to the nature of the waste. All total alpha activity values were well below the safety screening thresholds. The total alpha activity mean for the sludge was 0.296 μCi/g, with the highest upper limit to one-sided 95 percent confidence interval on the mean being 1.414 μCi/g for the centrifuged solids and 0.296 μCi/mL for the centrifuged liquid. The total alpha activity mean for the supernate was 0.163 μCi/mL, with an upper limit to one-sided 95 percent confidence interval on the mean of 0.290 μCi/mL. The tank headspace flammability was measured at 0 percent of the LFL.

Waste compatibility DQO energetics decision criteria are based on the ratio of exothermic energy to endothermic energy. All supernate samples exhibited exotherm/endotherm ratios well below the limit of 1. The $^{239/240}$Pu concentration was measured to evaluate criticality safety for waste transfers. The results were two orders of magnitude below the criticality prevention limit. The specific gravity of the supernate samples was evaluated to determine the potential for the waste to accumulate flammable gas. The mean specific gravity from the supernate samples was 1.41, exceeding the DQO threshold of 1.3 for source wastes and equalling the limit of 1.41 for commingled waste. The hydroxide ion concentration of the corrosion-inhibiting constituents of the waste was outside the limits imposed by the compatibility DQO. The mean hydroxide ion concentration of 0.23 M is below the threshold limit of 0.3 M. The concentrations of transuranic (TRU) elements in the supernate samples were measured to evaluate TRU segregation. The combined results of ^{241}Am and $^{239/240}$Pu equalled 0.102 μCi/g, slightly exceeding the limit of 0.1 μCi/g.

The heat generated by the radioactivity in the tank waste is estimated (from the radionuclide analytical data) to be 8,140 W (27,800 Btu/hr), which is within the operating specification limit of 20,500 W (70,000 Btu/hr) (Harris 1994). Additional estimates of 12,000 W (41,000 Btu/hr) (Kummerer 1994) and 10,600 W (36,300 Btu/hr) (Agnew et al. 1996a) were also below this limit. Surveillance information indicated that between January 1990 and January 1996, the mean tank temperature was 35 °C (95 °F), with a minimum of 25 °C (77 °F), and a maximum of 39.4 °C (103 °F).

According to the decision criteria of the waste compatibility and safety screening DQOs the waste currently in tank 241-AN-102 may continue to be stored in the tank, but special action (caustic mitigation) will be required to inhibit corrosion. The sample mean of 0.21 M was below the minimum required level of 0.3 M. Since the tank contains concentrated complexant waste, its waste must remain segregated from non-complexant waste types. In addition, it was revealed that the TRU level slightly exceeded the TRU segregation limit, needing further segregation. Although exothermic reactions were observed in the waste, the water content of the waste is sufficiently high to prevent any propagating exothermic reactions. Finally, no additional characterization efforts will be required until caustic addition effort begins.

The concentration and tank inventories for the major constituents and analytes of concern in the tank waste are summarized in Tables ES-2 and ES-3.

Table ES-2. Concentrations and Inventories for Major Analytes and Analytes of Concern in the Supernate of Tank 241-AN-102.[1,2] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
METALS	μg/mL	%	kg
Aluminum	15,100	1.48	56,700
Chromium	297	2.62	1,120
Iron	50.9	10.30	191
Manganese	39.1	23.67	147
Nickel	381	2.95	1,430
Potassium	3,880	6.76	14,600
Sodium	2.40E+05	3.72	9.01E+05
ANIONS	μg/mL	%	kg
Chloride	3,810	6.18	14,300
Fluoride	1,860	8.24	6,980
Hydroxide	3,610 (0.21 M)	4.78	13,600
Nitrate	2.25E+05	7.11	8.45E+05
Nitrite	82,600	6.96	3.10E+05
Phosphate	4,820	6.80	18,100
Sulfate	13,800	5.88	51,800
RADIONUCLIDES	μCi/mL	%	Ci
^{241}Am	0.138	10.58	518
^{137}Cs	351	3.96	1.32E+06
$^{239/240}$Pu	0.00582	6.71	21.8
$^{89/90}$Sr	74.5	1.21	2.80E+05
Total alpha	0.163	4.63	612
CARBON	μg C/mL	%	kg C
TIC	13,200	1.46	49,600
TOC	26,200	0.97	98,400

Table ES-2. Concentrations and Inventories for Major Analytes and Analytes of Concern in the Supernate of Tank 241-AN-102.[1,2] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
PHYSICAL PROPERTIES		%	kg
Specific gravity	1.41	0.67	---
pH	13.2	0.39	---
Weight percent water	49.7	0.27	2.63E+06

Notes:

[1]All analytical results are reported on a wet-weight basis.

[2]The supernate waste volume used for the inventory estimation was 3,755 kL (992 kgal).

Table ES-3. Concentrations and Inventories for Major Analytes and Analytes of Concern in the Sludge of Tank 241-AN-102.[1,2]

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
ANIONS	μg/g	%	kg
Cyanide (centrifuged solids only)	20.9	0.92	10.4
RADIONUCLIDES	μCi/g	%	Ci
Total alpha	0.296	8.47	147
CARBON	μg C/g	%	kg C
TOC	24,400	6.00	12,100
PHYSICAL PROPERTIES		%	kg
Density (sludge)[3]	1.47	1.23	---
Density (slurry)[4]	1.49	1.01	---
Volume % solids (centrifuged solids only)	55.6	10.07	---
Volume % solids (slurry)[3]	50.1	6.99	---
Weight percent water	44.6	3.00	2.21E+05

Notes:

[1]All analytical results are reported on a wet-weight basis.

[2]The sludge waste volume used for the inventory estimation was 337 kL (89 kgal).

[3]The result for the analyte denoted as "sludge" was derived by combining weighted fractions of the centrifuged solids and centrifuged liquid portions.

[4]For those analytes with the "slurry" designation, the analyses were performed on the grab samples after shaking to suspend the settled solids.

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APPENDICES

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LIST OF TERMS

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
g C/L	grams of carbon per liter
HDW	Hanford Defined Waste
HTCE	Historical Tank Content Estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inches
J/g	joules per gram
kg	kilograms
kg C	kilograms carbon
kgal	kilogallons
kL	kiloliters
LEL	lower explosive limit
LFL	lower flammability limit
m	meters
M	moles per liter
mg	milligrams
mL	milliliters
mmol/g	millimoles per gram
mmol C/g	millimoles of carbon per gram
mR/hr	milliroentgens per hour
ppm	parts per million
PUREX	plutonium-uranium extraction
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
SACS	Surveillance Analysis Computer System
SAP	sampling and analysis plan
SMM	Supernate Mixing Model

LIST OF TERMS (Continued)

SpG	specific gravity
TC	thermocouple
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	Tank Layer Model
TOC	total organic carbon
TRU	transuranic
W	watts
WHC	Westinghouse Hanford Company
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
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg C/g	micrograms carbon per gram
μg C/mL	micrograms carbon per milliliter
μg/g	micrograms per gram
μg/mL	micrograms per milliliter
ΔH	change in enthalpy

1.0 INTRODUCTION

This tank characterization report presents an overview of double-shell tank 241-AN-102 and its waste contents. It provides estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities, in combination with background tank information. The characterization of tank 241-AN-102 is based on the results from grab sampling events in October 1994, February 1995, and November and December 1995. For informational purposes, results from three previous sampling events (in 1984, 1989, and 1990) have also been presented.

Tank 241-AN-102 contains concentrated complexant waste, which must be segregated from non-complexant wastes (Fowler 1995). Thus, although the volume may change, it is unlikely that the composition will change substantially. Although the tank is in service, there have been no waste tranfer to or from the tank since 1992. The concentration and inventory values reported in this document reflect the best estimates based on the most recent analytical data. 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-AN-102. When possible, this information will be used to assess issues associated with safety, operational, environmental, and process development activities. This report also provides a reference point for more detailed information about tank 241-AN-102.

1.2 SCOPE

The November/December 1995 grab sampling event for tank 241-AN-102 supported the evaluation of the tank waste according to the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). The primary safety screening analyses, including DSC (to evaluate fuel level and energetics), TGA (to determine the moisture content), total alpha activity analysis (to evaluate the criticality potential), specific gravity or density, and a visual check for an organic layer (liquids only), were performed on the samples. Combustible gas meter readings of the tank headspace vapors were also taken to address flammability concerns. Because of high energetics, TOC and cyanide were also analyzed (cyanide only on the centrifuged solids). The supernate samples and the liquid portions of the sludge samples were further subjected to a waste compatibility evaluation which, in addition to the safety screening determinations, required analyses for TOC, TIC, ^{137}Cs, $^{239/240}Pu$, ^{90}Sr, metals (aluminum, chromium, iron, manganese, nickel, silicon, sodium, and uranium), anions (chloride, fluoride, hydroxide, nitrate, nitrite, phosphate, and sulfate), pH, and percent solids. An additional characteristic measured for the sludge grab samples was volume percent solids.

The February 1995 grab sampling event was originally performed for process control and process development purposes. In January 1996, archived waste material from this sampling event was retrieved for a safety screening evaluation. The primary safety screening analyses were performed on the archived samples. In addition, TOC measurements were done on the supernate samples and a volume percent solids determination was made on the sludge sample.

The four October 1994 grab samples were also originally taken for process control and process development reasons. The sludge sample was archived, and the three supernate samples were analyzed in 1994 for percent water, total alpha activity, ^{137}Cs, ^{90}Sr, TOC, TIC, pH, density, metals, and anions. Archived portions of the sludge sample and one of the supernate samples were retrieved in January 1996 for a safety screening evaluation. The primary safety screening analyses were performed on both samples. In addition, TOC was measured on the liquid sample, and volume percent solids was measured on the sludge sample.

2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-AN-102 based on historical information. The first part details the current condition of the tank. This is followed by discussions of the tank 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. Events that may be related to tank safety issues, such as potentially hazardous tank contents or off-normal operating temperature, 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 April 30, 1996, tank 241-AN-102 contained an estimated 4,092 kL (1,081 kgal) of waste classified as complexant concentrate (Hanlon 1996). The volume of liquids in the tank was estimated using a combination Food Instrument Corporation (FIC) gauge and manual tape. The solids volume was estimated using a sludge measurement device. The last update on the solids level was August 22, 1989. The estimated amounts of various waste phases in the tank are presented in Table 2-1 (Hanlon 1996).

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

Waste Form	Estimated Volume	
	kL	kgal
Total waste	4,092	1,081
Supernate liquid	3,755	992
Sludge	337	89
Saltcake	0	0
Drainable interstitial liquid	11	3
Drainable liquid remaining	3,766	995
Pumpable liquid remaining	3,755	992

Note:

[1]For definitions and calculation methods refer to Appendix C of the monthly summary (Hanlon 1996).

Tank 241-AN-102 is in service at the present time; however, there have been no waste transfers to or from the tank since 1992. The tank is actively ventilated, and its integrity categorized as sound. Tank 241-AN-102 is not on any of the Watch Lists. All monitoring systems were in compliance with documented standards as of April 30, 1996 (Hanlon 1996).

2.2 TANK DESIGN AND BACKGROUND

The AN Tank Farm is the newest generation double-shell tank farm design built between 1980 and 1981. This tank farm consists of seven 4,390 kL (1,160 kgal) tanks of the 100-series type. These tanks were designed for a maximum fluid temperature of 177 °C (350 °F). The 241-AN Tank Farm does not use a cascade system between tanks.

Tank 241-AN-102 was constructed with concrete walls that are 46 cm (1.5 ft) thick and a concrete dome that is 38 cm (1.25 ft) thick. The mild carbon steel liner on the bottom is 1.3 cm (1/2 in.) thick, while the lower portion of the sides are 1.9 cm (3/4 in.) thick. The upper portion of the sides is 1.3 cm (1/2 in.) thick and the dome liner is 0.95 cm (3/8 in.) thick steel. The inner liner has been heat-treated and stress-relieved. The secondary liner is made of 0.95 cm (3/8 in.)-thick mild carbon steel. The outer liner has not been heat-treated. The tank has a flat bottom and a maximum operating depth of 10.7 m (35.2 ft). The tank is set on an insulated, reinforced-concrete foundation. This foundation has a grid of drain slots designed to collect any tank leakage and divert it to a leak-detection well. The grid also serves as an escape route for free water released from the concrete grout during initial heating of the tank. Various coatings and sealants were used to ensure that no leaks and intrusions occurred.

A list of tank 241-AN-102 risers (annular risers not included), showing the size and general use, is provided in Table 2-2. A plan view that depicts the riser configuration and locations is shown in Figure 2-1. Tank 241-AN-102 has 59 risers ranging in diameter from 10.0 cm (4 in.) to 1.1 m (42 in.), with 22 risers that provide surface level access to the underground tank. This tank has four risers classified as spares: three 10.0 cm (4 in.)-dia risers (10A, 15A, and 21A) and one 30.0 cm (12 in.)-dia riser (7A). If used as sampling ports, these risers would give access to a wide area of the northern half of the tank. A tank cross-section showing the approximate waste level, along with a schematic of the tank equipment, is found in Figure 2-2.

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

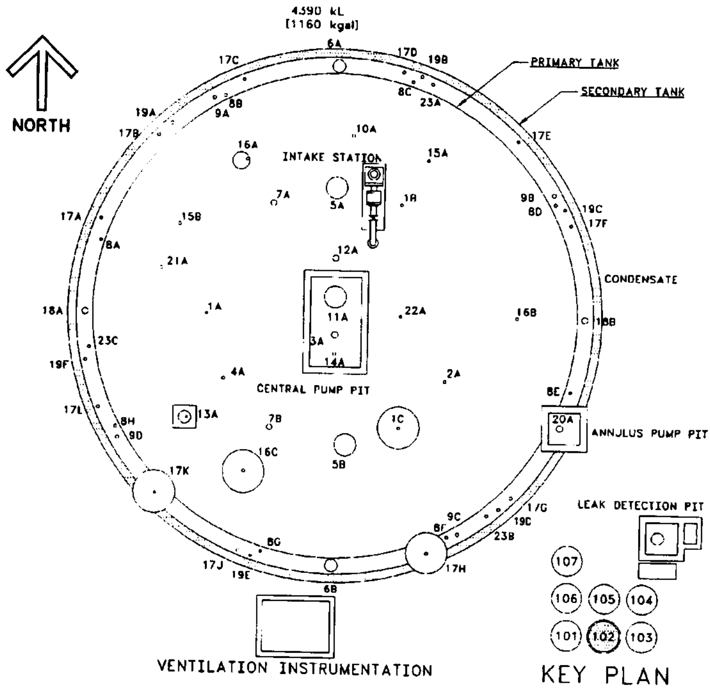


Table 2-2. Tank 241-AN-102 Risers.[1,2,3,4,5]

Riser Number[6,7]	Diameter (in.)	Description and Comments
1A	4	Sludge measurement
1B	4	Sludge measurement
1C	4	Sludge measurement (12-in. metal cover)
2A	4	Liquid level, (level indicating transmitter)
3A	12	Supernate pump, central pump pit
4A	4	Thermocouple tree
5A	42	Spare
5B	42	Spare
7A	12	Spare
7B	12	Tank ventilation
10A	4	Spare
11A	42	Slurry distributor, central pump pit
12A	12	Observation port, spare
13A	4	Tank pressure
14A	4	Dropleg nozzle, central pump pit
15A	4	Vessel vent drain
15B	4	High liquid level sensor
16A	4	Sludge measurement
16B	4	Sludge measurement
16C	4	Sludge measurement (12-in. metal cover)
21A	4	Spare
22A	4	Sludge measurement

Notes:

[1]Salazar (1994)

[2]VEC (1982)

[3]WHC (1995)

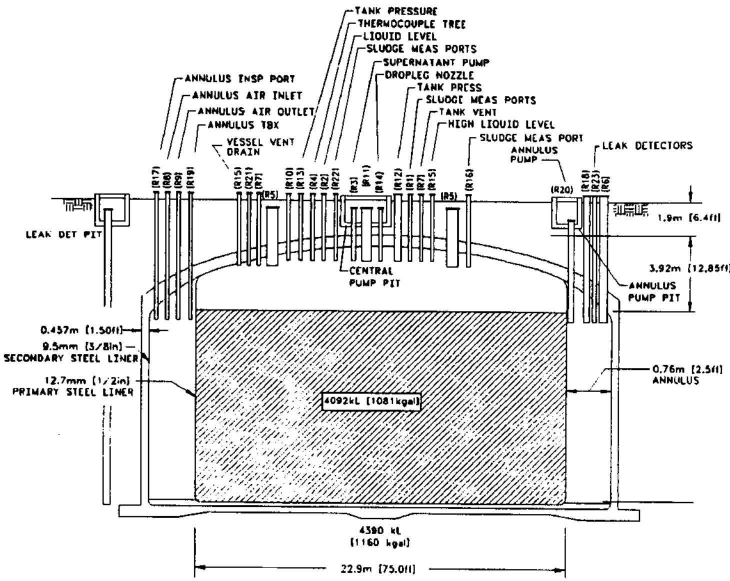
[4]Tran (1993)

[5]If there was a discrepancy between the documents and the drawing, the drawing took precedence. There were no Engineering Change Notices written against the referenced drawings.

[6]Tank risers only, annulus risers excluded.

[7]Riser orientation for risers with identical numbers is based on the tank farm axis as indicated on Figure 2-1.

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



2.3 PROCESS KNOWLEDGE

Section 2.3.1 presents the waste transfer history of tank 241-AN-102. Section 2.3.1.1 provides information on transfers occurring after January 1, 1994. Section 2.3.2 describes the historical estimation of the tank waste contents.

2.3.1 Waste Transfer History

A small amount of water for hydrotest was received by tank 241-AN-102 in 1981. Dilute, non-complexed waste from tank 241-SY-102 was received during the second and third quarters of 1982. Water was added to tank 241-AN-102 intermittently from the second quarter of 1982 until the third quarter of 1983.

During the third quarter of 1982, most of the waste in tank 241-AN-102 was transferred to the 242-A Evaporator feed tank (tank 241-AW-102). Tank 241-AN-102 then received non-complexed waste processed in the 242-A Evaporator (Brager 1993; Agnew et al. 1996b). Most of this waste was removed during the third quarter of 1983, leaving approximately 125 kL (33 kgal) of waste in tank 241-AN-102. Between the fourth quarter of 1983 and the first quarter of 1984, the tank was filled with evaporator feed from tanks 241-SY-102, 241-AY-102, 241-AW-105, and 241-AN-101. Most of this waste was removed in the second quarter of 1984 for an evaporator campaign, leaving a heel of approximately 129 kL (34 kgal) in tank 241-AN-102. By the fourth quarter of 1984, tank 241-AN-102 was nearly filled with concentrated complexant waste (from a previous 242-A Evaporator campaign) from tank 241-AW-101 (Brager 1993). Since then, tank 241-AN-102 has received only small amounts of miscellaneous waste from the PUREX Plant and waste water. A chronological summary of the major transfers of waste through tank 241-AN-102 is shown in Table 2-3. Slight fluctuations in the waste level have been recorded since 1992. These variations are not due to waste transfers. According to Hanlon (1996), such unknown waste gains or losses may be the result of rounding calculations, clean water slowly leaking through a valve, changes in levels (expansion/contraction) because of ambient temperature changes, different measuring devices being used by tank farm operators, transfers taking place during the end of the month, or tank farm activities such as miscellaneous water additions not associated with facility waste generation.

Table 2-3. Tank 241-AN-102 Waste Transfer Summary.[1,2,3,4]

Transfer	Time Period	Volume Received kL (kgal)	Volume Removed kL (kgal)
Hydrotest (water)	1981	57 (15)	0
Evaporator feed and water	1982	3,926 (1,037)	3,801 (1,004)
Concentrated non-complexed waste from tank 241-AW-102	1982	1,760 (465)	1,760 (465)
Evaporator feed and water	1983-84	4,020 (1,062)	4,020 (1,062)
Concentrated complexant waste from tank 241-AW-101	1984	4,100 (1,083)	0
PUREX miscellaneous waste and water	1984-92	121 (32)	0

Notes:

[1]Note that this table only reflects actual waste transfers. Unknown changes in the waste volume not attributed to waste transfers have not been included; therefore, the volume derived by subtracting the "Volume Removed" values from the "Volume Received" values will not equal the current waste volume.

