Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

DEC 1 0 1995

95-TSD-147

Mr. John T. Conway, Chairman
Defense Nuclear Facilities Safety Board
625 N. Indiana Avenue, N.W., Suite 700
Washington, D.C. 20004

Dear Mr. Conway:

FERROCYANIDE SAFETY PROGRAM: STATUS OF 90-7 PROGRAM PLAN MILESTONES 3.4.5.1.1.C, 3.4.5.1.1.D, AND 3.4.5.1.1.E

References: (1) DOE/RL-94-110, Rev. 1, "Program Plan for Resolution of the Ferrocyanide Waste Tank Safety Issue at the Hanford Site," U.S. Department of Energy, Richland, Washington, dated October 1994.

(2) WHC-EP-0474-17, "Quarterly Report on the Ferrocyanide Safety Program for the Period Ending June 30, 1995," Westinghouse Hanford Company, Richland, Washington, dated July 1995.

(3) WHC-EP-0474-18, "Quarterly Report on the Ferrocyanide Safety Program for the Period Ending September 30, 1995," Westinghouse Hanford Company, Richland, Washington, dated October 1995.

This letter provides notification that 90-7 Fiscal Year (FY) 1995 Milestone 3.4.5.1.1.C, listed in the Ferrocyanide Safety Program Plan, Reference 1, will be completed February 16, 1996. This is due to equipment failure, modification, and staff retraining. Notification that this milestone would be delayed was provided earlier via quarterly reports, References 2 and 3, in accordance with the change control provisions, Section 3.7.2, of Reference 1.

Further, this letter transmits the third report (for Tank 241-C-108) of a set of four tank characterization reports. The U.S. Department of Energy, Richland Operations Office, has approved the enclosed report.

In addition, this letter advises the Defense Nuclear Facilities Safety Board (DNFSB) that work towards completing the FY 1996 90-7 Milestones 3.4.5.1.1.D and 3.4.5.1.1.E is currently on hold. This is because flammable gas controls were placed on all 177 Hanford tanks, which suspended rotary core sampling until the Safety Assessment for sampling flammable gas tanks is prepared and approved. Sampling by rotary mode will be rescheduled when this safety issue is resolved. A schedule for safety issue resolution is being developed and will be transmitted by the end of December. The subject milestones are interim milestones on the path to closure of Part 4 of DNFSB Recommendation 90-7.

If you have any questions, please contact me on (509) 376-7395 or your staff may contact Mr. Jackson Kinzer, Assistant Manager, Tank Waste Remediation System on (509) 376-7591.

Sincerely,

John D. Wagoner
Manager

TSD:MFJ

Enclosure

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WHC-SD-WM-ER-503
Revision 0
UC-2070

Tank Characterization Report for Single-Shell Tank 241-C-108

Date Published
September 1995

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

Westinghouse Hanford Company
P.O Box 1970
Richland, Washington

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

EXECUTIVE SUMMARY

This Tank Characterization Report summarizes the information on the historical uses, current status, and sampling and analysis results of waste stored in single-shell underground storage tank 241-C-108. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994),[1] Milestone M-44-09, and the Ferrocyanide Tank Safety Program Milestone T2B-95-123 (Jordan 1994).[2]

Tank 241-C-108 is one of 16 single-shell tanks located in the 200 East Area C Tank Farm at the Hanford Site. It is the second tank of the three-tank cascade (tanks 241-C-107 to 241-C-108 to 241-C-109). The tank went into service in September 1947 and received cascade overflow from tank 241-C-107 until March 1948 and again in 1952. The tank was declared inactive in 1977. The tank received five major types of waste throughout its service life: first-cycle decontamination (1C) waste from the bismuth phosphate process, waste from the uranium recovery process, scavenged ferrocyanide sludge, Plutonium-Uranium Extraction (Facility) (PUREX) cladding wastes, and Hot Semiworks Plant waste. The Tank Layer Model predicts that the sludge currently in the tank is composed of an upper ferrocyanide waste layer, a middle uranium recovery waste layer, and a bottom layer of 1C waste.[3]

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[1]Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

[2]Jordan, K. N., 1994, *Tank Waste Remediation System Multi-Year Work Plan*, WHC-SP-1101, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[3]Agnew, S. F., P. Baca, R. Corbin, K. Jurgensen, and B. Young, 1995, *Tank Layer Model for Northeast, Southwest, and Northwest Quadrants*, LAUR-94-4269, Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico.

Salt-well pumping occurred from 1976 through 1978. Intrusion prevention was completed by December 1982. A level adjustment was made in February 1984, and interim stabilization was completed in March 1984 (this was performed on an administrative level because of the limited volume of pumpable liquid in the tank at the time).