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

[3]Agnew et al. (1996b)

[4]There has been no transfer since 1992.

2.3.2 Historical Estimation of Tank Contents

The following is an estimate of the contents for tank 241-AN-102 based on historical transfer data. The historical data used for the estimate are from the *Waste Status and Transaction Record Summary for the Southeast Quadrant* (WSTRS) (Agnew et al. 1996b) and the *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996a). The WSTRS is a balanced tank-by-tank quarterly summary transaction spreadsheet. Using these fill records, the Tank Layer Model (TLM) provides a definition of the sludge and saltcake layers within each tank. The Supernate Mixing Model (SMM) uses information from both the WSTRS and the TLM to describe the supernates and concentrates within each of the tanks. Together, the WSTRS, TLM, and SMM determine each tank's inventory estimate. In most cases, the available data are incomplete, reducing the reliability of the transfer data and the derived modeling results. Thus, these model predictions are considered estimates that require further evaluation using analytical data.

Based on the TLM, tank 241-AN-102 contained a top layer of 3,808 kL (1,006 kgal) of supernate waste, and a bottom layer of 337 kL (89 kgal) of concentrated supernate solids. Within the TLM, concentrated supernate solids are considered as part of the total supernate and not as a solid. A representation of the estimated waste types and volumes for these layers is given in Figure 2-3.

The supernate should contain large amounts of nitrate and sodium. Additionally, smaller amounts of hydroxide, nitrite, aluminum, carbonate, sulfate, and complexants should be present, along with trace amounts of phosphate and chloride. Table 2-4 presents the tank 241-AN-102 inventory estimates from the historical tank content estimate (Agnew 1996a).

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

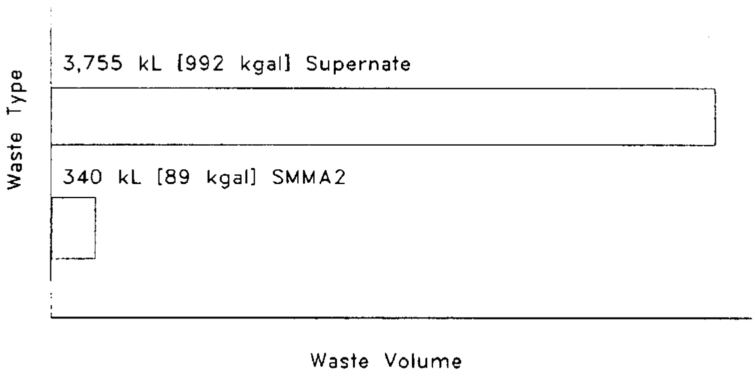


Table 2-4. Tank 241-AN-102 Historical Inventory Estimate.[1,2] (2 sheets)

Total Inventory Estimate			
Physical Properties			
Total waste	7.03E+06 kg (1,090 kgal)		
Heat load	10,600 W (36,300 Btu/hr)		
Bulk density	1.70 (g/mL)		
Water wt%	27.6		
TOC wt% Carbon (wet)	1.53		
Chemical Constituents	**M**	**µg/g**	**kg[3]**
Na^{+}	15.0	2.03E+05	1.42E+06
Al^{3+}	2.07	32,800	2.30E+05
Fe^{3+} (total Fe)	0.00845	277	1,950
Cr^{3+}	0.0661	2,020	14,200
Bi^{3+}	0.00146	179	1,260
La^{3+}	2.44E-05	1.99	14.0
Hg^{2+}	1.14E-05	1.35	9.47
Zr (as $ZrO(OH)_2$)	8.01E-04	42.9	301
Pb^{2+}	0.00153	186	1,310
Ni^{2+}	0.00709	244	1,720
Sr^{2+}	8.15E-06	0.419	2.95
Mn^{4+}	0.00707	228	1,600
Ca^{2+}	0.0384	903	6,340
K^{+}	0.0751	1,720	12,100
OH^{-}	9.11	91,000	6.39E+05
NO_3^{-}	5.86	2.13E+05	1.50E+06
NO_2^{-}	3.03	81,800	5.75E+05
CO_3^{2-}	0.695	24,500	1.72E+05
PO_4^{3-}	0.124	6,910	48,500
SO_4^{2-}	0.358	20,200	1.42E+05
Si (as SiO_3^{2-})	0.100	1,650	11,600
F^{-}	0.0876	977	6,870
Cl^{-}	0.267	5,560	39,000

Table 2-4. Tank 241-AN-102 Historical Inventory Estimate.[1,2] (2 sheets)

Chemical Constituents	M	μg/g	kg[3]
citrate	0.0473	5,260	36,900
$EDTA^{4-}$	0.0381	6,450	45,300
$HEDTA^{3-}$	0.0683	11,000	77,300
glycolate	0.174	7,660	53,800
acetate	0.0252	873	6,130
oxalate	2.09E-05	1.08	7.59
DBP	0.0351	3,320	23,300
butanol	0.0351	1,530	10,700
NH_3	0.0579	578	4,060
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	**Ci/L**	**μCi/g**	**Ci[3]**
Pu	---	0.0582	6.81 (kg)
U	0.0139 (M)	1,950 (μg/g)	13,700 (kg)
Cs	0.331	194	1.37E+06
Sr	0.153	89.6	6.29E+05

Notes:

[1]These estimates have not been validated and should be used with caution.

[2]Agnew et al. (1996a)

[3]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-AN-102 surveillance consists of surface level measurements (liquid and solid), temperature monitoring inside the tank (waste and vapor space), and leak detection well monitoring for radioactive liquids outside the primary tank. Also, liquid level measurements indicate major leaks into or out of the tank. Solid surface level measurements provide an indication of physical changes and consistency of the solid layers of a tank. Leak detection systems within the annulus of the tank detect leaks from the primary tank. The data provide the basis for determining tank integrity.

2.4.1 Surface Level Readings

Tank 241-AN-102 waste surface level is monitored with a FIC gauge and a manual tape. Except for a small transfer in 1992, the surface level shows a slow but continuous drop of approximately 5.0 cm (2 in.) per year probably due to evaporation. The FIC surface level measurement on June 26, 1996 was 9.98 m (393 in.). A representation of the volume measurements is presented as a level history graph in Figure 2-4.

2.4.2 Internal Tank Temperatures

Temperature data for tank 241-AN-102 are recorded by 18 thermocouples (TCs) attached at known elevations, on one TC tree located in riser 4. Temperature data from the Surveillance Analysis Computer System (SACS) (WHC 1996) recorded from January 1990 to June 1996 are available for all 18 TCs. The mean temperature of the SACS data for this time span was 35 °C (95 °F), the minimum temperature was 25 °C (77 °F), and the maximum temperature was 39.4 °C (103 °F). The mean temperature of the SACS data for the period of June 1995 to June 1996 was 35.4 °C (95.7 °F) with a minimum temperature of 31.4 °C (88.5 °F) and a maximum temperature of 38.3 °C (101 °F). The minimum temperature on June 25, 1996, was 32.9 °C (91.2 °F) on TC 1 and the maximum was 36.7 °C (98.1 °F) on TC 8. Both TCs were in the supernate. A graph of the weekly high temperature can be found in Figure 2-5. Plots of the individual TC readings for tank 241-AN-102 can be found in the supporting documents for the Historical Tank Content Estimate (HTCE) (Brevick et al. 1995).

2.4.3 Tank 241-AN-102 Photographs

There are no photographs of the tank interior available.

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

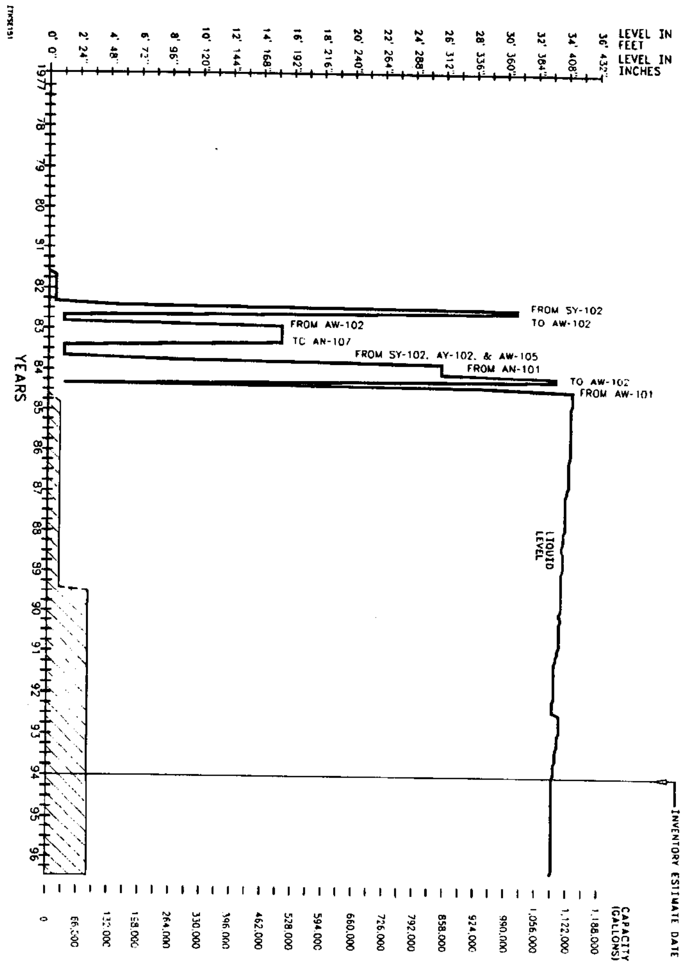
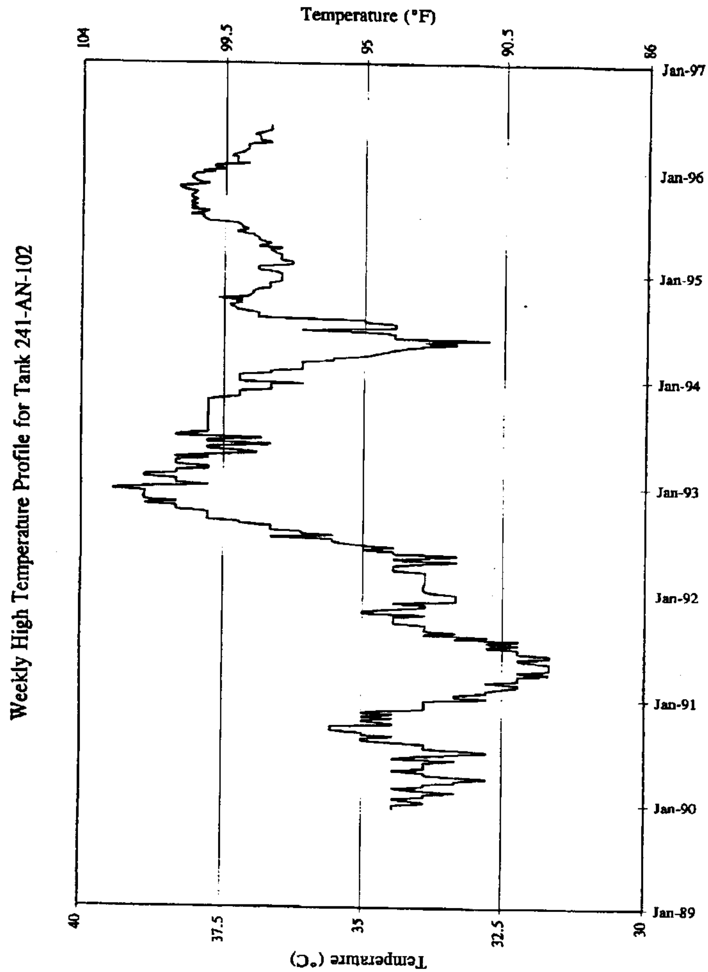


Figure 2-5. Tank 242-AN-102 Weekly High Temperature Plot.



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3.0 TANK SAMPLING OVERVIEW

This section describes the October 1994, February 1995, and November/December 1995 sampling and analysis events for tank 241-AN-102. The grab samples obtained in October 1994 and February 1995 were originally taken for process control and process development purposes. The sampling and analysis of the October 1994 samples were directed by *Letter of Instruction for Analysis of Double-Shell Tank 241-AN-102 Grab Samples* (Bratzel 1994), while the sampling and analysis of the February 1995 samples were performed in accordance with *Tank 241-AN-102 Tank Characterization Plan* (Schreiber 1995). The November/December 1995 grab samples were acquired to satisfy the requirements of the safety screening and waste compatibility DQOs. The sampling and analysis plan (SAP), *Tank 241-AN-102 Grab Sampling and Analysis Plan* (Jo 1996), summarized and integrated the requirements of these two DQOs. This SAP also directed the safety screening analyses performed on archived samples from the October 1994 and February 1995 grab samples. Descriptions of the three previous sampling events have also been included for information. Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

3.1 OCTOBER 1994 GRAB SAMPLING EVENT

3.1.1 Description of October 1994 Grab Sampling Event

Four grab samples (three supernate and one sludge), were obtained from riser 22A of tank 241-AN-102 on October 21, 1994 (Herting 1994, Jones 1994). Sampling depths and sample numbers are presented in Table 3-1. To differentiate these samples from those taken in February 1995, an "(A)" has been appended to the sample numbers. An "(A)" was not needed for sample 102-AN-4, since a similarly labeled sample was not taken during the February 1995 sampling event. The immediate objective of the sampling was to determine whether the free-hydroxide concentration of the waste was within tank corrosion control specifications. Because the sampling was performed for process control purposes, no tank characterization plan was required and no DQOs were applicable. For the same reason, no field/trip blank was required. No problems were noted with the sampling event.

Table 3-1. October 1994 Grab Sampling Event Information.

Sample Number	Sample Type	Sample Elevation[1]	Contact Dose Rate (mR/hr)
102-AN-1(A)	Supernate	884 cm (348 in.)	Not given
102-AN-2(A)	Supernate	541 cm (213 in.)	Not given
102-AN-3(A)	Sludge	15 cm (6 in.)	1,000
102-AN-4	Supernate	127 cm (50 in.)	1,000

Note:
[1]Sample elevation is measured from the tank bottom to the mouth of the sample bottle.

The four grab samples were delivered to the Westinghouse Hanford Company 222-S Laboratory in 120-mL sample bottles on October 24, 1994. The characterization of these samples was performed in two phases. The initial phase occurred in late 1994, when the sludge sample was archived and the three supernate samples were analyzed. In early 1996, archived samples of the sludge sample (102-AN-3(A)) and one supernate sample (102-AN-4) were retrieved for safety screening and waste compatibility analyses.

3.1.2 Handling of October 1994 Grab Samples

3.1.2.1 Sample Handling (1994). Upon receipt by the Westinghouse Hanford Company 222-S Laboratory, the sludge sample (102-AN-3(A)) was archived, while observations were recorded for the three supernate samples. No observations were made of the sludge sample. The three supernate samples were described as being very dark brown, almost black (Herting 1994).

The samples were agitated by shaking before two 15-mL aliquots were removed from each bottle. The aliquots were then transferred into separate centrifuge cones. Each aliquot was centrifuged for 1 hr, after which the liquids were clear. The liquid phase was decanted from each cone into a sample vial. All of the six cones contained two distinct layers of solids of roughly equal volume. The weight percent centrifuged solids for the cones ranged from 1.1 to 1.3 percent. The top layer was dark brown and the bottom layer was white. Each layer of solids was analyzed by polarized light microscopy and by x-ray diffraction. The white solids were composed mostly of octahedral crystals of sodium fluoride diphosphate. There was also a trace of sodium carbonate crystals. The dark brown solids were made up of submicron-sized particles that could not be identified by either method (Herting 1994).

Although not discussed in Herting (1994), at some point during the sample handling, waste material from the supernate samples was archived.

3.1.2.2 Sample Handling (1996). Two of the archived samples from the October 1994 grab sampling event (102-AN-3(A) and 102-AN-4), were retrieved and subjected to safety screening and waste compatibility analyses in 1996. On January 8, 1996, the two samples were subsampled for analysis. For sample 102-AN-4, one unfiltered subsample was recovered for safety screening analyses only. Immediately after retrieving sample 102-AN-3(A), the volume percent settled solids was measured. The results of this measurement are presented in Table 3-2. The supernate above the settled solids was then removed and discarded, and the remaining sludge was transferred to two centrifuge cones for a volume percent solids determination (by centrifugation), and separation of the solids from the remaining liquid. Individual bulk density measurements of the centrifuged solids and liquids were made. Subsamples were created from both the centrifuged solid and liquid portions, and identical analyses were performed on each (Esch 1996a).

Physical descriptions of the two recovered samples are listed in Table 3-2. Note that these are descriptions of the samples after archival for over one year, and they differ from the original observations given in Section 3.1.2.1.

Table 3-2. Appearance of the October 1994 Grab Samples Analyzed in January 1996.[1]

Grab Sample	Laboratory Identification	Appearance			
		Color	Clarity	Organic Layer	Solids
102-AN-3(A)	S96T000001	Dark yellow/brown	Translucent	None	74.1 volume %; Red/tan; settled
102-AN-4	S95T003926	Dark yellow/brown	Translucent	None	Trace; settled

Note:
[1]Esch (1996a)

3.1.3 Analysis of October 1994 Grab Samples

3.1.3.1 Sample Analysis (1994). In addition to physical measurements (density, percent water, and pH), the centrifuged supernate samples were analyzed for eight metals, seven anions, TOC, TIC, two radionuclides, and total alpha activity (Jones 1994). No specific quality control (QC) information was provided in Herting (1994), although results with QC problems were flagged and not included in mean calculations. Analysis procedure numbers were not reported with the analytical results.

3.1.3.2 Sample Analysis (1996). As stated in Section 3.1.2.2, safety screening analyses were performed on grab sample 102-AN-4. These included analyses for energetics by DSC, moisture content by TGA, fissile content by total alpha activity analysis, and bulk density. Although the DSC runs did not exhibit changes in enthalpy greater than the -480 J/g safety screening DQO limit, a TOC analysis was run because most of the other tank grab samples did show changes in enthalpy that exceeded the limit.

Both the centrifuged solid and liquid portions of sample 102-AN-3(A) were subjected to a safety screening analysis. In addition, a volume percent solids determination was made on the solids fraction after centrifuging. No analyses for TOC were performed.

All reported analyses were performed in accordance with approved laboratory procedures. An assessment of the QC data is presented in Section 5.1.2. A list of the sample numbers and applicable analyses from this analytical event (and the February 1995 and November/December 1995 sampling and analytical events) is presented in Section 3.3.3, Table 3-7. Table 3-8 displays the analytical procedures by title and number.

3.2 FEBRUARY 1995 GRAB SAMPLING EVENT

3.2.1 Description of February 1995 Grab Sampling Event

Three grab samples were obtained from riser 22A on February 15, 1995. Two of the grab samples were primarily supernate, while the third contained both sludge and supernate. Sampling depths and sample numbers are presented in Table 3-3. To differentiate these samples from those taken in October 1994, a "(B)" has been appended to the sample numbers. The sampling event was a followup to the 1994 grab sampling event. During the 1994 sampling event, it was discovered that the free hydroxide concentration was out of the tank operating specification limit. The February 1995 samples were taken to use in experiments to determine the effects of adding hydroxide to the tank. At the time of sampling, no DQOs were applicable to the sampling event. No problems were noted during the sampling event.

Table 3-3. February 1995 Grab Sampling Event Information.

Sample Number	Sample Type	Sample Elevation[1]	Contact Dose Rate (mR/hr)
102-AN-1(B)	Supernate	721 cm (284 in.)	2,200
102-AN-2(B)	Supernate	244 cm (96 in.)	2,000
102-AN-3(B)	Sludge	175 cm (69 in.)	2,500

Note:

[1]Sample elevation is measured from the tank bottom to the mouth of the sample bottle.