A description and status of tank 241-C-108 are summarized in Table ES-1 and Figure ES-1. The tank is on the Ferrocyanide Watch List, and is considered to not have leaked, nor be leaking. It has a capacity of 2,010 kL (530 kgal) and currently contains 250 kL (66 kgal)[1] of sludge. Tank 241-C-108 was push-mode core sampled in June 1994.[2] However, because only a small amount of sample was retrieved, three auger samples were collected in November and December 1994.[3] Sampling and analysis procedures are discussed in detail in WHC-SD-WM-TI-648, *Tank Characterization Reference Guide* (De Lorenzo et al. 1994).[4] Estimates of concentrations and projected inventories for major analytes and analytes of concern are summarized in Table ES-2. Because of the apparent heterogeneity of the waste, the data in Table ES-2 should only be considered rough estimates.

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[1]Hanlon, B. M., 1995, *Waste Tank Summary Report for Month Ending June 30, 1995*, WHC-EP-0182-87, Westinghouse Hanford Company, Richland, Washington.

[2]Schreiber, R. D., 1994a, *Tank 241-C-108 Tank Characterization Plan*, WHC-SD-WM-TP-211, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[3]Schreiber, R. D., 1994b, *Tank 241-C-108 Tank Characterization Plan*, WHC-SD-WM-TP-211, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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

Table ES-1. Description and Status of Tank 241-C-108.

Tank description	
Type:	Single shell
Constructed:	1944
In-service:	1947
Diameter:	23 m (75 ft)
Operating depth:	5.2 m (17 ft)
Capacity:	2,010 kL (530 kgal)
Bottom shape:	Dish
Ventilation:	Passive
Tank status	
Total waste volume:	250 kL (66 kgal)
Sludge volume:	250 kL (66 kgal)
Waste surface level:	48.3 cm (19.0 in.) as of 07/2/95
Temperature:	17 °C (81 °F) to 33 °C (79 °F) from 1/1/90 to 9/1/95
Integrity:	Sound
Watch List:	Ferrocyanide
Sampling dates	
Core sampled:	June 1994
Auger sampled:	November and December 1994
Service status	
Removed from service:	1976
Declared inactive:	1977
Intrusion prevention:	1982
Interim stabilized:	1984

C = Celsius
cm = centimeters
ft = feet
kgal = kilogallons
kL = kiloliters
m = meters
F = Fahrenheit

Figure ES-1. Tank 241-C-108 Riser Configuration and Waste Profile.

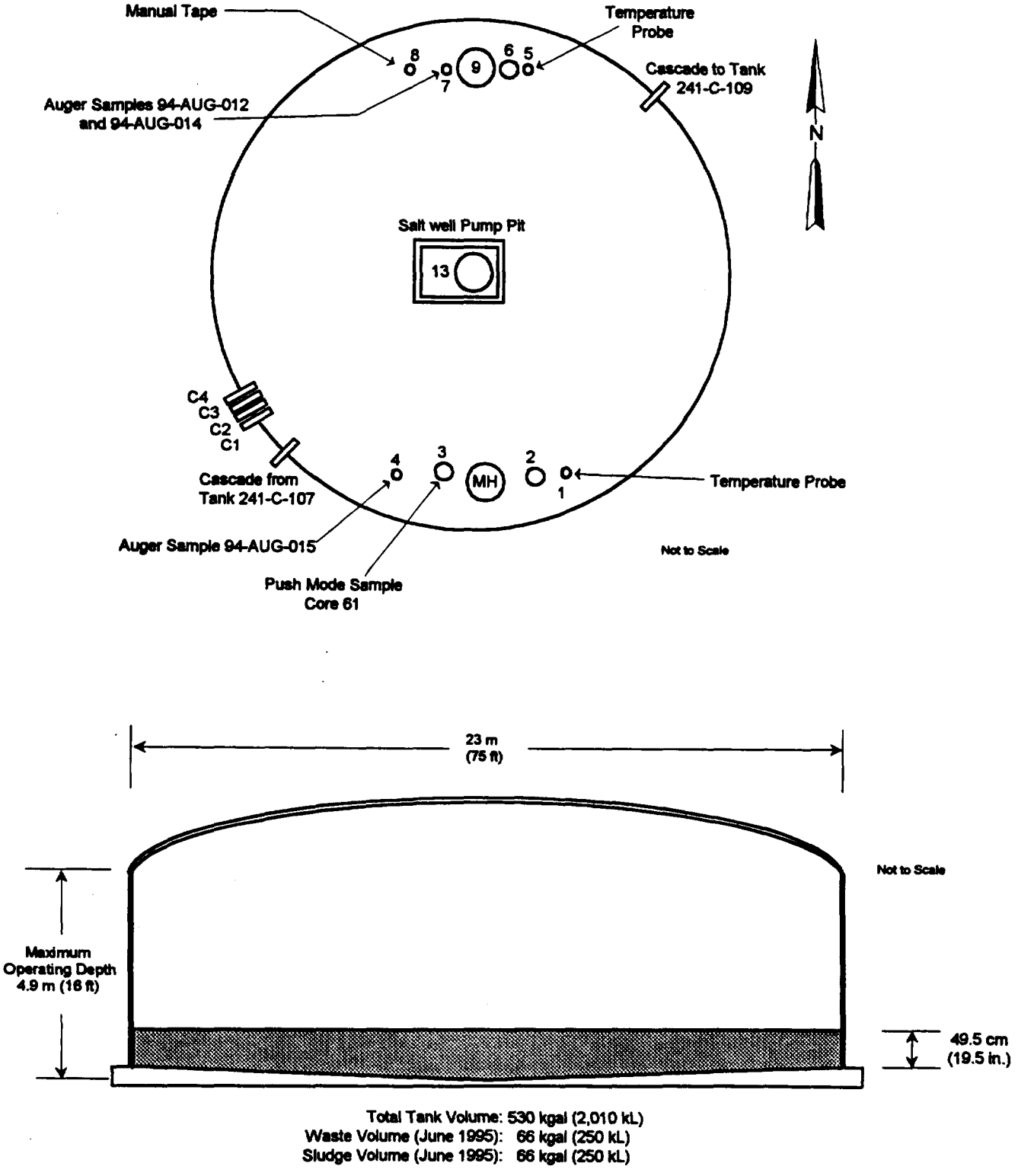

Table ES-2. Single-Shell Tank 241-C-108 Average Concentrations and Inventories for Major Analytes and Analytes of Concern.[c] (sheet 1 of 2)

Physical properties	Results		
Density[a]	1.40 g/mL		
Percent water	38.8 (RSD [Mean] = 29.0)[d,e]		
Heat load	492 W (1,680 Btu/h)		
Chemical constituents	**Concentration**	**RSD (Mean)[e]**	**Projected inventory**
Metals	**(μg/g)**	**(%)**	**(kg)**
Aluminum	52,100	24.2	18,200
Calcium	12,700	33.5	4,450
Iron	7,170	24.5	2,510
Nickel	8,410	23.7[d]	2,940
Phosphorus	26,800	35.0	9,380
Sodium	94,100	22.7	32,900
Anions	**(μg/g)**	**(%)**	**(kg)**
CN^{-}[b]	1,980	51.6[d]	693
Cl^{-}	725	1.6	254
F^{-}	3,770	35.8	1,320
NO_3^{-}	44,600	7.4	15,600
NO_2^{-}	24,700	6.7	8,650
PO_4^{3-}	80,600	33.2	28,200
Radionuclides	**(μCi/g)**	**(%)**	**(Ci)**
^{137}Cs	259	30.3[d]	90,700
^{90}Sr	27.0	28.0[d]	9,450
$^{239/240}Pu$	0.00936	20.2	3.28
Uranium	421 (μg/g)	15.3	147 (kg)
Total alpha	<0.0511	-	<17.9
Total beta	200	45.8	70,000

Example Calculation:

For aluminum

$$(52{,}100\ \mu g/g)(1.40\ g/mL)(1{,}000\ mL/L)(250{,}000\ L)\left(\frac{1\ kg}{1 \times 10^{9}\ \mu g}\right) = 18{,}200$$

Table ES-2. Single-Shell Tank 241-C-108 Average Concentrations and Inventories for Major Analytes and Analytes of Concern.[c] (sheet 2 of 2)

Chemical constituents	Concentration	RSD (Mean)[e]	Projected inventory
Total carbon	(μg/g)	(%)	(kg)
Total organic carbon	1,250	29.3	438
Total inorganic carbon	2,380	0.84	833

[a]Brevick, C. H., L. A. Gaddis, and W. W. Pickett, 1994, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Areas, ICF Kaiser Hanford Company*, WHC-SD-WM-ER-349, Rev. 0A, ICF Kaiser Hanford Company, Richland, Washington. {Data not verified use with caution}

[b]Reported on a wet weight basis.

[c]Data reported are from the 1994 auger sample analysis event unless otherwise noted.

[d]These values were computed on data other than composites.