3.2.2 Handling of February 1995 Grab Samples

After sampling, the three grab samples were archived. They remained archived until January 8, 1996, when they were subsampled for analysis. One unfiltered subsample was recovered from both samples 102-AN-1(B) and 102-AN-2(B) for safety screening analyses. Sample 102-AN-3(B) was first subjected to a volume percent settled solids determination, the results of which are reported in Table 3-4. Then, the supernate above the settled solids was removed and discarded, and the remaining sludge was centrifuged for a volume percent solids measurement. Centrifuging also separated the solids from the remaining liquids. Bulk densities were evaluated on both the centrifuged solid and liquid phases. Subsamples were created from both the centrifuged solid and liquid portions, and identical analyses were performed on each (Esch 1996a).

Descriptions of the February 1995 grab samples are presented in Table 3-4.

Table 3-4. Appearance of the February 1995 Grab Samples.[1]

Grab Sample	Laboratory Identification	Appearance			
		Color	Clarity	Organic Layer	Solids
102-AN-1(B)	S95T003924	Dark yellow/brown	Translucent	None	Trace; settled
102-AN-2(B)	S95T003925	Dark yellow/brown	Translucent	None	Trace; settled
102-AN-3(B)	S96T000002	Dark yellow/brown	Translucent	None	18.8 volume %; red/tan; settled

Note:
[1]Esch (1996a)

3.2.3 Analysis of February 1995 Grab Samples

All three grab samples from the February 1995 sampling event were analyzed according to the safety screening DQO. Because of the presence of exothermic reactions greater than the DQO decision threshold, TOC was also analyzed on samples 102-AN-1(B) and 102-AN-2(B). Both the solid and liquid fractions of sample 102-AN-3(B) were subjected to a safety screening analysis. As stated previously, a volume percent solids determination was made on the solids portion after centrifuging.

All reported analyses were performed in accordance with approved laboratory procedures. An assessment of the QC data is presented in Section 5.1.2. A list of the sample numbers and applicable analyses from this analytical event is presented in Section 3.3.3, Table 3-7. Table 3-8 displays the analytical procedures by title and number.

3.3 NOVEMBER/DECEMBER 1995 GRAB SAMPLING EVENT

3.3.1 Description of November/December 1995 Grab Sampling Event

Five grab samples were acquired from riser 21A on November 30, 1995. Three samples contained supernate (2AN-95-1, 2AN-95-2, and 2AN-95-3), while the other two were expected to contain sludge (2AN-95-4 and 2AN-95-5). However, upon inspection at the Westinghouse Hanford Company 222-S Laboratory, it was discovered that the two supposed sludge samples actually contained supernate. Consequently, two more grab samples (2AN-95-4A and 2AN-95-5A) were obtained on December 14, 1995, in an attempt to recover some sludge. The sample numbers for this second set of samples were appended with an "A" to differentiate them from the original samples with the same sample numbers. No analyses were performed on samples 2AN-95-4 and 2AN-95-5; consequently, they are not discussed further in this report. A field blank was collected with the first five grab samples. All of the grab samples from this sampling event were taken to support evaluation of the tank waste according to the safety screening and waste compatibility DQOs. Table 3-5 presents sampling information concerning the November/December 1995 grab samples. Note that sample 2AN-95-2 was obtained at a lower elevation than sample 2AN-95-3 (Esch 1996a). These elevations were confirmed on the sample label, as well as by notes on the chain-of-custody forms.

Before grab sampling, the flammability of the tank headspace vapors was measured as required by the safety screening DQO. In addition, the concentration of oxygen, ammonia, and total organic vapor were determined. The result of the flammable gas monitoring are presented in Table 4-5. Monitoring of the headspace gases with a combustible gas meter was performed at a depth of 20 ft, through riser 21A (Engineering 1995).

Table 3-5. November/December 1995 Grab Sampling Event Information.[1]

Sample Number	Sample Type	Sample Elevation[2,3]	Contact Dose Rate (mR/hr)
2AN-95-1	Supernate	767 cm (302 in.)	2,000
2AN-95-2	Supernate	310 cm (122 in.)	1,000
2AN-95-3	Supernate	538 cm (212 in.)	1,500
2AN-95-4	Supernate[4]	45.7 cm (18 in.)	1,500
2AN-95-5	Supernate[4]	12.7 cm (5 in.)	1,500
2AN-95-6	Field blank	1,100 cm (432 in.)	< 0.5
2AN-95-4A	Sludge	45.7 cm (18 in.)	1,500
2AN-95-5A	Sludge	12.7 cm (5 in.)	1,000

Notes:

[1]Esch (1996b)

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

[3]Sample elevations were taken from Engineering (1995).

[4]Samples were expected to contain sludge. Because sludge was not recovered, the samples were retaken. No analyses were performed on these samples.

3.3.2 Handling of November/December 1995 Grab Samples

Physical descriptions of the November/December 1995 grab samples are presented in Table 3-6. Samples 2AN-95-1, 2AN-95-2, 2AN-95-3, 2AN-95-4A, and 2-AN-95-5A were subsampled for analysis between January 5 and 11, 1996. For samples 2AN-95-1, 2AN-95-2, and 2AN-95-3, two unfiltered subsamples were removed from each for safety screening and waste compatibility analyses. A subsample was also archived for each of the three grab samples (Esch 1996a).

Table 3-6. Appearance of the November/December 1995 Grab Samples.[1,2]

Grab Sample	Laboratory Identification	Appearance			
		Color	Clarity	Organic Layer	Solids
2AN-95-1	S95T003864	Dark yellow/brown	Translucent	None	None
2AN-95-2	S95T003865	Dark yellow/brown	Translucent	None	Trace; settled
2AN-95-3	S96T003866	Dark yellow/brown	Translucent	None	None
2AN-95-4A	S95T003959	Dark yellow/brown	Translucent	None	61.5%; tan; settled
2AN-95-5A	S95T003960	Dark yellow/brown	Translucent	None	61.5%; tan; settled
2AN-95-6 field blank	S95T003961	Colorless liquid	Clear	None	None

Notes:

[1]Esch (1996a)

[2]No description of samples 2AN-95-4 and 2AN-95-5 was provided in Esch (1996a).

For samples 2AN-95-4A and 2AN-95-5A, the volume percent settled solids was first determined by visual estimation. The results of this measurement are given in Table 3-6. The samples were then shaken to suspend the settled solids. The resulting slurry for each sample was then transferred to three centrifuge cones for a volume percent solids determination (by centrifugation), and for separation of the solids and liquids. Bulk densities of the slurry, the centrifuged solids, and the centrifuged liquids were determined. Subsamples were created from both the centrifuged solid and liquid portions, and identical analyses were performed on each (Esch 1996a).

3.3.3 Analysis of November/December 1995 Grab Samples

All six grab samples listed in Table 3-6 were analyzed according to the safety screening DQO, which required analyses for energetics, moisture content, total alpha activity, and bulk density. In addition, the supernate grab samples (2AN-95-1, 2AN-95-2, and 2AN-95-3) and the field blank (2AN-95-6) were subjected to a waste compatibility evaluation. The waste compatibility DQO requires analyses for energetics, moisture content, TOC, TIC, total alpha activity, ^{137}Cs, $^{239/240}Pu$, ^{241}Am, ^{90}Sr, metals (iron, manganese, uranium, chromium, nickel, aluminum, sodium, and silicon) by inductively coupled plasma spectroscopy (ICP), anions (chloride, fluoride, phosphate, sulfate, nitrate, and nitrite) by ion chromatography (IC), hydroxide, pH, specific gravity, and percent solids, along with a visual check for an organic layer. In addition, a cyanide analysis was required if the DSC results exceeded the decision threshold.

For the sludge grab samples (2AN-95-4A and 2AN-95-5A), the only additional analytes were volume percent solids, TOC, and cyanide. The TOC and cyanide evaluations were secondary analyses of the safety screening DQO, and were required because exothermic reactions with changes in enthalpy greater than the -480 J/g decision threshold were found.

All reported analyses were performed in accordance with approved laboratory procedures. An assessment of the QC data is presented in Section 5.1.2. Two deviations from the SAP were noted by the laboratory. Due to the absence of solids in the supernate samples, the volume percent solids determination by centrifugation was not performed on those samples. Although the SAP required a cyanide analysis on both the solid and liquid matrices, it was decided by the tank coordinator to perform the cyanide analyses only on the solids. If cyanide is present, it is expected to be in much higher quantities in the solids than in the liquids. Since the cyanide results for the solids were approximately three orders of magnitude below the established notification limit, a cyanide analysis on the liquids was deemed unnecessary. The procedure for the evaluation of $^{239/240}Pu$ changed during analysis of the samples. Samples S95T003871 and S95T003872 were analyzed using procedure LA-943-127. On February 1, 1996, the laboratory began using procedure LA-943-128, which was used in the analysis of samples S95T003870 and S95T003963. The use of an extraction resin (as used in procedure LA-943-128) rather than an anion resin (as used in procedure LA-943-127), yields better tracer recovery and therefore, better accuracy (Esch 1996b).

A list of the sample numbers and applicable analyses from this analytical event and the October 1994 and February 1995 sampling and analytical events is presented in Table 3-7. Table 3-8 displays the analytical procedures by title and number.

Table 3-7. Summary of Samples and Analyses.[1] (3 sheets)

Grab Sample	Laboratory Identification	Waste Matrix	Subsample Labcore Number	Analysis
102-AN-1(A)	n/a	Centrifuged liquid from supernate sample	n/a	TGA, density, pH, metals, anions, TOC, TIC, total alpha, ^{137}Cs, ^{90}Sr
102-AN-2(A)	n/a	Centrifuged liquid from supernate sample	n/a	TGA, density, pH, metals, anions, TOC, TIC, total alpha, ^{137}Cs, ^{90}Sr
102-AN-3(A)	S96T000001	Centrifuged liquid from sludge sample	S96T000005	DSC, TGA, density, total alpha
		Centrifuged solids from sludge sample	S96T000003	DSC, TGA, density, volume % solids
			S96T000007	total alpha
102-AN-4	n/a	Centrifuged liquid from supernate sample	n/a	TGA, density, pH, metals, anions, TOC, TIC, total alpha, ^{137}Cs, ^{90}Sr
	S95T003926	Supernate	S95T003984	DSC, TGA, total alpha, SpG, TOC
102-AN-1(B)	S95T003924	Supernate	S95T003982	DSC, TGA, total alpha, SpG, TOC
102-AN-2(B)	S95T003925	Supernate	S95T003983	DSC, TGA, total alpha, SpG, TOC
102-AN-3(B)	S96T000002	Centrifuged liquid from sludge sample	S96T000006	DSC, TGA, density, total alpha
		Centrifuged solids from sludge sample	S96T000004	DSC, TGA, density, volume % solids
			S96T000008	total alpha

Table 3-7. Summary of Samples and Analyses.[1] (3 sheets)

Grab Sample	Laboratory Identification	Waste Matrix	Subsample Labcore Number	Analysis
2AN-95-1	S95T003864	Supernate	S95T003867	DSC, TGA, SpG, pH, metals, anions, TOC, TIC
			S95T003870	radionuclides (including total alpha)
2AN-95-2	S95T003865	Supernate	S95T003868	DSC, TGA, SpG, pH, metals, anions, TOC, TIC
			S95T003871	radionuclides (including total alpha)
2AN-95-3	S95T003866	Supernate	S95T003869	DSC, TGA, SpG, pH, metals, anions, TOC, TIC
			S95T003872	radionuclides (including total alpha)
2AN-95-4A	S95T003959	Slurry (after shaking of the sample)	S95T003959	Density, volume % solids
		Centrifuged liquid from sludge sample	S95T004133	DSC, TGA, density, total alpha, TOC
		Centrifuged solids from sludge sample	S95T004137	DSC, TGA, density, TOC, cyanide
			S95T004141	total alpha
2AN-95-5A	S95T003960	Slurry (after shaking of the sample)	S95T003960	Density, volume % solids
		Centrifuged liquid from sludge sample	S95T004135	DSC, TGA, density, total alpha, TOC
		Centrifuged solids from sludge sample	S95T004139	DSC, TGA, density, TOC, cyanide
			S95T004142	total alpha

Table 3-7. Summary of Samples and Analyses.[1] (3 sheets)

Grab Sample	Laboratory Identification	Waste Matrix	Subsample Labcore Number	Analysis
2AN-95-6	S95T003961	Field blank	S95T003962	DSC, TGA, SpG, pH, metals, anions, TOC, TIC
			S95T003963	radionuclides (including total alpha)
n/a	n/a	Tank headspace vapors	n/a	Concentration of flammable gas, oxygen, ammonia, and total organic vapor concentrations

Notes:
n/a = not applicable
SpG = specific gravity

[1]Esch (1996b)

Table 3-8. Analytical Procedures.[1] (2 sheets)

Analyte	Instrument or Analysis	Preparation Procedure	Analytical Procedure
Energetics by DSC	Mettler™ Perkin-Elmer™	n/a	LA-514-113, Rev. C-1 LA-514-114, Rev. C-1
Percent water by TGA	Mettler™ Perkin-Elmer™	n/a	LA-560-112, Rev. B-1 LA-514-114, Rev. C-1
Solid bulk density	n/a	n/a	LO-160-103, Rev. B-0
Liquid specific gravity	n/a	n/a	LA-510-112, Rev. C-3
pH	Electrode	n/a	LA-212-106, Rev. A-0
Organic layer	Visual and over-the-top reading	n/a	LA-519-151, Rev. E-2
Hydroxide	Potentiometric titration	n/a	LA-211-102, Rev. C-0
Cyanide	Microdistillation	n/a	LA-695-102, Rev. E-0
Anions by IC	Ion chromatograph	n/a	LA-533-105, Rev. D-1
Metals by ICP	Inductively coupled plasma spectrometer	n/a	LA-505-161, Rev. B-0
TIC	Furnace oxidation	n/a	LA-622-102, Rev. C-0[2]
TOC	Furnace oxidation	n/a	LA-344-105, Rev. C-0[2] (supernate)
			LA-342-100, Rev. C-0 (solids)
Total alpha activity	Alpha proportional counter	n/a (supernate)	LA-508-101, Rev. D-2
		LA-549-141, Rev. E-0 (solids: fusion digest)	
^{137}Cs	Gamma energy analysis	n/a	LA-548-121, Rev. D-1
^{90}Sr	Separation and beta counting	n/a	LA-220-101, Rev. D-1
^{241}Am	Separation and alpha counting	n/a	LA-953-103, Rev. A-4
$^{239/240}Pu$	Separation and alpha counting	n/a	LA-943-127, Rev. B-1[3] LA-943-128, Rev. A-0

Table 3-8. Analytical Procedures.[1] (2 sheets)

Analyte	Instrument or Analysis	Preparation Procedure	Analytical Procedure
Flammable gas, oxygen	Combustible gas meter	n/a	WHC-IP-0030, IH 1.4
Ammonia, total organic vapor	Total organic monitor	n/a	WHC-IP-0030, IH 2.1

Notes:

Mettler™ is a registered trademark of Mettler Electronics, Anaheim, California.
Perkin-Elmer™ is a registered trademark of Perkins Research and Manufacturing Company, Inc.

[1]Esch (1996b)

[2]This is the correct procedure. The procedure listed in the SAP was incorrect.

[3]Procedure LA-943-127, listed in the SAP, was used for the analysis of samples S95T003871 and S95T003872. On February 1, 1996, the laboratory began using procedure LA-943-128. This new procedure was used to analyze samples S95T003870 and S95T003963 (Esch 1996b).

3.4 PREVIOUS SAMPLING EVENTS

3.4.1 Description of 1990 Core Sampling Event

Two three-segment core samples of the tank sludge were obtained from riser 7A of tank 241-AN-102 on May 24, 1990. Sludge levels at the time of the sampling event indicated almost two full segments of sludge could be expected from each core (Strasser 1990). To ensure that the entire sludge was core-sampled, three segments were obtained. One core was shipped to the Pacific Northwest National Laboratory for extrusion and chemical, radiochemical, and physical analyses. The other was extruded at the Westinghouse Hanford Company 222-S Process Chemistry Laboratory and archived. No chain-of-custody forms are available, so drill string dose rates are not reported.

On July 10 and 11, 1990, the three segments delivered to the Pacific Northwest National Laboratory were extruded from the core sample collected from tank 241-AN-102. The segment descriptions presented in Table 3-9 come from laboratory core characterization worksheets. Douglas (1996) describes the subsequent sample preparation, analytical methods, and analytical results. A composite was prepared from the three segments. Some of the composite was archived for future analyses. The balance of the composite sample was either analyzed directly, or centrifuged into liquid and solids fractions that were analyzed for physical, chemical, and radiochemical properties (the laboratory identified the centrifuged solids fraction as AN-102-SOL and the liquids fraction as AN-102-SUP). Rheological

Table 3-9. Tank 241-AN-102 Extruded Core Segments.[1]

Segment	Length	Sample Recovery[2] (%)	Liner Liquid (mL)	Gross Weight (g)	Description
1	Not given	Not given	15	496	Mostly a noncohesive slurry; medium brown in color.
2	41 cm (16 in.)	84	10	538	Semi-solid. The bottom 15 cm (6 in.) were gray-brown; the remainder of the segment was light brown. The waste had a glossy surface; it was sticky, becoming less cohesive in the upper 10 to 12 cm (4 to 5 in.).
3	44 cm (17.5 in.)	92	10	544	Entire segment was semi-glossy. The lowest 2.5 cm (1 in.) of the sample was dark brown and semi-solid; a 3.8-cm (1.5-in.) space with a trace of liquid followed. The space was followed by 5 cm (2 in.) of dark brown semi-solid waste, 15 cm (6 in.) of light brown semi-solid waste, and then 22 cm (8.5 in.) of a light brown waste of pudding consistency.

Notes:

[1]Douglas (1996)

[2]Sample recovery is an approximation derived by dividing the length of the recovered segment by the length of the sampler (48 cm [19 in.]).

analysis was also performed on the centrifuged solids fraction. The analytical results are tabulated in Appendix B. Comparisons between results from this sampling event and the recent analytical data are presented in Section 5.2.

Concentration of the metals in both the liquid and solids core composite fractions was determined using ICP. Before analysis, solids centrifuged from the core composite were chemically fused using two separate fusions. A sodium peroxide fusion was run in a zirconium crucible, while a potassium hydroxide fusion was run in a nickel crucible. The fused solid material was then dissolved in hydrochloric acid. All metals were prepared for analysis using the sodium peroxide fusion, except for sodium and zirconium. Analyses for sodium and zirconium, along with additional determinations for aluminum, calcium, chromium, iron, manganese, potassium, and phosphorus, were performed after digestion with a potassium hydroxide fusion. Anion determinations in water leachates of the solids fraction were made using IC. The IC analysis of the liquid fraction was performed by direct column injection of the liquid.

Both the liquid and solids fractions were analyzed for their TRU element content. Concentrations were determined using both mass spectrometry and alpha energy analysis. Separation of americium and curium fractions from plutonium was accomplished using standard ion exchange techniques. The plutonium and americium/curium fractions were then analyzed by alpha counting, followed by alpha energy analysis. Concentrations of plutonium and uranium were found to be too low for mass spectrometry determination.

Carbon-14 activity was measured on both the composite core solids and supernate materials by scintillation counting. Before analysis, oxidation (hot acidic persulfate method) and extraction of the carbon were accomplished using an acidification module. Tritium activity was measured using scintillation counting on water leachates of the solids samples. Activity in the supernate samples was determined directly. Precipitation or ion exchange methods were used to purify ^{63}Ni, ^{79}Se, and ^{99}Tc, and activities were determined using beta or liquid scintillation counting. Activity for ^{237}Np was measured directly by alpha energy analysis.

The data from this sampling event should be used with caution. Douglas (1996) compiles the analytical results, but the source documents for Douglas (1996) are incomplete, and at times contradictory. In addition, no QC information was provided in the source documents, and there is no way to assess the reliability of the analytical results. Therefore, these results should not be used to make safety or operational decisions.

3.4.2 Description of 1989 Sampling Event

A supernate sample was obtained from tank 241-AN-102 in 1989. Other than the sample status report included as an attachment to Herting (1994), no other information was available, including descriptions of the tank location from which the sample was obtained and collection techniques. Because the sample is supernate, it was likely collected using the bottle-on-a-string method. The sample was described as being dark brown and aqueous with solids present. The sample was analyzed for density and pH, 11 metals, 4 anions, TOC, and 6 radionuclides. Analytical results are presented in Appendix B. Comparisons between results from this sampling event and the recent analytical data are provided in Section 5.2.