[e]In order to calculate the RSD for the composite analytical results, the overall mean and the means from each of the two sample and duplicate pairs (one for each riser) must first be calculated. Using aluminum as an example (overall mean of 52,100 μg/g), and the mean of the sample duplicate from riser 7 was 64,650 μg/g, and the mean from riser 4 was 39,450 μg/g. The calculation is then as follows:

$$\left(\frac{\sqrt{[2(64{,}650 - 52{,}100)^2 + 2(39{,}450 - 52{,}100)^2] / 4}}{52{,}100} \right) * 100$$

Btu/h = British thermal units/h
Ci = Curies
μCi/g = microcuries per gram
μg/g = micrograms per gram
kg = kilograms
g/mL = grams per milliliter
W = Watts
RSD = Relate Standard Deviation of the Mean

The push-mode and auger sampling analysis events, on which the waste characterization presented in this report are based, were performed in accordance with WHC-SD-WM-SP-004, *Tank Safety Screening Data Quality Objective* (Safety Screening DQO) (Babad and Redus 1994)[1] and WHC-SD-WM-DQO-007, *Data Requirements for the*

[1]Babad, H. and K. S. Redus, 1994, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Ferrocyanide Safety Issue Developed through the Data Quality Objective Process (Ferrocyanide Safety Program DQO) (Meacham et al. 1994).[1] Auger samples were collected from at least two widely-spaced risers.

The differential scanning calorimetry measurements did not identify any exothermic reactions above the 481 J/g safety screening notification limit.

Thermogravimetric analyses indicate that the water content is above the 17 percent minimum threshold except for two subsamples derived from auger sample 94-AUG-012. The first sample exhibited results between 15.4 and 2.99 wt% H_2O. The second sample exhibited results between 9.94 and 27.7 wt% H_2O.

Cyanide analyses exhibited a range of 781 μg/g to 5,050 μg/g, far below the 39,000 μg/g notification limit as listed in WHC-SD-WM-TP-211, *Tank 241-C-108 Tank Characterization Plan* (Schreiber 1994).[2]

The heat load of 492 W (1,680 Btu/h) is much less than the criterion of 11,700 W (40,000 Btu/h) used to distinguish a high-heat tank from a low-heat tank.

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[1]Meacham, J. E., R. J. Cash, G. T. Dukelow, H. Babad, J. W. Buck, C. M. Anderson, B. A. Pulsipher, J. J. Toth, and P. J. Turner, 1994, *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objective Process*, WHC-SD-WM-DQO-007, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[2]Schreiber, R. D., 1994, *Tank 241-C-108 Tank Characterization Plan*, WHC-SD-WM-TP-211, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Plutonium-239/240 analyses exhibited results of 0.00936 μCi/g, which are several orders of magnitude lower than the tank safety screening limit of 43.9 μCi/g.

In addition, tank 241-C-108 was vapor sampled in August 1994 in accordance with WHC-SD-WM-DQO-002, *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution, March 7, 1994* (Osborne et al. 1994).[1] Results from this vapor sampling event are reported in WHC-SD-WM-ER-423, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report* (Huckaby 1995).[2] All gases and vapors of concern showed concentrations lower than the safety screening limit of 25 percent of the lower flammability limit.

[1]Osborne, J. W., J. L. Huckaby, T. P. Rudolph, E. R. Hewitt, D. D. Mahlum, J. Y. Young, and C. M. Anderson, 1994, *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution, March 7, 1994*, WHC-SD-WM-DQO-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[2]Huckaby, J. L., 1995, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-423, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

CONTENTS

CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

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LIST OF TERMS

ANOVA	analysis of variance
CAS	Chemical Abstracts Service
CWP	PUREX cladding waste
DBP	Dibutylphosphate
DQO	data quality objective
DSC	differential scanning calorimetry
EDTA	Ethylenediametetraacetic acid
EPA	Environmental Protection Agency
GEA	gamma energy analysis
HDW	Hanford Defined Waste
HEDTA	N-(hydroxyethyl)-ethylenediaminetriacetic acid
HS	Hot Semiworks
HTCE	Historical Tank Content Estimate
IC	ion chromatography
ICP	inductively coupled plasma
LFL	lower flammability limit
MS	mass spectrometry
NPH	normal paraffin hydrocarbon
NTA	Nitrilotriacetate
OGIST	Oregon Graduate Institute of Science and Technology
ORNL	Oak Ridge National Laboratory
PNL	Pacific Northwest Laboratory
ppm	parts per million
ppmv	parts per million by volume
PUREX	Plutonium-Uranium Extraction (Facility)
RPD	relative percent difference
RSD	relative standard deviation
SNL	Sandia National Laboratory
SST	single-shell tank
TCP	tank characterization plan
TCR	Tank Characterization Report
TFeCN	in-farm ferrocyanide scavenging
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	Tank Layer Model
TMACS	Tank Monitoring and Control System
TOC	total organic carbon
TST	triple sorbent trap
UR	uranium recovery
WHC	Westinghouse Hanford Company
WSTRS	Waste Status and Transaction Record Summary
1C	first-cycle decontamination

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TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-C-108

1.0 INTRODUCTION

This Tank Characterization Report (TCR) presents an overview of single-shell tank (SST) 241-C-108 and its waste contents. It provides estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities and background tank information. This TCR describes the results of three auger samples, a core sample, and headspace gas and vapor samples, all taken in 1994.

Tank 241-C-108 began operation in 1947 and received waste until it was removed from service during the first quarter of 1976. Interim stabilization and intrusion prevention of the tank were completed in 1984 and 1982 respectively, therefore, the composition of the waste should not change until pretreatment and retrieval activities commence. The concentrations reported in this document reflect best composition estimates of the waste based on the available data. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994), Milestone M-44-09, and the Ferrocyanide Tank Safety Program Milestone T2B-95-123 (Jordan 1994). Tank 241-C-108 is on the Ferrocyanide Watch List.

1.1 PURPOSE

The primary purpose of this TCR is to summarize the information concerning the use and the contents of tank 241-C-108. Where possible, this information will be used to assess issues associated with safety, operations, and process development activities. This TCR also provides a reference point for more detailed information concerning tank 241-C-108.

1.2 SCOPE

The core and auger samples discussed in this report were obtained in accordance with WHC-SD-WM-TP-211, *Tank 241-C-108 Tank Characterization Plan* (Schreiber 1994a, 1994b). These samples were subsequently analyzed according to WHC-SD-WM-SP-004, *Tank Safety Screening Data Quality Objective* (Safety Screening DQO) (Babad and Redus 1994). Because tank 241-C-108 is on the Ferrocyanide Watch List, the acquisition and analysis of the samples are also governed by WHC-SD-WM-DQO-007, *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objective Process* (Ferrocyanide Safety Program DQO) (Meacham et al. 1994). Sampling and analysis activities are therefore focused on either the verification of the Watch List tank status or identification of any unknown safety issues associated with the tank. The sampling events include a core sample taken on June 2, 1994; two auger samples collected on

November 18, 1994; and an auger sample obtained on December 12, 1994. Analyses addressed eight primary parameters: energetics, percent water, cyanide content, metals content (by inductively coupled plasma procedure), total alpha activity, total organic carbon content, gamma energy level, and total beta activity.

The headspace gas and vapor samples discussed in this report were collected and analyzed in accordance with WHC-SD-WM-DQO-002, *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution, March 7, 1994* (Osborne and Story 1994) to help determine the potential risks to tank farm workers from potential fugitive emissions from the tank. The drivers and objectives of waste tank headspace sampling and analysis are discussed in WHC-EP-0526, *Program Plan for the Resolution of Tank Vapor Issues* (Osborne and Huckaby 1994). Detailed analytical results of the vapor samples obtained from this tank are reported in WHC-SD-WM-ER-423, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report* (Huckaby 1995a).

2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-C-108 based on historical information. The first part details the current condition of the tank, followed by discussions of tank background, transfer history, and process sources that contributed to the tank's waste, including an estimate of the current contents. Events that may be related to tank safety issues, such as potentially hazardous tank contents (e.g., ferrocyanide, and organics) or off-normal operating temperatures, are included. The final part summarizes surveillance data available for the tank. Surface-level data are used to assess tank integrity (e.g., detect leaks) and to provide clues to internal activity in the solid layers of the tank (e.g., shrinkage from drying). Temperature data are provided to evaluate the heat-generating characteristics of the waste.

2.1 TANK STATUS

As of June 30, 1995, tank 241-C-108 contained 250 kL (66 kgal) of noncomplexed waste (Hanlon 1995). The volume of the various waste phases found in the tank are shown in Table 2-1.

As shown in Table 2-1, the waste is comprised entirely of sludge with no pumpable liquid remaining. Further, Hanlon (1995) has listed this tank on the Ferrocyanide Watch List since January 1991 and identifies it as a low heat-load tank. The tank is categorized as sound. The tank has been interim stabilized, and intrusion prevention has been completed.

2.2 TANK DESIGN AND BACKGROUND

The 241-C Tank Farm is a first-generation tank farm built between 1943 and 1944. It consists of 12 2,010-kL (530-kgal) tanks and four 208-kL (55-kgal) tanks. These tanks were designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F). As with all first-generation tank farms, equipment to monitor and maintain the waste is sparse. A typical C Farm tank contains 9 to 13 risers ranging in size from 100 mm (4 in.) to 1.07 m (42 in.) in diameter, which provide surface-level access to the underground tank. Generally, there is one riser through the center of the tank dome, five each on opposite sides of the tank, and the remaining one to three risers scattered around the dome.