3.4.3 Description of 1984 Sampling Event

Two samples were collected from tank 241-AN-102 in 1984 and analyzed at the Westinghouse Hanford Company 222-S Laboratory (Bratzel 1985). A sludge sample (R-3640) was obtained from the bottom of the tank and a supernate sample (R-3639) was obtained from 4.5 m (15 ft) above the tank bottom. However, a description of the techniques used to extract the samples was not available. The samples were centrifuged to separate suspended solids and aliquots were then analyzed. Solids were weighed, dried, and dissolved in 12 M HNO_3/0.2 M HF. A pretreatment procedure was used to destroy organics in the sample that had the potential to interfere with plutonium and americium determinations. Plutonium and americium were separated using anion exchange, precipitation, and solvent extraction. Activity was determined using scintillation counting. Metal cation analyses were determined by ICP, and anions were determined by IC. The TOC content was determined by coulometric titration. Analytical results are presented in Appendix B and showed that the waste stored in tank 241-AN-102 approached the TRU categorization threshold of 100 nCi/g (Bratzel 1985).

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4.0 ANALYTICAL RESULTS

Section 4.0 presents a summary of the analytical results associated with the October 1994, February 1995, and November/December 1995 grab sampling events of tank 241-AN-102. The sampling and analysis parameters governing these events were described in Section 3.0. Analysis of the grab samples was performed at the Westinghouse Hanford Company 222-S Laboratory.

Data locations for this characterization report are displayed in Table 4-1. As noted in Table 4-1, the complete analytical data set can be found in Appendix A. Only analyte overall means are reported in Section 4.0.

Table 4-1. Analytical Data Presentation Tables.

Data Type	Tabulated Location
Supernate chemical data summary	Table 4-2
Sludge chemical data summary	Table 4-3
DSC exothermic data summary	Table 4-4
Headspace flammability screening results	Table 4-5
Comprehensive analytical data	Appendix A

4.1 DATA PRESENTATION

The analytical results from the sampling events involving tank 241-AN-102 are summarized in this section. The data were reported in the *Final Report for Tank 241-AN-102, Grab Samples 2AN-95-1 through 2AN-95-6 and 102-AN-1 through 102-AN-4* (Esch 1996b). Additional data from the October 1994 sampling event were reported in *Characterization of Supernate Samples from Tank 102-AN* (Herting 1994).

4.1.1 Chemical Data Summary

Data from the grab samples were combined to derive an overall mean for all analytes with the exception of DSC, which does not require the calculation of a mean. The supernate overall means were calculated by first averaging the primary and duplicate results for each grab sample to obtain a sample mean. These sample means were then simply averaged to derive the overall mean. The data for silicon, uranium, and fluoride contained nondetected results. For silicon, the overall mean was considered nondetected since over 50 percent of the individual primary and duplicate results were nondetected. Because the use of nondetected data in the mean and inventory estimates causes a bias in those estimates, those particular results should be used with caution. The magnitude of the bias is unknown. The overall mean for uranium was nondetected since all of the results were below the detection limit. Because the nondetected results for fluoride were considered suspect, they were not included in the derivation of the overall mean. Table 4-2 presents the supernate chemical data.

The sludge means were derived by combining centrifuged solids and centrifuged liquid results. Results from the two fractions were combined according to weighting factors. These weighting factors were based on the masses of each fraction. Refer to Appendix A, Section A.2 for a listing of these weighting factors. Table 4-3 displays the sludge chemical data. The cyanide and volume percent solids means are actually based solely on the centrifuged solids results, since neither analyte was analyzed on the centrifuged liquid. The slurry results are from the analyses before centrifuging.

All information contained in Tables 4-2 and 4-3 were taken from the Appendix A tables. The first two columns of each table contain the analyte and overall mean. The third column displays the relative standard deviation (RSD) of the mean, defined as the standard deviation (of the mean) divided by the mean, multiplied by 100. The RSDs were determined by using the standard one-way analysis of variance (ANOVA) statistical technique, and were computed only for analytes that had detected results. The projected inventories listed in the final column of Table 4-2 were derived by multiplying the overall means for the supernate by the liquid waste volume of 3,755 kL (992 kgal), and utilizing the appropriate conversion factors. The projected inventories listed in the final column of Table 4-3 were derived by multiplying the overall mean for the sludge by the overall sludge density of 1.47 g/mL, the sludge waste volume of 337 kL (89 kgal), and the appropriate conversion factors.

Table 4-2. Supernate Chemical Data Summary.[1] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
METALS	μg/mL	%	kg
Aluminum	15,100	1.48	56,700
Calcium	434	1.53	1,630
Chromium	297	2.62	1,120
Iron	50.9	10.30	191
Manganese	39.1	23.67	147
Nickel	381	2.95	1,430
Phosphorus	1,610	0.86	6,040
Potassium	3,880	6.76	14,600
Silicon	< 20.2	n/a	< 76.0
Sodium	2.40E+05	3.72	9.01E+05
Sulfur	4,750	1.01	17,900
Uranium	< 200	n/a	< 751
ANIONS	μg/mL	%	kg
Chloride	3,810	6.18	14,300
Fluoride	1,860	8.24	6,980
Hydroxide	3,610	4.78	13,600
Nitrate	2.25E+05	7.11	8.45E+05
Nitrite	82,600	6.96	3.10E+05
Phosphate	4,820	6.80	18,100
Sulfate	13,800	5.88	51,800
RADIONUCLIDES	μCi/mL	%	Ci
^{241}Am	0.138	10.58	518
^{137}Cs	351	3.96	1.32E+06
^{60}Co	0.148	1.87	556
$^{239/240}$Pu	0.00582	6.71	21.8

Table 4-2. Supernate Chemical Data Summary.[1] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
RADIONUCLIDES (Cont.)	**μCi/mL**	**%**	**Ci**
$^{89/90}Sr$	74.5	1.21	2.80E+05
Total alpha	0.163	4.63	612
CARBON	**μg C/mL**	**%**	**kg C**
TIC	13,200	1.46	49,600
TOC	26,200	0.97	98,400
PHYSICAL PROPERTIES		**%**	**kg**
Specific gravity	1.41	0.67	---
pH	13.2	0.39	---
Weight percent water	49.7	0.27	2.63E+06

Note:

[1]Esch (1996b)

Table 4-3. Sludge Chemical Data Summary.[1]

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
ANIONS	µg/g	%	kg
Cyanide[2]	20.9	0.92	10.4
RADIONUCLIDES	µCi/g	%	Ci
Total alpha	0.296	8.47	147
CARBON	µg C/g	%	kg C
TOC	24,400	6.00	12,100
PHYSICAL PROPERTIES		%	kg
Density (sludge)[3]	1.47	1.23	---
Density (slurry)[4]	1.49	1.01	---
Weight percent water	44.6	3.00	---
Volume % solids[2]	55.6	10.07	---
Volume % solids (slurry)[4]	50.1	6.99	2.21E+05

Note:

[1]Esch (1996b)

[2]Mean based on two centrifuged solids results from 2AN-95-4A and 2AN-95-5A.

[3]The result for the analyte denoted as "sludge" was derived by combining weighted fractions of the centrifuged solids and centrifuged liquid portions.

[4]For those analytes with the "slurry" designation, the analyses were performed on the grab samples after shaking to suspend the settled solids.

4.1.2 Physical Data Summary

Thermal analyses and density measurements were performed on the tank 241-AN-102 grab samples to satisfy the requirements of the safety screening and waste compatibility DQOs (Dukelow et al. 1995, Fowler 1995). Both DQOs also required a visual check of liquid samples for the presence of an organic layer. In addition, the waste compatibility DQO required the measurement of pH. Volume percent solids measurements were made for the sludge samples.

4.1.2.1 Thermogravimetric Analysis. During a TGA, the mass of a sample is measured while its temperature is increased at a constant rate. Nitrogen is passed over the sample during the heating to remove any released gases. Any decrease in the weight of a sample represents a loss of gaseous matter from the sample 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 to 200 °C) is due to water evaporation. The TGA was performed directly on the supernate and the centrifuged solid and liquid samples.

The TGA results for tank 241-AN-102 are presented in Appendix A, Table A-32. All centrifuged solids and liquid samples exhibited a large weight loss between the ambient temperature and 205 °C, and the supernate samples exhibited this large weight loss between ambient temperature and 235 °C. This weight loss is associated with the first endothermic transition, and was attributed to the evaporation of water. The overall mean percent water for the supernate was 49.7 weight percent and the mean percent water for the sludge was 44.6 weight percent. The individual mean of each grab sample is presented in Table 4-4.

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

The DSC results (wet-weight basis) are presented in Appendix A, Table A-33. The peak temperature and maximum enthalpy change are given for each transition. For all samples, the first transition was endothermic and represented the evaporation of free and interstitial water. All but one of the liquid samples had two transitions, with the second being exothermic. One sample had three transitions, with the third being exothermic. Two of the four centrifuged solids samples contained exothermic reactions in the second transition. Because exothermic reactions are associated with negative enthalpy changes, they have been denoted in Table A-33 with a negative sign.

Table 4-4 presents the samples that exhibited exothermic reactions. In order to compare the exothermic enthalpy changes with the safety screening DQO decision criteria threshold of -480 J/g (dry-weight basis), all exothermic reactions were first converted to a dry-weight basis using the respective sample weight percent water. The wet-weight values listed in column four were converted to the dry weights listed in column six, using the sample weight percent water result given in column five. The sample mean is given in column seven, and the upper limit to a one-sided 95 percent confidence interval on the mean associated with each sample is given in column eight.

An interference was observed with the DSC scans for samples 2AN-95-1 and 102-AN-3(A), which created unacceptable baseline curvature that biased the integration. These samples were reanalyzed on a different instrument and a better baseline was observed. The second instrument yielded results that were more consistent with those obtained for the other samples analyzed. Therefore, the first set of results were not used and the raw data scans can be found in Esch (1996b). The relative percent differences (RPDs) between primary and duplicate runs for one sludge and four supernate samples were outside the QC parameter of ≤ 10 percent. Under these circumstances, a triplicate analysis is typically conducted for these samples. However, no additional analyses were performed because one sample was below the decision threshold, and statistics conducted on the other four showed that even with a third analysis, the upper limit to a one-sided 95 percent confidence interval on the mean would still exceed -480 J/g.

As can be seen in Table 4-4, the majority of the exothermic reactions and all but one of the upper limits to a one-sided 95 percent confidence interval on the mean exceeded the decision threshold of -480 J/g. The highest individual sample result was -1,200 J/g (dry-weight), and the highest upper limit to a one-sided 95 percent confidence interval on the mean was -1,501 J/g (both from sample 2AN-95-2).

4.1.2.3 Density/Specific Gravity. Specific gravity measurements were performed on the supernate and centrifuged liquid samples, while density evaluations were run on the centrifuged solids. The supernate samples were analyzed in duplicate, but not the centrifuged solids or liquids. For the sludge samples from the November/December 1995 sampling event (2AN-95-4A and 2AN-95-5A), a density measurement was made on the parent samples after they had been shaken to suspend the settled solids (denoted as "slurry" in the Appendix A table). The average densities were 1.47 g/mL for the sludge (see Table 4-3), 1.41 g/mL for the supernate (see Table 4-2), and 1.49 g/mL for the slurry (see Table 4-3). The results are presented in Table A-29.

4.1.2.4 Volume Percent Solids. Volume percent solids determinations were made on centrifuged solids from the sludge samples from the October 1994 and February 1995 sampling events. In addition, the two sludge samples from the November/December 1995 sampling event were subjected to a volume percent solids measurement after the samples had been shaken to suspend the settled solids (denoted as "slurry" in the Appendix A table). The average volume percent solids for the centrifuged solids and the slurry were 55.6 and 50.1 percent, respectively (see Table 4-3). Results from these analyses are presented in Table A-31 in Appendix A.

4.1.2.5 pH. Measurements for pH were performed on the supernate samples from the October 1994 and November/December 1995 sampling events. The pH data is presented in Appendix A, Table A-30. The overall mean was 13.2 (see Table 4-2). Results greater than 12.5 are suspect and should be considered estimates, because the highest calibration buffer available was 12.5, and the pH electrode performance degrades at values higher than this.

Table 4-4. DSC Exothermic Results and 95 Percent Confidence Interval Upper Limits.

Sample Number	Grab Sample	Run	Wet Wt. Δ H J/g	Sample Wt% Water %	Dry Wt. Δ H J/g	Mean J/g	Upper Limits to a One-sided 95% Confidence Interval J/g
Supernates							
S96T003982	102AN-1(B)	1	-284.2	49.56	-563.6	-596.5	-804.2
		2	-317.4		-629.4		
S96T003983	102AN-2(B)	1	-361.3	49.83	-720.3	-640.2	-1,146
		2	-281.0		-560.2		
S96T003984	102AN-4	1	-223.2	49.36	-440.8	-415.0	-577.9
		2	-197.1		-389.2		
S96T003867	2AN-95-1	1	-283.9	49.14	-558.2	-558.3	-558.9
		2	-284.0		-558.4		
S96T003868	2AN-95-2	1	-616.1	48.97	-1,200	-1,150	-1,501
		2	-557.8		-1,090		
S96T003869	2AN-95-3	1	-277.2	50.08	-555.3	-560.7	-594.8
		2	-282.6		-566.1		
Centrifuged Liquids							
S96T000005[1]	102-AN-3(A)	1	-237.0	49.09	-465.6	-459.0	-500.9
		2	-230.2		-452.3		
S96T000006	102-AN-3(B)	1	0	47.39	0	-26.11	-190.9
		2	-27.47		-52.21		
S96T004133	2AN-95-4A	1	-258.0	47.03	-487.1	-481.5	-516.9
		2	-252.1		-475.9		
S96T004135	2AN-95-5A	1	-279.7	49.74	-556.5	-577.0	-706.4
		2	-300.3		-597.5		
S96T004137	2AN-95-4A	1	-279.7	42.70	-488.1	-473.1	-567.5
		2	-262.5		-458.2		
S96T004139	2AN-95-5A	1	-283.2	43.75	-492.1	-530.6	-773.7
		2	-327.5		-569.1		

Note:

[1]The exothermic reactions for this sample came from the third transition, whereas those for all other samples came from the second transition.

4.1.2.6 Visual Check for an Organic Layer. A visual check for an organic layer was made in accordance with the safety screening and waste compatibility DQOs. An organic layer was not observed in any of the samples.

4.1.3 Headspace Flammability Screening Results

As required by the safety screening DQO (Dukelow et al. 1995) and requested in the SAP (Jo 1996), the tank headspace inside riser 21A was sampled and analyzed for the presence of flammable gases before grab sampling. The safety screening DQO notification limit for flammable gas concentration is 25 percent of the LFL. Monitoring of the tank headspace gases with a combustible gas meter was performed at a depth of 6.1 m (20 ft) from the top of the riser (Engineering 1995). The combustible gas meter 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). The reported LFL of 0 percent was well below the safety screening limit. In addition, the concentrations of oxygen gas, ammonia gas, and total organic vapors were determined. The results of the flammable gas monitoring are presented in Table 4-5.

Table 4-5. Headspace Flammability Screening for Tank 241-AN-102.[1]

Vapor Characteristic Measured	Results
Flammability as percent of the LFL	0%
Volume percent oxygen gas	20.9%
Concentration of ammonia gas	300 ppm
Concentration of total organic vapor	19 ppm

Note:
[1]Esch (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-AN-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 safety screening DQO (Dukelow et al. 1995) objective that vertical profiles of the waste be obtained from at least two widely-spaced risers was fulfilled (grab samples were taken from multiple depths). No problems were noted during the October 1994 and February 1995 sampling events, and recoveries were good. During the November/December 1995 sampling event, it was discovered that the two samples expected to contain sludge actually contained supernate. The samples were retaken, with satisfactory results. It should also be noted that the sampling depths for 2AN-95-2 and 2AN-95-3 were switched. None of these sampling anomalies should impact the usability of the data.

5.1.2 Quality Control Assessment

The usual QC 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 QC tests were conducted on the grab samples from the three sampling events that were subjected to the safety screening evaluation. The specific criteria for the QC checks on these grab samples were provided in the SAP (Jo 1996). Only limited QC information was available for the grab samples from the 1994 sampling event that were analyzed in 1994. One standard was run in conjunction with each analyte. The QC results for all grab samples outside of the given criteria are identified by superscripts in the Appendix A tables. A summary of the QC results is presented below.

The standard and matrix spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike is above or below the given criterion, then the analytical results may be biased. All standard recoveries were within the defined criteria. Fluoride, nitrate, and nitrite each had 1 out of 3 spikes above the QC limits, while total alpha activity had 2 of 14 spikes below the QC limit. Low total alpha activity spike recoveries are common due to difficulties in preparing the sample mount, which can cause self-shielding.

Analytical precision is estimated by the RPD, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100. For total alpha activity, 1 out of 14 RPDs were outside the criterion, while TOC had 1 out of 10 exceed the criterion. Nine of the 21 samples with exothermic reactions had RPDs above the criterion. This was not unusual given the small sample sizes (8 to 60 mg) and possible sample heterogeneity problems. Manganese and potassium had 2 out of 3 RPDs outside the criterion, while iron had 1 out of 3 outside the limits. Finally, none of the samples exceeded the criteria for preparation blanks, and therefore contamination was not a problem for any of the analytes.

As stated previously, the only QC check performed in conjunction with the 1994 analyses was one standard for each analyte. Since no tank characterization plan governed this sampling event, no specific criterion was given to evaluate the standards. However, to maintain consistency, the same criteria applied to the other grab samples was applied to these samples (80 to 120 percent recovery for all analytes except DSC and TGA, which were 90 to 110 percent recovery). None of the standards conducted on the 1994 supernate analytes violated the QC limits.

In summary, practically all of the QC results were within the boundaries specified in the SAP (Jo 1996). The few discrepancies 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. A good comparison strengthens the credibility of both results, whereas a poor comparison brings the reliability of the data into question. The quantity of data available made possible the comparisons of total alpha activity to the sum of the individual alpha emitters, the ICP phosphorus result with the IC phosphate number, and the ICP sulfur value with the IC sulfate result. In addition, mass and charge balances were calculated.

5.1.3.1 Comparison of Results from Different Analytical Methods. A comparison was made in Table 5-1 between the total alpha activity mean and the sum of the activity means of the individual alpha emitters for the supernate data. The sum of the activities of the individual alpha emitters was determined by adding the ^{241}Am and $^{239/240}$Pu activities.

The total alpha activity result indicates that the sum of the alpha emitters should be 0.163 μCi/mL, since the sum of the individual alpha emitters should be equal to the total alpha emitted. The two values agreed well, as evidenced by the ratio of 0.88.

Table 5-1. Comparison of Total Alpha Activities With the Sum of the Individual Activities for the Supernate.

Analyte	Overall Mean (μCi/mL)
^{241}Am	0.138
$^{239/240}$Pu	0.00582
Sum of alpha emitters	0.144
Total alpha activity	0.163
Ratio	0.88

Table 5-2 provides comparisons between the ICP phosphorus and sulfur concentration means, and the concentration means for phosphate and sulfate determined by IC analysis. The ICP phosphorus result, which represents total phosphorus, was 1,610 μg/mL. Since the analyzed portion was supernate, the majority of this amount would be expected to be water soluble. Therefore, since IC measures water soluble phosphorus in the form of phosphate, the ICP and IC values should be similar. The IC phosphate value of 4,820 μg/mL converted to 1,570 μg/mL of phosphorus, which agreed extremely well with the ICP phosphorus value (ratio of 1.03). Like phosphorus, because of the waste matrix, sulfate is expected to be primarily water soluble. This prediction was borne out by the analytical results, since the sulfur value of 4,610 μg/mL (converted from the IC sulfate value of 13,800 μg/mL) compared quite well with the ICP sulfur result of 4,750 μg/mL (ratio of 1.03).