Tank 241-C-108 entered service in September 1947 and is second in a three-tank cascading series. The tanks are connected in step series by a cascade line 76 mm (3 in.) in diameter. The cascade overflow height is approximately 4.78 m (188 in.) from the tank bottom and 60 cm (2 ft) below the top of the steel liner. The SST is constructed of reinforced concrete with a mild carbon steel liner on the bottom and sides, and a domed concrete top. The tank has a dished bottom with a 1.2 m (4-ft) radius knuckle. The tank is set on a reinforced concrete foundation.

Table 2-1. Summary of Tank Contents.[1]

Waste form	Volume kL (kgal)
Total waste	250 (66)
Supernate	0 (0)
Drainable interstitial liquid	0 (0)
Drainable liquid remaining	0 (0)
Pumpable liquid remaining	0 (0)
Sludge	250 (66)
Salt cake	0 (0)

[1]Hanlon, B. M., 1995, *Waste Tank Summary Report for Month Ending June 30, 1995,* WHC-EP-0182-87, Westinghouse Hanford Company, Richland, Washington.

The surface level of the waste is monitored through riser 8 using a manual tape gauge. This tank is passively ventilated through a breather filter located on riser 4. A list of tank 241-C-108 risers, including size and general description, is provided in Table 2-2. A plan view depicting the riser configuration is shown as Figure 2-1.

A tank cross-section showing the approximate waste level along with a schematic of the tank equipment is found in Figure 2-2. Of the nine risers for tank 241-C-108, only three risers (3, 6, and 7) were deemed acceptable from which to obtain samples (Schreiber 1994a, 1994b).

The locations in the tank wall of the cascade overflow inlet, overflow outlet, and four spare nozzles are depicted in Figures 2-1 and 2-2.

2.3 PROCESS KNOWLEDGE

This section presents the transfer history of tank 241-C-108 and an estimation of the tank contents based on its process history. Ferrocyanide was introduced to the tank during an in-farm campaign to scavenge the cesium as insoluble cesium nickel ferrocyanide.

2.3.1 Waste Transfer History

Although construction of tank 241-C-108 was completed in 1944, the tank received no waste until 1947. First-cycle decontamination (1C) waste from the bismuth phosphate process began cascading from tank 241-C-107 during the third quarter of 1947 (Agnew et al. 1994). Tank 241-C-108 was filled, and waste began overflowing via the cascade line to tank 241-C-109 during the second quarter of 1948. The entire cascade was filled by September 1948.

Table 2-2. Tank 241-C-108 Risers.[1]

Riser number	Diameter (in.)	Description and comments
R1	4	New Thermocouple tree (installed July 26, 1993)
R2	12	Recirculating dip tubes (benchmark)
R3	12	Flange with lead
R4	4	Breather filter
R5	4	Temperature probe
R6	12	Flange with lead
R7	12	Flange with lead/B-222 observation port
R8	4	Manual tape
R13	12	Salt well riser (weather covered)
A	3	Cascade overflow nozzle
B	3	Cascade inlet nozzle
C1	3	Spare nozzle
C2	3	Spare nozzle
C3	3	Spare nozzle
C4	3	Spare nozzle

[1]Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-RE-TI-053, Rev. 9, Westinghouse Hanford Company, Richland, Washington.

Supernate was pumped from tank 241-C-108 during the second quarter of 1952, leaving behind about 129 kL (34 kgal) of waste. The tank began receiving uranium recovery (UR) waste via the cascade line from tank 241-C-107 during the fourth quarter of 1952. During the first quarter of 1953, the tank was filled and the waste began cascading to tank 241-C-109. After the second quarter of 1953, the tank received no further transfers of UR waste.

UR waste from tank 241-C-108 was transferred to tanks 241-C-109 and 241-C-111 for in-tank ferrocyanide scavenging during the first quarter of 1956. Agnew (1993) estimates a layer of about 170 kL (45 kgal) of solids settled from the UR waste in tank 241-C-108. This layer would have been added to another layer of about 68 kL (18 kgal) of 1C solids predicted to have settled on the bottom of the tank during its early history.

Beginning in May 1955, UR was routed to the 244-CR Vault for scavenging with nickel ferrocyanide (Simpson et al. 1993). The scavenged waste was returned to tanks to allow the waste to settle; was then be sampled and decanted to a crib (for a further discussion of ferrocyanide scavenging, see WHC-SD-WM-TI-648, *Tank Characterization Reference Guide* [De Lorenzo et al. 1994]). Tank 241-C-108 was used as a primary settling tank from the

Figure 2-1. Tank 241-C-108 Riser Location.

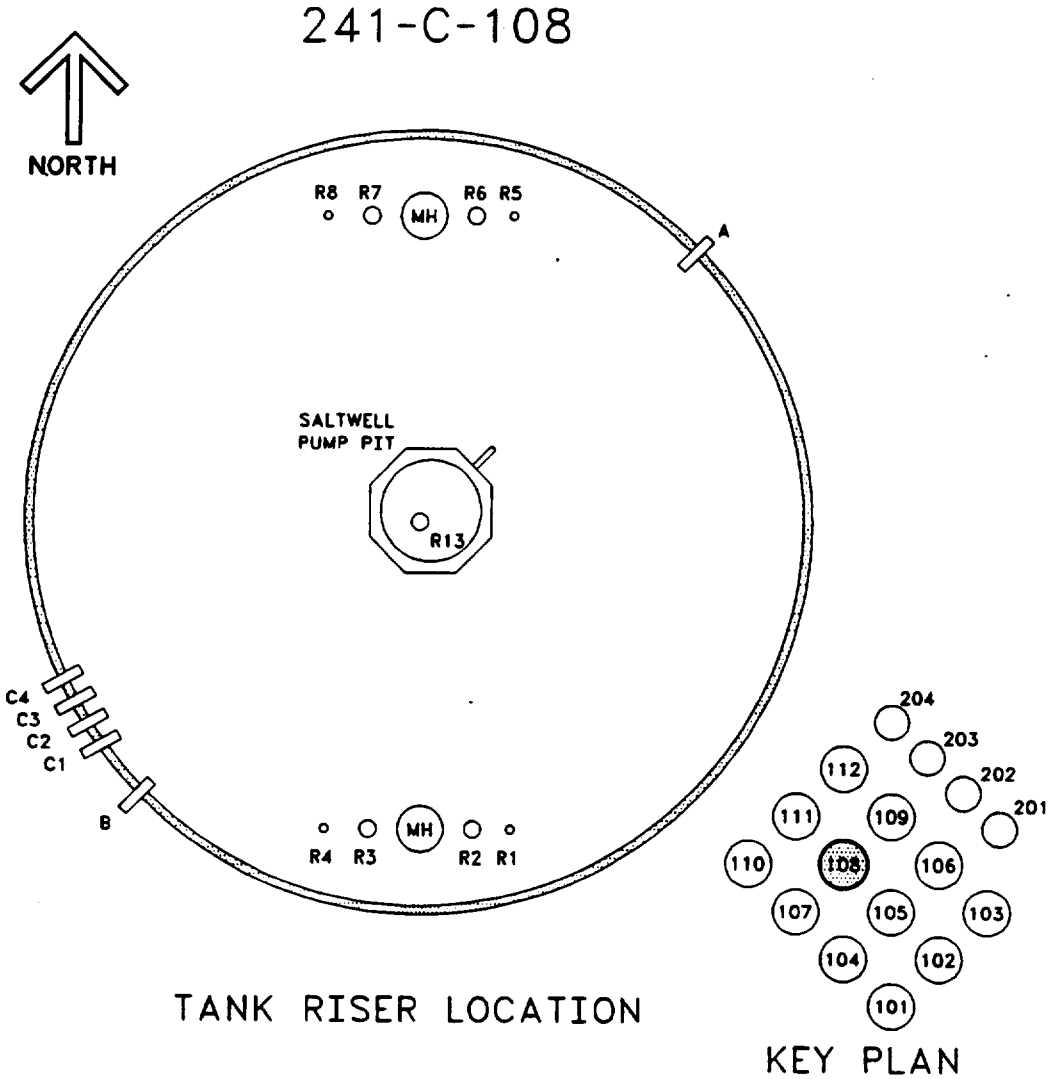
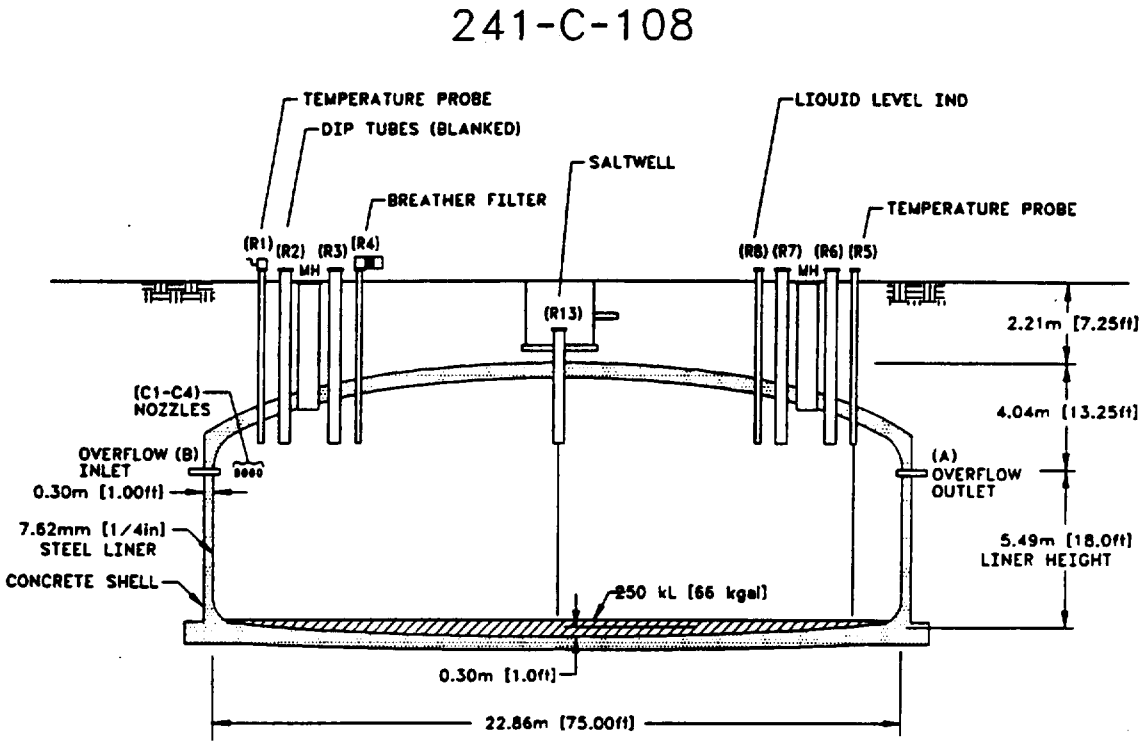