Table 5-2. Tank 241-AN-102 Comparison of Phosphorus and Sulfur Concentrations With the Equivalent Concentrations of Phosphate and Sulfate.

Analyte	Overall Mean (μg/mL)
Phosphorus	
Measured mean phosphorus concentration	1,610
Phosphorus concentration from phosphate	1,570
Ratio	1.03
Sulfur	
Measured mean sulfur concentration	4,750
Sulfur concentration from sulfate	4,610
Ratio	1.03

5.1.3.2 Mass and Charge Balances. The principle objective in performing mass and charge balances is to determine if the measurements were consistent. Calculation of these balances was only possible for the supernate because no metals or anions were analyzed in the solids. However, most of the waste was accounted for since the tank is nearly 92 percent supernate. In calculating the balances, only analytes listed in Table 4-2 [which were detected at a concentration of 1,000 μg/g (0.1 weight percent) or greater] were considered. All analytical results presented in this section were first converted from μg/mL to μg/g (using the specific gravity mean of 1.41 g/mL), before use in the tables.

Sodium and potassium were the only cationic species detected in large quantities in the tank 241-AN-102 supernate. Aluminum was assumed to be present as the aluminate anion. The carbonate data were derived from the TIC analyses and the acetate data were derived from the TOC analyses. The other anionic analytes listed in Table 5-4 were assumed to be present as sodium and potassium salts and expected to balance the positive charge exhibited by the cations. The sum of the cationic species in Table 5-3, the sum of the anionic species in Table 5-4, and the percent water estimate were then 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 5-5, 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 conversion factor from μg/g to weight percent is 0.0001.

$$\begin{aligned}\text{Mass balance} &= \text{Percent water} + 0.0001 \times [\text{total analyte concentration}] \\ &= \text{Percent water} + 0.0001 \times [Na^+ + K^+ + AlO_2^- + CO_3^{-2} + C_2H_3O_2^- + \\ &\quad Cl^- + F^- + OH^- + NO_3^- + NO_2^- + PO_4^{-3} + SO_4^{-2}]\end{aligned}$$

The total analyte concentrations calculated from the above equation is 527,000 μg/g. The mean weight percent water obtained from TGA (reported in Table 4-2) is 49.7 percent, or 497,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 102 percent (see Table 5-5).

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

<u>Total cations</u> (μeq/g) = $[Na^+]/23.0 + [K^+]/39.1$ = 7,460 μeq/g

<u>Total anions</u> (μeq/g) = $[AlO_2^-]/59.0 + [CO_3^{-2}]/30.0 + [C_2H_3O_2^-]/59.0 + [Cl^-]/35.5 +$ $[F^-]/19.0 + [OH^-]/17.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 + [PO_4^{-3}]/31.7 + [SO_4^{-2}]/48.0 =$ 7,190 μeq/g

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 1.04.

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

Table 5-3. Cation Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	RSD (Mean) (%)	Charge (μeq/g)
Potassium	2,750	K^+	2,750	6.76	70.3
Sodium	170,000	Na^+	170,000	3.72	7,390
Total			173,000	3.66	7,460

Table 5-4. Anion Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	RSD (Mean) (%)	Charge (μeq/g)
Aluminum	10,700	AlO_2^-	23,400	1.48	396
TIC	9,360	CO_3^{-2}	46,800	1.46	1,560
TOC	18,600	$C_2H_3O_2^-$	45,700	0.97	775
Chloride	2,700	Cl^-	2,700	6.18	76
Fluoride	1,320	F^-	1,320	8.24	69
Hydroxide	2,560	OH^-	2,560	4.78	150
Nitrate	160,000	NO_3^-	160,000	7.11	2,580
Nitrite	58,600	NO_2^-	58,600	6.96	1,270
Phosphate	3,420	PO_4^{-3}	3,420	6.80	108
Sulfate	9,790	SO_4^{-2}	9,790	5.88	204
Total			354,000	3.47	7,190

Table 5-5. Mass Balance Totals.

Totals	Concentrations (μg/g)	RSD (Mean) %
Cation total from Table 5-3	173,000	3.66
Anion total from Table 5-4	354,000	3.42
Water	497,000	0.27
Grand total	1,020,000	1.35

5.2 COMPARISON OF HISTORICAL AND ANALYTICAL RESULTS

The comparison of results from two different sampling events gives an indication of the precision of the sampling and analyses, assuming that the tank contents have remained unchanged between the events. This is a fairly good assumption for tank 241-AN-102, since only small quantities of dilute non-complexed waste and water have been added to the tank since 1984 and no waste was tranferred to and from the tank since 1992.

Table 5-6 gives the results of two sampling events of the supernate portion of tank 241-AN-102. The data from the 1989 sampling event is limited since it was based on a single analysis of a single sample, while the 1994/1995 results were derived from eight grab samples. No sampling and analysis uncertainty estimates are available for the 1989 sampling event since there was only one sample and no replicate analysis. In addition, no QC information was available for the 1989 sampling event. The comparisons show very good agreement, with only two analytes (potassium and hydroxide) showing slightly greater than a two-fold difference. It appears that there is a depletion of hydroxide ion.

Table 5-7 gives the results of two sampling events comparing the analytes within the sludge layer of tank 241-AN-102. The results generally show good agreement with the exception of total alpha. The problems in agreement may be caused by the approximation of total alpha using ^{241}Am and $^{239/240}$Pu for the 1990 result. Different sampling locations may also have an effect, since the 1990 core sample was taken from riser 7A and the 1994/1995 sludge results are based on sludge samples from riser 22A.

Table 5-6. Historical Comparisons of Analytes in the Supernate Layer of Tank 241-AN-102.

Analyte	1989 Supernate[1]	1994/1995 Supernate[2]
METALS	**M**	**M**
Al	0.46	0.56
Ca	0.010	0.011
K	0.041	0.099
Na	7.65	10.4
Ni	0.006	0.0065
P	0.050	0.052
IONS	**M**	**M**
NO_3^-	3.54	3.63
NO_2^-	1.36	1.80
OH^-	0.45	0.21
RADIONUCLIDES	**μCi/L**	**μCi/L**
^{137}Cs	4.00E+05	3.51E+05
PHYSICAL PROPERTIES	**g/mL**	**g/mL**
Density	1.34	1.41
CARBON	**μg C/mL**	**μg C/mL**
TIC	13,200	13,200
TOC	27,300	26,200

Notes:
[1]Herting (1994)
[2]Esch (1996b)

Table 5-7. Historical Comparisons of Analytes in the Sludge Layer of Tank 241-AN-102.

Analyte	1990 Sludge[1]	1994/1995 Sludge[2]
RADIONUCLIDES	µCi/g	µCi/g
Total alpha	0.654[3]	0.296
CARBON	µg C/g	µg C/g
TOC	16,300	24,400
PHYSICAL PROPERTIES		
Density[4]	1.5 g/mL	1.47 g/mL
Percent Water[5]	40.3	44.6

Notes:

[1]Douglas (1996)

[2]Esch (1996b)

[3]Value approximated by taking the sum of ^{241}Am and $^{239/240}$Pu, since total alpha analysis was not performed on the centrifuged solids from the 1990 sampling event.

[4]The density value for the 1990 sampling event was taken from a density determination on the core composite. The density value for the 1994/1995 sampling event was calculated by taking a weighted mean from the centrifuged solids and centrifuged liquid results.

[5]The weight percent water value for the 1990 sampling event was taken from a percent solids determination on the core composite. The weight percent water value for the 1994/1995 sampling event was calculated by taking a weighted mean from the centrifuged solids and centrifuged liquid results.

5.3 TANK WASTE PROFILE

According to the estimate of Hanlon (1996), the 998 cm (393 in.) of waste in tank 241-AN-102 consists of 3,755 kL (992 kgal) of supernate on top of 337 kL (89 kgal) of sludge. The TLM estimates were similar to those of Hanlon (1996), predicting a large amount of supernate over a small amount of sludge (see Figure 2-3). The visual descriptions of the samples from all three sampling events were nearly the same. The supernate was described as yellow/brown in color for all samples, and the solids were described as red/tan for the October 1994 and February 1995 sampling events, and tan in color for the November/December 1995 sampling event.

Initially a nested ANOVA model (sample location nested within riser) was fit to the data. The results of this ANOVA indicated that there were no significant differences between analyte means between the two risers. Consequently, it was decided to estimate the mean concentrations based on the initial grab samples, i.e. based upon sample location. A second ANOVA model (one-way ANOVA using location) was fit to the data. The RSD mean was estimated using this ANOVA.

The ANOVA models were fit to the data that had all of the individual primary and duplicate measurements above detection limits. The single exception was fluoride, which had two sample/duplicate pairs with results below the detection limit. These results were eliminated from the fluoride analysis due to a very large dilution factor in the IC analyses. The p-value from the ANOVA is used as a measure of the level of significance to the statistical tests. The p-value is compared to a standard level of performance ($\alpha = 0.05$). The p-value is less than 0.05 and the analyte mean are significantly different from each other. In the following paragraphs, the p-values are in parentheses. All of these results were originally reported in Welsh and Cromar (1996).

For the supernate, the results of the one-way ANOVA indicated that there were significant differences in concentration between locations for 16 of the 28 analytes: iron (0.0181), nickel (0.0468), pH (0.0083), chloride (0.0045), fluoride (0.0095), hydroxide (0.0067), nitrate (0.0083), nitrite (0.0053), phosphate (0.0029), sulfate (0.0032), total alpha activity (0.0008), ^{241}Am (0.0001), ^{137}Cs (0.0001), ^{60}Co (0.0275), $^{239/240}$Pu (0.0001), and ^{90}Sr (0.00368).

The one-way ANOVA model was also fit to concentration data on 3 sludge analytes (weight percent water, total alpha activity, and TOC), and on the centrifuged solids cyanide results. The ANOVA model could not be fit to the density, volume percent solids, or volume percent slurry data due to a lack of duplicate analyses. The results of the ANOVA indicated that there were significant differences in analyte concentrations between locations for 2 of the 4 analytes tested: weight percent water (0.0002) and total alpha activity (0.0167).

In summary, the Hanlon (1996) estimates, the TLM, and the visual descriptions of the samples clearly delineate two waste phases in tank 241-AN-102: supernate and solid. The sample visual descriptions indicate uniformity within the supernate layer, but the statistical results indicated concentration differences between locations for 16 of 28 analytes within the supernate. Two of 4 analytes also showed concentration differences within the sludge layer. Thus, it appears that the tank contents are vertically heterogeneous with two waste phases present, but also somewhat heterogeneous within each of these waste phases.

5.4 COMPARISON OF TRANSFER HISTORY WITH ANALYTICAL RESULTS

The historical predictions (Agnew et al. 1996a) for tank 241-AN-102 are given in Table 5-8, along with the analytical results from the recent sampling events (from Table 4-2). The historical estimate in column five is a single value for each analyte for the entire tank

Table 5-8. Comparisons of Analytical Data to Historical Tank Content Estimate Values.

Analyte	1994/1995 Supernate Results[1]	1990 Sludge Results[2]	Sum of Analytical Results	Agnew Estimate[3]
METALS	**kg**	**kg**	**kg**	**kg**
Al	56,700	6,170	62,900	2.30E+05
Ca	1,630	410	2,040	6,340
Cr	1,120	693	1,800	14,200
Fe	191	759	950	1,950
K	14,600	---	14,600	12,100
Mn	147	242	389	1,600
Na	9.01E+05	1.18E+05	1.02E+06	1.42E+06
Ni	1,430	425	1,860	1,720
IONS	**kg**	**kg**	**kg**	**kg**
Cl^-	14,300	1,040	15,300	39,000
F^-	6,980	---	6,980	6,870
OH^-	13,600	---	13,600	6.39E+05
NO_3^-	8.45E+05	56,700	9.02E+05	1.50E+06
NO_2^-	3.10E+05	19,900	3.30E+05	5.75E+05
PO_4^{-3}	18,100	1,530	19,600	48,500
SO_4^{-2}	51,800	13,100	64,900	1.42E+05
RADIONUCLIDES	**Ci**	**Ci**	**Ci**	**Ci**
^{137}Cs	1.32E+06	1.44E+05	1.46E+06	1.37E+06
$^{89/90}Sr$	2.80E+05	85,500	3.66E+05	6.29E+05
PHYSICAL PROPERTIES	**g/mL**	**g/mL**	**g/mL**	**g/mL**
Density	1.41	1.5	n/a	1.70
CARBON	**kg C**	**kg C**	**kg C**	**kg C**
TIC	49,600	6,220	55,800	34,400
TOC	98,400	8,250	1.06E+05	1.08E+05

Notes:

[1]Esch (1996b)

[2]Douglas (1996)

[3]Agnew et al. (1996a)

[4]Inventory value for TOC was calculated by multiplying the weight percent TOC by the HTCE total waste estimate of 7.03E+06 kg.

contents; separate estimates for the supernate and sludge were not provided. However, most of the analytes from the recent sampling events were only evaluated on the supernate. Consequently, to make a comparison, the historical sludge data from the 1990 core sample were added to the supernate results.

Comparison of the historical estimate with the analytical values gives varied results. Some analytes are reasonably close in their estimates (fluoride and ^{137}Cs), while others are very different (hydroxide and chromium). In general, most comparisons were of the same order of magnitude.

5.5 EVALUATION OF PROGRAM REQUIREMENTS

An evaluation of the analytical results from the 1994 and 1995 grab sampling events was made according to the safety screening (Dukelow et al. 1995) and waste compatibility (Fowler 1995) DQOs. The safety screening DQO lists requirements for examining the waste in Hanford's high-level underground storage tanks to identify safety problems and to evaluate the tank for placement on a Watch List. The compatibility DQO identifies potential safety and operational problems that may be encountered when combining waste from two sources; for example, the saltwell liquor from a single-shell tank with the waste in a receiving double-shell tank. This section discusses the requirements of each DQO and compares the analytical data to defined concentration limits.

5.5.1 Safety Screening Evaluation

Data criteria identified in the safety screening DQO were used to assess the safety of the waste in tank 241-AN-102. The requirement that vertical profiles of the waste (or grab samples from multiple depths) be obtained from at least two widely-spaced risers was met. Of the five primary analyses required by the safety screening DQO, three have decision criteria thresholds that could warrant further investigation to ensure tank safety if they were exceeded. These three analyses include DSC (to measure the fuel content), a measurement of the total alpha activity (to determine the criticality potential), and a determination of the flammability of the tank headspace vapors. Table 5-9 lists the applicable safety issues, decision variables, and thresholds of the safety screening DQO, along with the mean analytical results from the grab sampling events.

The safety screening DQO has established a decision criteria threshold of -480 J/g (dry-weight basis) for the DSC analyses (Dukelow et al. 1995). Twelve of the 14 samples contained exothermic reactions; and 8 of these were greater than the DQO limit of -480 J/g. All but one of the samples had upper limit to a one-sided 95 percent confidence interval on the mean exceeding the threshold. The highest individual sample result was -1,200 J/g (dry-weight), and the highest upper limit to a one-sided 95 percent confidence interval on the mean was -1,501 J/g (both from sample 2AN-95-2).

Table 5-9. Safety Screening Data Quality Objective Criteria.

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Supernate Analytical Result
Ferrocyanide/ organics	Total fuel content	-480 J/g (dry-weight)	8 of 14 samples exceeded the threshold (highest value = -1,200 J/g). 11 samples had upper limit to a one-sided 95% confidence interval on the mean above threshold (highest value = -1,501 J/g).
Criticality	Total alpha	1 g/L[1] (sludge = 41.8 μCi/g) (supernate = 61.5 μCi/mL)	Mean sludge alpha activity = 0.296 μCi/g
			Mean supernate alpha activity = 0.163 μCi/mL
Ferrocyanide/ organics	TOC	3 wt% (dry-weight) (30,000 μg C/g)	Mean sludge TOC = 44,000 μg C/g (dry-weight)
			Mean supernate TOC = 37,000 μg C/g (dry-weight)
Flammable gas	Flammable gas	25% of the LFL	0% of LFL

Note:

[1]Although the actual decision criterion listed in the DQO is 1 g/L, total alpha is measured in μCi/g rather than g/L. For the sludge, to convert the notification limit for total alpha into a number more readily usable by the laboratory, it was assumed that all alpha decay originates from ^{239}Pu. The 41.8 μCi/g notification limit for the sludge is derived using the overall sludge density of 1.47 g/mL and the specific activity of ^{239}Pu (0.0615 Ci/g). The following equation displays the derivation method for the notification limit:

$$\left[\frac{1\ \text{g}}{\text{L}}\right]\left[\frac{1\ \text{L}}{10^3\ \text{mL}}\right]\left[\frac{1}{\text{density}}\frac{\text{mL}}{\text{g}}\right]\left[\frac{0.0615\ \text{Ci}}{1\ \text{g}}\right]\left[\frac{10^6\ \mu\text{Ci}}{1\ \text{Ci}}\right] = \frac{61.5}{\text{density}}\frac{\mu\text{Ci}}{\text{g}}$$

Total cyanide and TOC were performed as secondary analyses when the DSC notification limit was exceeded. The results of these analyses help to determine if the tank should be placed on either the Organic or Ferrocyanide Watch Lists. The organic safety program has established a dry-weight TOC concentration limit of 3 weight percent, or 30,000 μg C/g. The mean TOC result (wet-weight) for the 1994/1995 supernate sampling was 26,200 μg C/mL, while the mean wet-weight TOC result from the 1995 sludge samples was 24,400 μg C/g. The corresponding dry weights for these values were 37,000 μg C/g and 44,000 μg C/g, respectively. Both results exceeded the notification limit of 3 weight percent. The ferrocyanide safety program has established a dry-weight cyanide concentration limit of 39,000 μg/g. The mean cyanide result for the November/December 1995 centrifuged solids samples was 20.9 μg/g. The corresponding dry weight for this value is 37.7 μg/g, far below the notification limit.

To investigate the relationship between DSC and the TOC content, the DSC dry-weight results for those samples that had exothermic reactions are compared with the corresponding dry-weight TOC results and the TOC energy equivalents in Table 5-10. This comparison may be biased since DSC reports net enthalpy change, and if endotherms are present, they could mask the full extent of the actual exothermic reactions. The TOC data were converted to their energy equivalents using the following equation. The 632 J/g value represents the energy equivalent of 5 weight percent TOC, based on a sodium acetate average energetics standard. Assuming that all of the TOC is present as sodium acetate may also bias this comparison.

$$\text{Energy Equivalent} = \text{wt\% TOC (dry weight)} \ \frac{(632 \text{ J/g})}{5}$$

The potential for criticality can be assessed from the total alpha activity data. The safety screening decision threshold is 1 g/L, or 61.5 μCi/mL for the supernate. The overall supernate mean was 0.163 μCi/mL, well below the decision threshold. The 95 percent confidence interval upper limits for each sample/duplicate pair were also below the DQO decision threshold, with the highest value being 0.290 μCi/mL. For the sludge, the 1 g/L decision threshold was converted to 41.8 μCi/g using the mean sludge density of 1.47 g/mL, as shown in the footnote of Table 5-9. The overall sludge mean was 0.296 μCi/g, well below the limit. Because the sludge was analyzed as centrifuged fractions, the 95 percent confidence interval limits on the mean were determined on the centrifuged solids and centrifuged liquid results. The highest upper limit to a one-sided 95 percent confidence interval on the mean for the centrifuged solids and centrifuged liquid were 1.414 μCi/g and 0.296 μCi/mL, respectively.

The flammability of the gas in the tank headspace is an additional safety screening DQO consideration. The safety screening DQO notification limit for the tank headspace flammability is 25 percent of the LFL. The reported LFL of 0 percent was well below the safety screening notification limit.

Table 5-10. Comparison of DSC Analytical Results with TOC Energy Equivalents (Dry-Weight Basis).

Sample Number	Grab Sample	Subsample	Run	TOC Analytical Result	TOC Energy Equivalent	DSC Analytical Result[1]
				µg C/g	J/g	J/g
S95T003982	102-AN-1(B)	Supernate	1	37,800	477.8	563.4
			2	36,800	465.2	629.3
S95T003983	102-AN-2(B)	Supernate	1	36,300	458.8	720.3
			2	38,900	491.7	560.2
S95T003984	102-AN-4	Supernate	1	36,000	455.0	440.8
			2	35,200	444.9	389.2
S95T003867	2AN-95-1	Supernate	1	38,900	491.7	558.2
			2	35,800	452.5	558.4
S95T003868	2AN-95-2	Supernate	1	34,500	436.1	1,220
			2	36,800	465.2	1,110
S95T003869	2AN-95-3	Supernate	1	37,600	475.3	555.3
			2	35,600	450.0	566.1
S95T004133	2AN-95-4A	Centrifuged liquid	1	45,500	575.1	487.1
			2	48,900	618.1	475.9
S95T004135	2AN-95-5A	Centrifuged liquid	1	48,300	610.5	556.5
			2	49,900	630.7	597.5
S95T004137	2AN-95-4A	Centrifuged solid	1	45,400	573.8	488.1
			2	47,100	595.3	458.1
S95T004139	2AN-95-5A	Centrifuged solid	1	35,000	442.4	492.1
			2	40,200	508.1	569.1

Note:

[1]The negative sign indicating an enthalpy change involving an exothermic reaction was not included, because total energy in J/g is being compared between the DSC and TOC results.

The mean water contents of both the sludge and supernate samples, as performed by TGA, were 44.6 and 49.7 weight percent, respectively. The lowest individual value was 35.60 percent. Consequently, all percent water results were above 17 weight percent, the minimum amount required to prevent a propagating exothermic reaction according to the organic DQO (Turner et al. 1995).

Another factor in assessing the safety of tank waste is the heat generation from radioactive decay. The heat-load value calculated using the supernate data from the 1994/1995 grab sampling events was 8,140 W (27,800 Btu/hr), as shown in Table 5-11. This estimate is biased low because not all radionuclides in the samples were determined. As a comparison, the Agnew total inventory estimate was 10,600 W (36,300 Btu/hr) and the value listed in Kummerer (1994) was 12,000 W (41,000 Btu/hr). All of these estimates are well below the design specification limit of 20,500 W (70,000 Btu/hr) for the AN Tank Farm. The tank has exhibited upper temperture extreme in the past, which no longer exhibits (Section 2.4.2). Therefore, it may be concluded that any heat generated from radioactive sources is adequately dissipated.

Table 5-11. Tank 241-AN-102 Projected Heat Load.[1]

	Specific Activity	Projected Inventory	Heat Load from Radioactive Decay
Radionuclide	μCi/mL	Ci	W
^{241}Am	0.138	518	17
^{137}Cs	351	1.32E+06	6,230
^{60}Co	0.148	556	8.56
$^{239/240}$Pu	0.00582	21.8	0.665
$^{89/90}$Sr	74.5	2.80E+05	1,880
Total		1.60E+06	8,140

Note:

[1]Based only on the supernate since radionuclides were not analyzed for the solids.

5.5.2 Waste Compatibility Evaluation

In accordance with Fowler (1995), tank 241-AN-102 was analyzed to assess the safety and operational implications of combining the wastes in the tank and the double-shell tank system. Safety considerations include criticality, flammable gas generation and accumulation, energetics, corrosion and leakage, and unwanted chemical reactions. Operational considerations include plugged pipelines and equipment, TRU segregation, complexant waste segregation, and heat-load limits of the receiving tank. Not all of the safety and operational considerations are within the scope of this report, notably the potential chemical reactivity of the waste in a variety of different situations, and the tendency of the waste to plug piping and equipment. Table 5-12 presents the analyses used to evaluate the waste in terms of the safety and operational considerations that are within the scope of this report. The primary decision variable, the decision criteria threshold, and the analytical results from the 1994/1995 grab sampling events are listed for each safety and operational issue.

The 0.013 g/L notification limit for criticality is based on the mean concentration of $^{239/240}Pu$. Since the analytical results for the 1994/1995 grab sampling events were reported in μCi/mL, the limit was converted to those units by using the method described in Note 1 of Table 5-12. The analytical mean for $^{239/240}Pu$ was well below the decision threshold. Flammable gases may accumulate in wastes with high specific gravity (> 1.41), and the waste compatibility DQO specifies that the specific gravity of the source waste in a waste transfer must be < 1.3. The commingled waste after the transfer must have a specific gravity $\leq$ 1.41. The mean specific gravity for the 1994/1995 grab samples was 1.41, exceeding the 1.3 limit and equalling the commingled waste 1.41 limit. Therefore, tank 241-AN-102 should not receive any waste with a specific gravity greater than 1.41. For energetics, the exotherm/endotherm ratio must be < 1 for all reactions below 500 °C (932 °F). All exotherm/endotherm ratios were below the given criterion of 1. The hydroxide ion concentration of the corrosion-inhibiting constituent of the waste was outside the limit imposed by the compatibility DQO. The mean hydroxide ion concentration of 0.23 M was below the corrosion control limit of 0.3 M. Because the waste does not meet the corrosion control limit, the hydroxide ion concentration must be brought into compliance during transfers or it must be verified prior to transfer, that composition limit in the receiving tank will not be violated.

Operations issues are based on the policy of segregating TRU and complexant wastes, avoiding excess heat in the tanks, and ensuring pumpability of the source waste to the receiving tank. The total concentration of TRU elements was calculated by converting the values to a per-weight basis from the per-volume basis, by dividing the analytical result for each radionuclide by the mean density, and summing the per-weight results. The total was then compared to the 0.1 μCi/g standard for segregating TRU waste from non-TRU. The results showed the concentration of TRU elements slightly exceeded the limit of 0.1 μCi/g, and therefore only TRU waste should be received by this tank. As stated previously, the heat load of the tank was well within operating specification limits.

Table 5-12. Decision Variables and Criteria for the Waste Compatibility Data Quality Objective.

Compatibility Issue	Primary Decision Variable	Decision Criteria Threshold	Supernate Mean Analytical Result
Safety			
Criticality	$^{239/240}Pu$	> 0.013 g/L (>0.800 μCi/mL)[1]	0.00582 μCi/mL
Flammable gas	Specific gravity	Source waste > 1.3; Commingled waste > 1.41	1.41
Ferrocyanide/ organics	Total fuel content	For thermal analysis < 500 °C (932 °F), the absolute value of exotherm/endotherm ratio ≥ 1	All exotherm/endotherm ratios < 1
Corrosion and leakage	OH^- NO_3^- NO_2^-	0.3 M ≤ [OH^-] < 10 M 3.0 M < [NO_3^-] ≤ 5.5 M [OH^-] + [NO_2^-] ≥ 1.2 M	3,610 μg/mL (0.21 M), out of control limit 225,000 μg/mL (3.6 M) 82,600 μg/mL (1.8 M)
Operations			
TRU segregation	TRU elements	$^{239/240}Pu$, ^{238}Pu, ^{241}Am, U total, $^{243/244}Cm$, ^{237}Np total concentration > 0.1 μCi/g	0.102 μCi/g
Complexant segregation	Determined by selected analyte concentration using PREDICT, or by performing a boildown test in the laboratory.		
Heat load	Heat generation rate from radioactive decay	≥ 20,500 W (70,000 Btu/hr)	8,140 W (27,800 Btu/hr)

Note:

[1]Although the actual decision criterion listed in the DQO was 0.013 g/L, $^{239/240}Pu$ was measured in μCi/mL rather than g/L. The following equation converts the decision threshold into the same units as the laboratory used. The 0.0615 Ci/g term is the specific activity of ^{239}Pu. The decision criterion was converted to 0.800 μCi/mL.

$$\left[\frac{0.013\ \text{g}}{\text{L}}\right]\left[\frac{1\ \text{L}}{10^3\ \text{mL}}\right]\left[\frac{0.0615\ \text{Ci}}{1\ \text{g}}\right]\left[\frac{10^6\ \mu\text{Ci}}{1\ \text{Ci}}\right] = 0.800\ \frac{\mu\text{Ci}}{\text{mL}}$$

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6.0 CONCLUSIONS AND RECOMMENDATIONS

The waste in tank 241-AN-102 has been evaluated according to the requirements listed in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). Results from three different grab sampling events were used in the characterization of the tank waste. Grab samples were taken in October 1994 and February 1995 for process control purposes, and in November/December 1995 for safety screening and waste compatibility purposes. Archived samples from the October 1994 and February 1995 sampling events were retrieved for safety screening and waste compatibility analyses in early 1996. This was done to meet the safety screening requirement of two vertical profiles of the tank waste from widely-spaced risers. To assess tank safety, the safety screening DQO required analyses for energetics, weight percent water, density, total alpha activity, and the flammable gas concentration in the tank headspace. To examine possible waste compatibility problems, the waste compatibility DQO required analyses for energetics, percent water, TIC, TOC, density, pH, and selected metals, anions, and radionuclides. Those analytes measured on the October 1994 grab samples for process control purposes included weight percent water, density, pH, TIC, TOC, and selected metals, anions, and radionuclides. All samples were analyzed at the Westinghouse Hanford Company 222-S Laboratory.

The waste contained in tank 241-AN-102 is classified as concentrated complexant waste, which contains high levels of organic carbon, nitrates, and nitrites. Because of the nature of the waste, exothermic activity is expected. The DSC results for eight out of 14 samples exceeded the safety screening threshold of -480 J/g. In addition, three out of the four that did not initially exceed the limit had 95 percent confidence interval upper limits greater than -480 J/g. However, all percent water results were well above 17 weight percent (the lowest was 35.60 percent), the minimum amount of moisture needed to prevent a propagating exothermic reaction (Turner et al. 1995). The TOC results were compared with the organic DQO limit of 3 weight percent (30,000 μg C/g) on a dry-weight basis. The results for both the sludge and supernate exceeded the limit, with dry-weight means of 44,000 μg C/g and 37,000 μg C/g for the sludge and supernate, respectively.

All remaining requirements of the safety screening DQO were satisfied. Total alpha activity overall means for the sludge and supernate were 0.296 μCi/g and 0.163 μCi/mL, respectively and upper limit to one-sided 95 percent confidence interval on the mean were nearly two orders of magnitude below the DQO decision threshold. Finally, the concentration of flammable gas in the tank headspace was 0 percent of the LFL.

Based on the decision criteria of the safety screening DQO, the waste currently in tank 241-AN-102 may continue to be safely stored with a correction to increase hydroxide ion concentration. The requirement regarding corrosion limits was not met for hydroxide ion concentration. Although exothermic reactions were found in the waste, they do not present a safety concern due to the high water contents of both the sludge and supernate. No additional characterization efforts are needed at this time.

Radionuclide data was used to calculate an estimate of 8,140 W (27,800 Btu/hr) for the tank heat load. Other estimates were available from the HTCE (10,600 W [36,300 Btu/hr]) and Kummerer (1994) (12,000 W [41,000 Btu/hr]). All estimates were below the operating specification limit of 20,500 W (70,000 Btu/hr). The tank has exhibited an upper temperature extreme in the past, which it no longer exceeds. Thus, it may be concluded that any heat generated from radioactive sources is adequately dissipated.

Because of the high levels of organic carbon, the waste in tank 241-AN-102 must already be segregated from non-complexant waste types. The waste compatibility evaluation did reveal other issues that may impact waste management decisions. The TRU content of the waste was found to be 0.102 μCi/g, slightly exceeding the 0.1 μCi/g TRU limit in the DQO. In addition, the mean supernate specific gravity of 1.41 exceeded the 1.3 source waste limit, and equalled the 1.41 commingled waste limit of the waste compatibility DQO. This issue may warrant monitoring to ensure that evaporation does not increase the specific gravity to a point at which flammable gas retention can occur. Furthermore, the mean hydroxide ion concentration of 0.23 M was below the lower limit of 0.3 M for corrosion protection. Only TRU waste with a specific gravity less than 1.41 should be transferred into this tank. Waste from this tank should only be transferred to tanks containing TRU waste with a specific gravity less than 1.41 and it must be verified, prior to transfer, that hydroxide ion concentration limit in the receiving tank will not be violated.

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APPENDIX A

ANALYTICAL RESULTS FROM THE OCTOBER 1994, FEBRUARY 1995, AND NOVEMBER/DECEMBER 1995 GRAB SAMPLINGS

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APPENDIX A

ANALYTICAL RESULTS FROM THE OCTOBER 1994, FEBRUARY 1995, AND NOVEMBER/DECEMBER 1995 GRAB SAMPLINGS

A.1 INTRODUCTION

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

Each data table lists the following: laboratory sample identification (where applicable), sample origin (grab sample), an original and duplicate result for each sample, a sample mean, a mean result for the tank, an RSD (mean), and a projected tank inventory for the particular analyte using the overall mean and the appropriate conversion factors. Projected tank inventory is not applicable to the DSC or density data. It should be noted that laboratory sample identification numbers were not assigned to grab samples 102-AN-1(A), 102-AN-2(A), and 102-AN-4 since they were analyzed for process control purposes. 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-33. A description of the units and symbols used in the analyte tables, and the references used in compiling the analytical data, are found in the List of Terms and Section 7.0, respectively. For a description of the sampling event and information on sampling rationale and locations, see Section 3.0.

A.2 ANALYTE TABLE DESCRIPTION

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

The "Grab Sample" column specifies the respective grab sample.

The "Result" and "Duplicate" columns are self-explanatory. The "Sample Mean" column lists the average of the result and duplicate values. If the result and duplicate values were both detected, or one of the two values is detected and the other non-detected, then the mean is expressed as a detected value. If the result and duplicate values were both nondetected, then the mean is expressed as a nondetected value. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the Tank Characterization Database. 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.

Because the initial ANOVA indicated that the variability due to different sampling risers was negligible (see Section 5.3), the overall (or analyte concentration) means for the supernate in tank 241-AN-102 were calculated using a straight average of the sample means from all grab samples. In cases where two sample means were recorded for a single grab sample, the two sample means were averaged together before averaging with the other grab samples means. For the sludge overall means, the centrifuged liquid and centrifuged solids data were combined. The combining was done on a weighted basis according to the masses of each centrifuged portion. Following are the weighting factors used in calculating the sludge means:

<u>Sample 102-AN-3(A)</u>
Solids = 62.3 percent
Liquids = 37.7 percent

<u>Sample 102-AN-3(B)</u>
Solids = 17.5 percent
Liquids = 82.5 percent

<u>Sample 2AN-95-4A</u>
Solids = 57.2 percent
Liquids = 42.8 percent

<u>Sample 2AN-95-5A</u>
Solids = 49.9 percent
Liquids = 50.1 percent

All values, including those below the detection level (indicated by the less-than symbol, "<"), were utilized in calculating the overall means. The exception to this is fluoride, as discussed in the footnote to Table A-15. If 50 percent or more of all the individual sample and duplicate results were detected, then the overall mean was expressed as a detected value. If less than 50 percent of all the individual results were detected, then the overall mean was expressed as a nondetected value. When nondetected observations are used as quantitative results, the mean concentration of inventory estimates are biased. The magnitude of the bias is unknown.

The RSD (mean) was computed for applicable analytes using a standard one-way ANOVA statistical analysis. If the overall mean for a given analyte was detected, then an RSD (mean) was also calculated for that analyte. If a nondetected result was used to the ANOVA, the RSD (mean) is biased. The magnitude of the bias is unknown.

The projected inventory is the product of the overall analyte concentration mean, the volume of tank waste (3,755 kL [992 kgal] for the supernate and 337 kL [89 kgal] for the solids), the density (only needed for sludge conversion; sludge density was 1.47 g/mL), and the appropriate conversion factors.

The four QC parameters assessed on the tank 241-AN-102 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. These were summarized in Section 5.1.2. More specific information is provided in the following tables. Sample and duplicate pairs in which any of the quality control parameters were outside their specified limits are superscripted in the "Sample Mean" column as follows:

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

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

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	15,100	14,600	14,900	15,100	1.48	56,700
n/a	102-AN-2(A)	15,700	14,000	14,900			
n/a	102-AN-4	15,100	14,900	15,000			
S95T003867	2AN-95-1	15,200	14,800	15,000			
S95T003869	2AN-95-3	16,300	16,000	16,200			
S95T003868	2AN-95-2	14,400	14,800	14,600			

Table A-2. Tank 241-AN-102 Analytical Results: Calcium.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	441	441	441	434	1.53	1,630
n/a	102-AN-2(A)	441	401	421			
n/a	102-AN-4	441	441	441			

Table A-3. Tank 241-AN-102 Analytical Results: Chromium.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	312	260	286	297	2.62	1,120
n/a	102-AN-2(A)	312	260	286			
n/a	102-AN-4	312	260	286			
S95T003867	2AN-95-1	327	297.0	312.0			
S95T003869	2AN-95-3	336	320.0	328.0			
S95T003868	2AN-95-2	283	287.0	285.0			

Table A-4. Tank 241-AN-102 Analytical Results: Iron.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S95T003867	2AN-95-1	65.70	47.30	56.50[QC:e]	50.9	10.30	191
S95T003869	2AN-95-3	61.30	50.40	55.85			
S95T003868	2AN-95-2	41.00	39.90	40.45			

Table A-5. Tank 241-AN-102 Analytical Results: Manganese.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S95T003867	2AN-95-1	68.30	24.00	46.15[QC:e]	39.1	23.67	147
S95T003869	2AN-95-3	66.80	34.00	50.40[QC:e]			
S95T003868	2AN-95-2	21.30	20.20	20.75			

Table A-6. Tank 241-AN-102 Analytical Results: Nickel.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	352	352	352	381	2.95	1,430
n/a	102-AN-2(A)	411	352	382			
n/a	102-AN-4	352	352	352			
S95T003867	2AN-95-1	403	381.0	392.0			
S95T003869	2AN-95-3	429	422.0	425.5			
S95T003868	2AN-95-2	381	381.0	381.0			

Table A-7. Tank 241-AN-102 Analytical Results: Phosphorus.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	1,610	1,580	1,600	1,610	0.86	6,040
n/a	102-AN-2(A)	1,700	1,550	1,630			
n/a	102-AN-4	1,610	1,610	1,610			

Table A-8. Tank 241-AN-102 Analytical Results: Potassium.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	2,420	4,500	3,460[QC:e]	3,880	6.76	14,600
n/a	102-AN-2(A)	3,280	4,340	3,810[QC:e]			
n/a	102-AN-4	4,030	4,690	4,360			

Table A-9. Tank 241-AN-102 Analytical Results: Silicon.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S95T003867	2AN-95-1	20.90	< 20.0	20.5	< 20.2	n/a	< 76.0
S95T003869	2AN-95-3	20.10	< 20.0	20.1			
S95T003868	2AN-95-2	< 20.00	< 20.0	< 20.0			

Table A-10. Tank 241-AN-102 Analytical Results: Sodium.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	2.52E+05	2.89E+05	2.71E+05	2.40E+05	3.72	9.01E+05
n/a	102-AN-2(A)	2.58E+05	2.36E+05	2.47E+05			
n/a	102-AN-4	2.78E+05	2.32E+05	2.55E+05			
S95T003867	2AN-95-1	2.21E+05	2.160E+05	2.180E+05			
S95T003869	2AN-95-3	2.37E+05	2.34E+05	2.36E+05			
S95T003868	2AN-95-2	2.11E+05	2.16E+05	2.14E+05			

Table A-11. Tank 241-AN-102 Analytical Results: Sulfur.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	4,870	4,650	4,760	4,750	1.01	17,900
n/a	102-AN-2(A)	4,940	4,460	4,700			
n/a	102-AN-4	4,840	4,740	4,790			

Table A-12. Tank 241-AN-102 Analytical Results: Uranium.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		μg/mL	μg/mL	μg/mL	μg/mL	%	kg
S95T003867	2AN-95-1	< 200	< 200	< 200	< 200	n/a	< 751
S95T003869	2AN-95-3	< 200	< 200	< 200			
S95T003868	2AN-95-2	< 200	< 200	< 200			

Table A-13. Tank 241-AN-102 Analytical Results: Chloride.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		μg/mL	μg/mL	μg/mL	μg/mL	%	kg
n/a	102-AN-1(A)	4,610[1]	3,550	3,550	3,810	6.18	14,300
n/a	102-AN-2(A)	3,900	3,550	3,730			
n/a	102-AN-4	4,250	3,900	4,080			
S95T003867	2AN-95-1	2,980	3,320	3,150			
S95T003869	2AN-95-3	3,460	3,610	3,530			
S95T003868	2AN-95-2	4,720	4,880	4,800			

Note:

[1]Value was not used in the mean calculations as directed by Herting (1994).

Table A-14. Tank 241-AN-102 Analytical Results: Cyanide.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Centrifuged Solids		µg/g	µg/g	µg/g	µg/g	%	kg
S95T004137	2AN-95-4A	21.70	20.30	21.00	20.9	0.92	10.4
S95T004139	2AN-95-5A	20.70	20.90	20.80			

Table A-15. Tank 241-AN-102 Analytical Results: Fluoride.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	2,470[1]	1,900	1,900	1,860	8.24	6,980
n/a	102-AN-2(A)	1,900	1,900	1,900			
n/a	102-AN-4	2,280	2,090	2,190			
S95T003867	2AN-95-1	< 133[2]	< 133[2]	< 133[QC:d;2]			
S95T003869	2AN-95-3	1,450	1,450	1,450			
S95T003868	2AN-95-2	< 133[2]	< 133[2]	< 133[2]			

Note:

[1]Value was not used in the mean calculations as directed by Herting (1994).

[2]Value considered suspect, and was therefore not used in the mean calculations.

Table A-16. Tank 241-AN-102 Analytical Results: Hydroxide.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	3,910	4,080	4,000	3,610	4.78	13,600
n/a	102-AN-2(A)	3,910	4,080	4,000			
n/a	102-AN-4	4,250	3,740	4,000			
S95T003867	2AN-95-1	3,310	3,080	3,200			
S95T003869	2AN-95-3	3,100	3,310	3,200			
S95T003868	2AN-95-2	3,310	3,240	3,280			

Table A-17. Tank 241-AN-102 Analytical Results: Nitrate.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	2.65E+05	2.20E+05	2.43E+05	2.25E+05	7.11	8.45E+05
n/a	102-AN-2(A)	2.32E+05	2.10E+05	2.21E+05			
n/a	102-AN-4	2.31E+05	2.15E+05	2.23E+05			
S95T003867	2AN-95-1	1.63E+05	1.930E+05	1.780E+05			
S95T003869	2AN-95-3	1.96E+05	1.970E+05	1.960E+05[QC:d]			
S95T003868	2AN-95-2	2.83E+05	2.990E+05	2.910E+05			

Table A-18. Tank 241-AN-102 Analytical Results: Nitrite.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		μg/mL	μg/mL	μg/mL	μg/mL	%	kg
n/a	102-AN-1(A)	97,500[1]	82,300	82,300	82,600	6.96	3.10E+05
n/a	102-AN-2(A)	87,900	78,700	83,300			
n/a	102-AN-4	86,900	81,900	84,400			
S95T003867	2AN-95-1	60,400	71,400	65,900			
S95T003869	2AN-95-3	73,200	72,700	72,900[QC:d]			
S95T003868	2AN-95-2	1.04E+05	1.100E+05	1.070E+05			

Note:
[1]Value was not used in the mean calculations as directed by Herting (1994).

Table A-19. Tank 241-AN-102 Analytical Results: Phosphate.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		μg/mL	μg/mL	μg/mL	μg/mL	%	kg
n/a	102-AN-1(A)	5,890[1]	4,750	4,750	4,820	6.80	18,100
n/a	102-AN-2(A)	4,940	4,650	4,800			
n/a	102-AN-4	5,410	5,030	5,220			
S95T003867	2AN-95-1	3,530	4,150	3,840			
S95T003869	2AN-95-3	4,220	4,170	4,200			
S95T003868	2AN-95-2	6,220	5,990	6,110			

Note:
[1]Value was not used in the mean calculations as directed by Herting (1994).

Table A-20. Tank 241-AN-102 Analytical Results: Sulfate.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
n/a	102-AN-1(A)	17,300[1]	13,400	13,400	13,800	5.88	51,800
n/a	102-AN-2(A)	13,400	13,400	13,400			
n/a	102-AN-4	15,400	14,400	14,900			
S95T003867	2AN-95-1	10,500	12,200	11,300			
S95T003869	2AN-95-3	12,700	12,800	12,800			
S95T003868	2AN-95-2	16,800	17,400	17,100			

Note:

[1]Value was not used in the mean calculations as directed by Herting (1994).

Table A-21. Tank 241-AN-102 Analytical Results: Americium-241.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S95T003870	2AN-95-1	0.167	0.163	0.165	0.138	10.58	518
S95T003872	2AN-95-3	0.129	0.135	0.132			
S95T003871	2AN-95-2	0.123	0.108	0.115			

Table A-22. Tank 241-AN-102 Analytical Results: Cesium-137.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
n/a	102-AN-1(A)	383	381	382	351	3.96	1.32E+06
n/a	102-AN-2(A)	392	378	385			
n/a	102-AN-4	384	372	378			
S95T003870	2AN-95-1	322	323.0	322.5			
S95T003872	2AN-95-3	323	328.0	325.5			
S95T003871	2AN-95-2	313	312.0	312.5			

Table A-23. Tank 241-AN-102 Analytical Results: Cobalt-60.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S95T003870	2AN-95-1	0.143	0.151	0.147	0.148	1.87	556
S95T003872	2AN-95-3	0.142	0.144	0.143			
S95T003871	2AN-95-2	0.148	0.157	0.152			

Table A-24. Tank 241-AN-102 Analytical Results: Plutonium-239/240.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S95T003870	2AN-95-1	0.00652	0.00658	0.00655	0.00582	6.71	21.8
S95T003872	2AN-95-3	0.00568	0.00571	0.00570			
S95T003871	2AN-95-2	0.00519	0.00524	0.00522			

Table A-25. Tank 241-AN-102 Analytical Results: Strontium-89/90.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
n/a	102-AN-1(A)	74.4	74.2	74.3	74.5	1.21	2.80E+05
n/a	102-AN-2(A)	74.5	74.0	74.3			
n/a	102-AN-4	73.8	71.2	72.5			
S95T003870	2AN-95-1	71.30	75.10	73.20			
S95T003872	2AN-95-3	78.20	79.40	78.80			
S95T003871	2AN-95-2	74.40	73.90	74.15			

Table A-26. Tank 241-AN-102 Analytical Results: Total Alpha Activity.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
n/a	102-AN-1(A)	0.164	0.175	0.170	0.163	4.63	612
n/a	102-AN-2(A)	0.160	0.169	0.165			
n/a	102-AN-4	0.164	0.167	0.166			
S95T003984		0.159	0.174	0.166			
S95T003982	102-AN-1(B)	0.144	0.156	0.150			
S95T003983	102-AN-2(B)	0.116	0.116	0.116			
S95T003870	2AN-95-1	0.175	0.173	0.174			
S95T003872	2AN-95-3	0.169	0.202	0.185			
S95T003871	2AN-95-2	0.182	0.169	0.175			
Sludge		µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T000005[L]	102-AN-3(A)	0.175	0.208	0.192	0.296	8.47	147
S96T000007[S]		0.306	0.332	0.319[QC:e]			
S96T000006[L]	102-AN-3(B)	0.239	0.218	0.228			
S96T000008[S]		0.952	0.778	0.865[QC:e]			
S95T004133[L]	2AN-95-4A	0.168	0.171	0.170			
S95T004141[S]		0.459	0.464	0.462[QC:e]			
S95T004135[L]	2AN-95-5A	0.137	0.153	0.145			
S95T004142[S]		0.329	0.333	0.331			

Notes:

L = centrifuged liquid
S = centrifuged solids

Table A-27. Tank 241-AN-102 Analytical Results: Total Inorganic Carbon.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg C/mL	µg C/mL	µg C/mL	µg C/mL	%	kg C
n/a	102-AN-1(A)	14,300	13,300	13,800	13,200	1.46	49,600
n/a	102-AN-2(A)	13,300	13,400	13,400			
n/a	102-AN-4	13,600	13,000	13,300			
S95T003867	2AN-95-1	12,200	12,500	12,400			
S95T003869	2AN-95-3	13,000	13,400	13,200			
S95T003868	2AN-95-2	13,100	13,500	13,300			

Table A-28. Tank 241-AN-102 Analytical Results: Total Organic Carbon. (2 sheets)

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Supernate		µg C/mL	µg C/mL	µg C/mL	µg C/mL	%	kg C
n/a	102-AN-1(A)	26,800	27,400	27,100	26,200	0.97	98,400
n/a	102-AN-2(A)	33,300[1]	25,000	25,000			
n/a	102-AN-4	25,900	26,400	26,200			
S95T003984		25,700	25,100	25,400			
S95T003982	102-AN-1(B)	26,900	26,200	26,600			
S95T003983	102-AN-2(B)	25,700	27,500	26,600			
S95T003867	2AN-95-1	27,900	25,700	26,800			
S95T003869	2AN-95-3	26,500	25,100	25,800			
S95T003868	2AN-95-2	24,800	26,500	25,600			

Table A-28. Tank 241-AN-102 Analytical Results: Total Organic Carbon. (2 sheets)

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Sludge		µg C/g	µg C/g	µg C/g	µg C/g	%	kg C
S95T004133[L]	2AN-95-4A	24,100	25,900	25,000	24,400	6.00	12,100
S95T004137[S]		26,000	27,000	26,500			
S95T004135[L]	2AN-95-5A	24,300	25,100	24,700			
S95T004139[S]		19,700	22,600	21,200[QC:e]			

Notes:

[1]Value was not used in the mean calculations as directed by Herting (1994).

L = centrifuged liquid
S = centrifuged solids

Table A-29. Tank 241-AN-102 Analytical Results: Density/Specific Gravity. (2 sheets)

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)
Supernate		g/mL	g/mL	g/mL	g/mL	%
n/a	102-AN-1(A)	1.397	1.403	1.400	1.41	0.67
n/a	102-AN-2(A)	1.394	1.409	1.402		
n/a	102-AN-4	1.406	1.399	1.403		
S95T003984[1]		1.370	1.480	1.425		
S95T003982[1]	102-AN-1(B)	1.440	1.430	1.435		
S95T003983[1]	102-AN-2(B)	1.390	1.510	1.450		
S95T003867[1]	2AN-95-1	1.388	1.382	1.385		
S95T003869[1]	2AN-95-3	1.394	1.383	1.389		
S95T003868[1]	2AN-95-2	1.432	1.402	1.417		

Table A-29. Tank 241-AN-102 Analytical Results: Density/Specific Gravity. (2 sheets)

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)
Sludge		g/mL	g/mL	g/mL	g/mL	%
S96T000003[S]	102-AN-3(A)	1.640	n/a	1.640	1.47	1.23
S96T000005[L]		1.280	n/a	1.280		
S96T000004[S]	102-AN-3(B)	1.560	n/a	1.560		
S96T000006[L]		1.390	n/a	1.390		
S95T004133[L]	2AN-95-4A	1.350	n/a	1.350		
S95T004137[S]		1.570	n/a	1.570		
S95T004135[L]	2AN-95-5A	1.390	n/a	1.390		
S95T004139[S]		1.580	n/a	1.580		
Slurry		g/mL	g/mL	g/mL	g/mL	%
S95T003959	2AN-95-4A	1.470	n/a	1.470	1.49	1.01
S95T003960	2AN-95-5A	1.500	n/a	1.500		

Notes:

L = centrifuged liquid
S = centrifuged solids

[1]Denoted as specific gravity in data tables, not density.

Table A-30. Tank 241-AN-102 Analytical Results: pH.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD %
Supernate						
n/a	102-AN-1(A)	12.97	13.15	13.06	13.2	0.39
n/a	102-AN-2(A)	13.06	13.13	13.10		
n/a	102-AN-4	13.09	13.15	13.12		
S95T003867	2AN-95-1	13.33	13.32	13.32		
S95T003869	2AN-95-3	13.28	13.30	13.29		
S95T003868	2AN-95-2	13.35	13.34	13.34		

Table A-31. Tank 241-AN-102 Analytical Results: Volume Percent Solids.

Sample Number	Grab Sample	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)
Centrifuged Solids		%	%	%	%	%
S96T000003	102-AN-3(A)	61.20	n/a	61.20	55.6	10.07
S96T000004	102-AN-3(B)	50.00	n/a	50.00		
Slurry		%	%	%	%	%
S95T003959	2AN-95-4A	53.60	n/a	53.60	50.1	6.99
S95T003960	2AN-95-5A	46.60	n/a	46.60		

Table A-32. Tank 241-AN-102 Analytical Results: Weight Percent Water.

Sample Number	Grab Sample	Result		Duplicate		Sample Mean	Overall Mean	RSD (Mean)
		% H_2O	Temperature Range (°C)	% H_2O	Temperature Range (°C)	% H_2O	% H_2O	%
Supernate								
n/a	102-AN-1(A)	50.0	n/a	50.0	n/a	50.0	49.7	0.27
n/a	102-AN-2(A)	49.9	n/a	50.0	n/a	50.0		
n/a	102-AN-4	50.0	n/a	50.0	n/a	50.0		
S96T003984		49.33	25-160	49.38	25-220	49.36		
S96T003982	102-AN-1(B)	50.06	25-210	49.07	25-190	49.56		
S96T003983	102-AN-2(B)	49.76	25-225	49.91	25-220	49.83		
S96T003867	2AN-95-1	49.74	35-215	48.54	35-235	49.14		
S96T003869	2AN-95-3	50.13	30-200	50.02	25-220	50.08		
S96T003868	2AN-95-2	48.58	35-190	49.35	35-220	48.97		
Sludge								
S96T000003[S]	102-AN-3(A)	35.60	25-150	35.98	25-165	35.79	44.6	3.00
S96T000005[L]		49.09	25-155	49.1	25-165	49.09		
S96T000004[S]	102-AN-3(B)	44.25	25-165	43.72	25-145	43.98		
S96T000006[L]		47.61	25-150	47.17	25-165	47.39		
S96T004133[L]	2AN-95-4A	45.26	35-160	48.80	35-205	47.03		
S96T004137[S]		43.35	35-165	42.06	35-185	42.70		
S96T004135[L]	2AN-95-5A	48.45	35-200	51.03	35-235	49.74		
S96T004139[S]		43.50	25-155	44.0	25-155	43.75		

Notes:

L = centrifuged liquid
S = centrifuged solids

Table A-33. Tank 241-AN-102 Analytical Results: Energetics. (2 sheets)

Sample Number	Grab Sample	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
			mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
Supernate									
S96T003982	102-AN-1(B)	1	34.7	133.8	900.1	437.8	-284.2[QC:e]	---	---
		2	38.4	137.8	1,075	435.9	-317.4[QC:e]	---	---
S96T003983	102-AN-2(B)	1	14.66	123.1	1,629	441.3	-361.3[QC:e]	---	---
		2	16.85	126.7	1,374	435.0	-281.0[QC:e]	---	---
S96T003984	102-AN-4	1	23.28	127.6	863.4	437.2	-223.2[QC:e]	---	---
		2	27.43	128.5	883.8	437.1	-197.1[QC:e]	---	---
S96T003867	2AN-95-1	1	28.48	130.5	922.9	435.7	-283.9	---	---
		2	31.13	133.8	968.2	437.8	-284.0	---	---
S96T003869	2AN-95-3	1	29.77	128.2	1,149	427.8	-277.2	---	---
		2	32.21	125	1,210	428.0	-282.6	---	---
S96T003868	2AN-95-2	1	26.39	133.8	914.9	305.3	-616.1	---	---
		2	32.23	139.9	783.7	297.5	-557.8	---	---
Centrifuged Liquids									
S96T000005	102-AN-3(A)	1	26.87	129.7	1,112	233.0	20.1	439.9	-237.0
		2	23.22	126.6	926.1	231.0	17.5	439.7	-230.2
S96T000006	102-AN-3(B)	1	8.65	112.9	1,713	---	---	---	---
		2	11.77	121.3	1,162	439.9	-27.47[QC:e]	---	---

Table A-33. Tank 241-AN-102 Analytical Results: Energetics. (2 sheets)

Sample Number	Grab Sample	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
			mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
Centrifuged Liquids									
S96T004133	2AN-95-4A	1	38.65	125.6	1,179	316.9	-258.0	---	---
		2	31.99	125.8	1,175	317.2	-252.1	---	---
S96T004135	2AN-95-5A	1	34.37	128.4	1,148	315.7	-279.7	---	---
		2	37.63	125.6	1,082	319.8	-300.3	---	---
Centrifuged Solids									
S96T000003	102-AN-3(A)	1	11.92	125.5	978.7	---	---	---	---
		2	17.85	123.9	935.5	---	---	---	---
S96T000004	102-AN-3(B)	1	8.36	118.3	1,035	---	---	---	---
		2	13.59	110.5	945.7	---	---	---	---
S96T004137	2AN-95-4A	1	39.35	130.2	991.8	405.4	-279.7	---	---
		2	59.97	131.6	1,009	404.3	-262.5	---	---
S96T004139	2AN-95-5A	1	51.9	131.7	1,037	428.7	-283.2[QC:e]	---	---
		2	39.12	128.6	1,029	429.2	-327.5[QC:e]	---	---

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APPENDIX B

HISTORICAL ANALYTICAL RESULTS

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APPENDIX B

HISTORICAL ANALYTICAL RESULTS

B.1 INTRODUCTION

Appendix B contains analytical results from three historical samplings, in 1984, 1989 and 1990. The 1984 sampling included both a sludge and supernate sample. Section B.1 presents the results of analyses of these samples. A grab sample of the supernate was obtained in 1989 and the sample results are given in Section B.2. Section B.3 discusses the core sample acquired in 1990.

B.1 1984 ANALYTICAL RESULTS

The sludge sample was taken from the bottom of the tank while the supernate sample was obtained from 15 ft above the tank bottom. The sample handling and preparation procedures are discussed in Section 3.4. Analyses were performed at the Westinghouse Hanford Company 222-S Laboratory, and the results were published in Bratzel (1985). Table B-1 contains the results from analyses of these samples. The second column displays the supernate results, while the third and fourth columns tabulate the results from centrifuged fractions of the sludge sample. The centrate is the centrifuged liquid, while the solids are centrifuged solids. The units used are those reported by the laboratory.

Table B-1. 1984 Analytical Results for Tank 241-AN-102.[1] (3 sheets)

Analyte	Supernate	Centrate	Solids
METALS	M	M	weight %
Al	0.537	0.538	1.4
Ba	< 1.25E-04	1.33E-04	< 0.0021
Ca	0.0123	0.0203	0.11
Cd	5.03E-04	4.48E-04	< 0.0085
Cr	0.00796	0.0101	0.085
Cu	< 5.41E-04	< 4.33E-04	0.0030
Fe	0.00180	0.00468	0.071
K	0.0531	0.0468	---
La	< 0.00114	< 9.10E-04	< 0.0085
Mg	3.57E-04	0.00378	0.0090
Mn	0.0184	< 0.0155	< 0.085
Mo	< 0.00895	< 0.00718	< 0.030
Na	10.4	40.6	3.5

Table B-1. 1984 Analytical Results for Tank 241-AN-102.[1] (3 sheets)

Analyte	Supernate	Centrate	Solids
METALS	**M**	**M**	**weight %**
Nd	---	---	< 0.017
Ni	0.00643	0.0655	0.037
Pb	< 0.00114	0.00105	---
Si	< 0.00561	< 0.00450	< 0.0085
Sr	---	---	5.8E-04
Zn	< 4.22E-04	7.00E-04	< 0.0038
Zr	< 0.00173	< 0.00139	< 0.026
IONS	**M**	**M**	**weight %**
Cl^-	0.0949	0.0903	< 0.23
CO_2^{3-}	0.840	1.46	3.13
F^-	< 0.118	< 0.132	---
NO_3^-	3.61	3.38	---
NO_2^-	1.32	1.28	---
OH^-	0.201	0.648	---
PO_4^{3-}	0.0473	0.0480	---
SO_4^{2-}	0.114	0.0196	---
RADIONUCLIDES	**μCi/L**	**μCi/L**	**μCi/g**
$^{239/240}Pu$	13.8	24.6	0.060 (Pu)
^{241}Am	147	268	0.38 (Am)
^{60}Co	551	635	---
^{137}Cs	3.10E+05	4.48E+05	410
^{154}Eu	850	---	---
^{155}Eu	1,260	---	---
$^{89/90}Sr$	1.24E+05	1.01E+05	160
U	0.0247 g/L	< 0.107 g/L	0.090 wt %
PHYSICAL PROPERTIES	**g/mL**	**g/mL**	**g/mL**
Specific gravity	1.39	1.39	---

Table B-1. 1984 Analytical Results for Tank 241-AN-102.[1] (3 sheets)

Analyte	Supernate	Centrate	Solids
CARBON	g C/L	g C/L	weight %
TOC	33.7	29.8	7.17

Note:

[1]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.

B.2 1989 GRAB SAMPLE RESULTS

A supernate sample was obtained from tank 241-AN-102 in 1989. Other than the Sample Status Report included as an attachment to Herting (1994), no other information was available. The sample was described as being dark brown and aqueous with solids present. The original Sample Status Report has been reproduced in Table B-2.

Table B-2. Analytical Results for 1989 Supernate Sample.[1] (2 sheets)

Analyte	Concentration
METALS	M
Al	0.460
B	0.00270
Ca	0.0101
Cr	0.00605
Cu	3.27E-04
Fe	0.00193
K	0.0407
La	1.26E-04
Na	7.65
Ni	0.00577
P	0.0497
ANIONS	M
CO_3^{2-}	1.10
NO_2^-	1.36
NO_3^-	3.54

Table B-2. Analytical Results for 1989 Supernate Sample.[1] (2 sheets)

Analyte	Concentration
RADIONUCLIDES	μCi/L
OH^-	0.445
^{241}Am	140
^{60}Co	324
^{137}Cs	4.00E+05
^{154}Eu	539
^{155}Eu	616
$^{239/240}Pu$	8.52
CARBON	g C/L
TOC	27.3
PROPERTIES	
Density	1.34 g/mL
pH	14

Notes:

[1]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.

B.3 1990 CORE SAMPLE RESULTS

Two three-segment core samples were obtained from riser 7A of tank 241-AN-102 on May 24, 1990. Surface and sludge levels at the time of the sampling event indicated almost two full segments of sludge and one full segment of supernate could be expected from each core (Strasser 1990). One core was shipped to the Pacific Northwest National Laboratory while the other was archived. Segment one of the analyzed core sample was described as a noncohesive slurry with a medium brown color. Segment two was semi-solid with a glossy surface and a sticky texture, becoming less cohesive in the upper 10 to 12 cm (4 to 5 in.). The color was mostly light brown, with the bottom 15 cm (6 in.) gray-brown. Segment three was entirely semi-glossy. The lowest 2.5 cm (1 in.) of the sample was dark brown and semi-solid, followed by a 3.8-cm (1.5-in.)-space with a trace of liquid. The space was followed by 5 cm (2 in.) of dark brown semi-solid waste, 15 cm (6 in.) of light brown semi-solid waste, and then 22 cm (8.5 in.) of light brown waste with the consistency of pudding.

The following three tables list analytical data that were obtained from analysis of the core sample. The sludge recovered was composited and then centrifuged, creating two fractions: a centrifuged solids sample and a centrifuged liquids sample. These two samples were chemically analyzed separately, and the two separate sets of results are presented in Tables B-3 and B-4. Table B-5 combines the data from the first two tables to present an estimate of the overall sludge concentration and a total inventory for the sludge layer. Although small quantities of dilute non-complexed waste and water were added to the tank after the 1990 core sample was taken, they did not contribute substantially to the contents of the sludge layer.

B.3.1 Centrifuged Solids Results

The analytical data from the 1990 sampling event for the chemical and radiochemical composition of the centrifuged solids portion of the sludge in tank 241-AN-102 are listed in Table B-3 (Douglas 1996). Table B-3 shows the analytes of interest, the concentrations as originally reported in mmol/g, and the concentrations converted to μg/g.

Table B-3. Centrifuged Solids Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
METALS	mmol/g[2]	μg/g[3]
Ag	< 1.8E-04	< 1.94
Al	0.54	14,600
As	< 0.0039	< 292
B	< 0.13	< 1,410
Ba	3.2E-04	43.9
Be	< 1.3E-04	< 1.17
Ca	0.087	3,490
Cd	< 2.4E-04	< 27.0
Ce	< 0.0051	< 715
Co	< 0.017	< 1,000
Cr	0.043	2,240
Cu	0.0014	89.0
Dy	< 1.5E-04	< 24.4
Fe	0.051	2,850
K	< 0.052	< 2,030
La	< 3.2E-04	< 44.5
Li	< 0.023	< 160

Table B-3. Centrifuged Solids Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
METALS	mol/g[2]	μg/g[2]
Mg	0.0084	204
Mn	0.015	824
Mo	4.6E-04	44.1
Na	14[3]	3.22E+05[3]
Nd	< 2.3E-04	< 33.2
Ni	0.0098[4]	575[4]
P	< 0.097	< 3,000
Pb	< 0.0018	< 373
Re	< 5.6E-04	< 104
Rh	< 0.0051	< 525
Ru	< 0.0039	< 394
Sb	< 0.0076	< 925
Se	< 0.014	< 1,110
Si	0.084	2,360
Sr	3.9E-04	34.2
Te	< 0.0027	< 345
Th	< 0.0020	< 464
Ti	< 9.4E-04	< 45.0
Tl	< 0.055	< 11,200
U[4]	0.012	2,860
V	< 5.2E-04	< 26.5
Zn	0.0021	137
Zr	0.011[3]	1,000[3]
IONS	mmol/g	μg/g
Cr^{6+}	< 5.8E-04	< 30.2
Br^-	< 0.01	< 799
Cl^-	0.081	2,870
F^-	< 0.01[6]	< 190[6]
NO_3^-	2.89	1.79E+05
NO_2^-	1.37	63,000

Table B-3. Centrifuged Solids Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
IONS	**mmol/g**	**µg/g**
PO_4^{3-}	0.038	3,610
SO_4^{2-}	0.46	44,200
RADIONUCLIDES		**µCi/g**[7]
^{241}Am		0.76 (0.99[8])
^{14}C		0.0019
^{144}Ce		< 1.8
^{242}Cm		Not Detected
$^{243/244}Cm$		0.059
^{60}Co		0.43
^{134}Cs		< 0.22
^{137}Cs		400
^{152}Eu		< 0.17
^{154}Eu		1.6
^{155}Eu		1.7
^{153}Gd		< 0.66
^{3}H		0.0035
^{94}Nb		3.1E-04
^{237}Np		0.0017
^{238}Pu		0.029
$^{239/240}Pu$		0.087
^{106}Ru		< 2.0
^{125}Sb		< 1.3
^{79}Se		0.0035
^{113}Sn		1.5
^{90}Sr		280
^{99}Tc		0.16
Total Beta		940
CARBON	**mmol C/g**	**µg C/g**
TIC	1.72	20,700
TOC	2.24	26,900

Table B-3. Centrifuged Solids Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
PHYSICAL PROPERTIES		
% Water by TGA		30
Density		1.7 g/mL

Notes:

[1]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.

[2]Average for the two independent analyses of the solids prepared by the two separate fusions.

[3]Single analysis from the KOH fusion in a nickel crucible.

[4]Single analysis from the NaOH fusion in a zirconium crucible.

[5]Reported uranium concentration determined by fluorescence.

[6]Matrix interference noted.

[7]Concentrations of fission products and total beta content decay corrected to January 1, 1991.

[8]Second concentration determined using gamma energy analysis.

B.3.2 Centrifuged Liquid Results

The analytical data from the 1990 sampling event for the chemical and radiochemical composition of the centrifuged liquid portion of the sludge in tank 241-AN-102 are listed in Table B-4 (Douglas 1996). Table B-4 shows the analytes of interest, the concentrations as originally reported in M or μCi/mL, and the concentrations converted to μg/g using the centrifuged liquid density of 1.4 g/mL.

Table B-4. Centrifuged Liquid Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
METALS	M	μg/g
Ag	< 1.5E-05	< 1.16
Al	0.48	9,250
As	1.9E-04	10.2
B	0.0032	24.7

Table B-4. Centrifuged Liquid Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
METALS	M	µg/g
Ba	2.6E-05	2.55
Be	2.2E-05	0.142
Ca	0.011	315
Cd	4.5E-04	36.1
Ce	< 1.6E-04	< 16.0
Co	< 7.3E-04	< 30.7
Cr	0.0077	286
Cu	4.6E-04	20.9
Dy	< 8.6E-06	< 0.998
Fe	0.0053	211
K	0.049	1,370
La	1.1E-04	10.9
Li	< 1.6E-04	< 0.793
Mg	3.3E-04	5.73
Mn	0.0013	51.0
Mo	4.9E-04	33.6
Na	7.6	1.25E+05
Nd	2.1E-04	21.6
Ni	0.0057	239
P	0.052	1,150
Pb	9.9E-04	147
Re	< 8.6E-06	< 1.14
Rh	< 1.2E-04	< 8.82
Ru	2.2E-04	15.9
Sb	< 9.0E-05	< 7.83
Se	< 1.4E-04	< 7.90
Si	0.0056	112
Sr	3.4E-05	2.13
Te	9.8E-05	8.93
Th	1.8E-04	29.8

Table B-4. Centrifuged Liquid Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
METALS	**M**	**µg/g**
Ti	< 2.5E-05	< 0.855
Tl	< 0.0016	< 234
U[2]	2.9E-05	4.93
V	< 2.2E-05	< 0.801
Zn	2.6E-04	12.1
Zr	1.6E-05	1.04
IONS	**M**	**µg/g**
Cr^{6+}	< 8.6E-05	< 3.19
Br^-	< 0.0002	< 11.4
Cl^-	0.042	1,060
F^-	0.13	1,760
NO_3^-	0.66	28,800
NO_2^-	0.30	9,860
PO_4^{3-}	0.034[3]	2,310
SO_4^{2-}	0.045	3,090
AMMONIA	**M**	**µg/g**
NH_3	0.0026	31.6
RADIONUCLIDES	**µCi/mL[4]**	**µCi/g[4]**
^{241}Am	0.089 (0.11[5])	0.0636 (0.0786[5])
^{14}C	7.1E-04	5.07E-04
^{144}Ce	< 0.26	< 0.186
^{242}Cm	5.0E-04	3.57E-04
$^{243/244}Cm$	0.0068	0.00486
^{60}Co	0.14	0.100
^{134}Cs	< 0.026	< 0.0186
^{137}Cs	200	143
^{152}Eu	< 0.0076	< 0.00543
^{154}Eu	0.30	0.214
^{155}Eu	0.33	0.236
^{153}Gd	< 0.10	< 0.0714

Table B-4. Centrifuged Liquid Results from the 1990 Sampling Event for Tank 241-AN-102.[1] (4 sheets)

Analyte	Concentration	Concentration
RADIONUCLIDES	μCi/mL[4]	μCi/g[4]
^{3}H	0.0018	0.00129
^{94}Nb	6.5E-06	4.64E-06
^{237}Np	< 2.3E-06	< 1.64E-06
^{238}Pu	0.024	0.0171
$^{239/240}Pu$	0.070	0.0500
^{106}Ru	< 0.28	< 0.200
^{125}Sb	< 0.15	< 0.107
^{79}Se	1.7E-04	1.21E-04
^{113}Sn	< 0.42	< 0.300
^{90}Sr	45	32.1
^{99}Tc	0.030	0.0214
Total beta	2,700	1,930
CARBON	M	μg C/g
TIC	0.23	1,970
TOC	0.37	3,170
PHYSICAL PROPERTIES		
Density		1.4 g/mL

Notes:

[1]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.

[2]Reported uranium concentration determined by fluorescence.

[3]Matrix interference noted.

[4]Concentrations of fission products and total beta content decay corrected to January 1, 1990.

[5]Second concentration determined using gamma energy analysis.

B.3.3 Combined Sludge Results

Table B-5 combines the results presented in Tables B-3 and B-4 (shown in Table B-5 in columns two and three, respectively), in order to estimate the total concentration of a given analyte in the sludge layer (column four). A weighted mean was calculated using the results from each centrifuged fraction and multiplying by the respective weight percent that each fraction represented in the composite. The total calculated sludge concentration was derived by multiplying the centrifuged solids concentration by the value of weight percent centrifuged solids (55.4 percent). Similarly, the centrifuged liquid concentration was multiplied by 44.6 percent. These two values were then added to arrive at the overall sludge number, listed in column four of Table B-5. For example, using the values for aluminum in Table B-5, column four would be derived by the following calculation:

$$\text{Sludge Aluminum Concentration} = \left[\frac{14{,}600\ \mu g}{g}\right] * (0.554) + \left[\frac{9{,}250\ \mu g}{g}\right] * (0.446)$$

The estimated total inventory for a given analyte with respect to the sludge layer is then given in column five. The total inventory estimates were calculated by the following equation for the metals and ions:

$$\text{Concentration} \left[\frac{\mu g}{g}\right] * \left[\frac{1\ kg}{1.0E{+}09\ \mu g}\right] * (5.06E{+}08\ g) = \text{Sludge Inventory (kg)}$$

For the radionuclides, the conversion formula used was:

$$\text{Concentration} \left[\frac{\mu Ci}{g}\right] * \left[\frac{1\ Ci}{1.0E{+}06\ \mu Ci}\right] * (5.06E{+}08\ g) = \text{Sludge Inventory (Ci)}$$

For TIC and TOC, the conversion formula used was:

$$\text{Concentration} \left[\frac{\mu g\ C}{g}\right] * \left[\frac{1\ kg\ C}{1.0E{+}09\ \mu g\ C}\right] * (5.06E{+}08\ g) = \text{Sludge Inventory (kg C)}$$

Table B-5. Calculated Sludge Results for Tank 241-AN-102[1]. (4 sheets)

Analyte	Centrifuged Solids Concentration	Centrifuged Liquid Concentration	Calculated Sludge Concentration	Total Projected Sludge Inventory
METALS	µg/g	µg/g	µg/g	kg
Ag	< 1.94	< 1.16	< 1.59	< 0.805
Al	14,600	9,250	12,200	6,170
As	< 292	10.2	< 166	< 84.0
B	< 1,410	24.7	< 792	< 401
Ba	43.9	2.55	25.5	12.9
Be	< 1.17	0.142	< 0.712	< 0.360
Ca	3,490	315	2,070	1,050

Table B-5. Calculated Sludge Results for Tank 241-AN-102[1]. (4 sheets)

Analyte	Centrifuged Solids Concentration	Centrifuged Liquid Concentration	Calculated Sludge Concentration	Total Projected Sludge Inventory
METALS	µg/g	µg/g	µg/g	kg
Cd	< 27.0	36.1	< 31.1	< 15.7
Ce	< 715	< 16.0	< 403	< 204
Co	< 1,000	< 30.7	< 568	< 287
Cr	2,240	286	1,370	693
Cu	89.0	20.9	58.6	29.7
Dy	< 24.4	< 0.998	< 14.0	< 7.08
Fe	2,850	211	1,670	845
K	< 2,030	1,370	< 1,740	< 880
La	< 44.5	10.9	< 29.5	< 14.9
Li	< 160	< 0.793	< 89.0	< 45.0
Mg	204	5.73	116	58.7
Mn	824	51.0	479	242
Mo	44.1	33.6	39.4	19.9
Na	3.22E+05	1.25E+05	2.34E+05	1.18E+05
Nd	< 33.2	21.6	< 28.0	< 14.2
Ni	575	239	425	215
P	< 3,000	1,150	< 2,170	< 1,100
Pb	< 373	147	< 272	< 138
Re	< 104	< 1.14	< 58.1	< 29.4
Rh	< 525	< 8.82	< 295	< 149
Ru	< 394	15.9	< 225	< 114
Sb	< 925	< 7.83	< 516	< 261
Se	< 1,110	< 7.90	< 618	< 313
Si	2,360	112	1,360	688
Sr	34.2	2.13	19.9	10.1
Te	< 345	8.93	< 195	< 98.7
Th	< 464	29.8	< 270	< 137
Ti	< 45.0	< 0.855	< 25.3	< 12.8
Tl	< 11,200	< 234	< 6,310	< 3,190

Table B-5. Calculated Sludge Results for Tank 241-AN-102[1]. (4 sheets)

Analyte	Centrifuged Solids Concentration	Centrifuged Liquid Concentration	Calculated Sludge Concentration	Total Projected Sludge Inventory
METALS	**µg/g**	**µg/g**	**µg/g**	**kg**
U[4]	2,860	4.93	1,590	< 805
V	< 26.5	< 0.801	< 15.0	< 7.59
Zn	137	12.1	81.3	41.1
Zr	1,000	1.04	554	280
IONS	**µg/g**	**µg/g**	**µg/g**	**kg**
Br^-	< 799	< 11.4	< 448	< 227
Cl^-	2,870	1,060	2,060	1,040
Cr^{6+}	< 30.2	< 3.19	< 18.2	< 9.21
F^-	< 190	1,760	< 890	< 450
NO_3^-	1.79E+05	28,800	1.12E+05	56,700
NO_2^-	63,000	9,860	39,300	19,900
PO_4^{-3}	3,610	2,310	3,030	1,530
SO_4^{-2}	44,200	3,090	25,900	13,100
RADIONUCLIDES	**µCi/g**	**µCi/g**	**µCi/g**	**Ci**
^{241}Am	0.99[2]	0.0786[1]	0.584	296
^{14}C	0.0019	5.07E-04	0.00128	0.648
^{144}Ce	< 1.8	< 0.186	< 1.08	< 547
^{242}Cm	Not Detected	3.57E-04	1.59E-04	0.0805
$^{243/244}Cm$	0.059	0.00486	0.0349	17.7
^{60}Co	0.43	0.100	0.283	143
^{134}Cs	< 0.22	< 0.0186	< 0.130	< 65.8
^{137}Cs	400	143	285	1.44E+05
^{152}Eu	< 0.17	< 0.00543	< 0.0966	< 48.9
^{154}Eu	1.6	0.214	0.982	497
^{155}Eu	1.7	0.236	1.05	531
^{153}Gd	< 0.66	< 0.0714	< 0.397	< 201
^{3}H	0.0035	0.00129	0.00251	1.27
^{94}Nb	3.1E-04	4.64E-06	1.74E-04	0.0880
^{237}Np	0.0017	< 1.64E-06	< 9.43E-04	< 0.477

Table B-5. Calculated Sludge Results for Tank 241-AN-102[1]. (4 sheets)

Analyte	Centrifuged Solids Concentration	Centrifuged Liquid Concentration	Calculated Sludge Concentration	Total Projected Sludge Inventory
RADIONUCLIDES	μCi/g	μCi/g	μCi/g	Ci
^{238}Pu	0.029	0.0171	0.0237	12.0
$^{239/240}Pu$	0.087	0.0500	0.0705	35.7
^{106}Ru	< 2.0	< 0.200	< 1.20	< 607
^{125}Sb	< 1.3	< 0.107	< 0.768	< 389
^{79}Se	0.0035	1.21E-04	0.00199	1.01
^{113}Sn	1.5	< 0.300	< 0.965	< 488
^{90}Sr	280	32.1	169	85,500
^{99}Tc	0.16	0.0214	0.0982	49.7
Total Beta	940	1,930	1,380	6.98E+05
PHYSICAL PROPERTIES				
Percent water	40.3[3]			2.04E+05
Density	1.7 g/mL	1.4 g/mL	1.5[4] g/mL	
CARBON	μg C/g	μg C/g	μg C/g	kg C
TIC	20,700	1,970	12,300	6,220
TOC	26,900	3,170	16,300	8,250

Notes:

[1]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.

[2]Based on gamma energy analysis data in order to provide the most conservative estimate.

[3]The weight percent water for the sludge was taken from a percent solids determination on the core composite (done by drying at 105 °C [221 °F] for 24 hr). A weight percent water mean based on TGA data could not be calculated because TGA was not performed on the centrifuged liquid.

[4]The reported density value is from a density determination on the core composite; it was not calculated by taking a weighted mean from the centrifuged solids and centrifuged liquid results.

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