Figure 2-2. Tank 241-C-108 Cross-Section.



first quarter of 1956 through 1957, receiving scavenged waste from tanks in the C, B, and BX Tank Farms. During this time, the tank received more than 7,570 kL (2,000 kgal) of in-farm ferrocyanide scavenging (TFeCN) waste; about 662 kL (175 kgal) of waste remained in the tank in early 1958 following the conclusion of the scavenging campaign (Agnew et al. 1994a). Agnew (1993) estimates that the settling of TFeCN waste added an additional sludge layer of about 57 kL (15 kgal) to tank 241-C-108. However, most of the TFeCN sludge is predicted to have been removed from the tank in a later transfer.

During 1960 and 1961, the tank received supernate (most likely Plutonium-Uranium Extraction [Facility] [PUREX] cladding waste [CWP] supernate) from tank 241-C-105 and apparently CWP directly from PUREX. During the same period, supernate was transferred from tank 241-C-108 to tanks 241-BY-101 and 241-BY-105. Agnew (1993) predicts a sludge layer of about 151 kL (40 kgal) resulted from the CWP waste.

During the second quarter of 1964, supernate was transferred from tank 241-C-108 to tanks in the 241-BX Tank Farm. During 1965 and 1966, the tank received waste from the Hot Semiworks Plant (HS) waste and HS supernate from tank 241-C-107. From 1965 to 1969, supernate was intermittently transferred from tank 241-C-108 to tank 241-C-102. An unsubstantive transfer during the fourth quarter of 1969 may have lowered the waste volume in tank 241-C-108 to 522 kL (138 kgal). Agnew (1993) predicts this transfer would have removed the CWP sludge layer and much of the TFeCN sludge layer. However, the receiving tank for this transfer is not identified and no other documentation shows this to have occurred.

During 1970 and 1973, tank 241-C-108 received supernatant wastes from tanks 241-C-110 and 241-C-104. Records indicate these supernates were likely a mixture of wastes, including PUREX organic wash waste, ion exchange waste, reduction oxidation waste, N Reactor waste, decontamination waste, and laboratory waste (Agnew et al. 1994).

Supernate was pumped from the tank during 1975 and early 1976; and tank 241-C-108 was removed from service in 1976. Salt-well pumping was completed in 1978, leaving a total waste volume of about 246 kL (65 kgal) in tank 241-C-108 (Welty 1988). Intrusion prevention was completed on December 15, 1982, and the tank was designated as interim stabilized on March 9, 1984.

The process history of tank 241-C-108 as summarized from Brevick et al. (1994a and 1994b) is presented in Table 2-3 and Figure 2-3.

2.3.2 Historical Estimation of Tank Contents

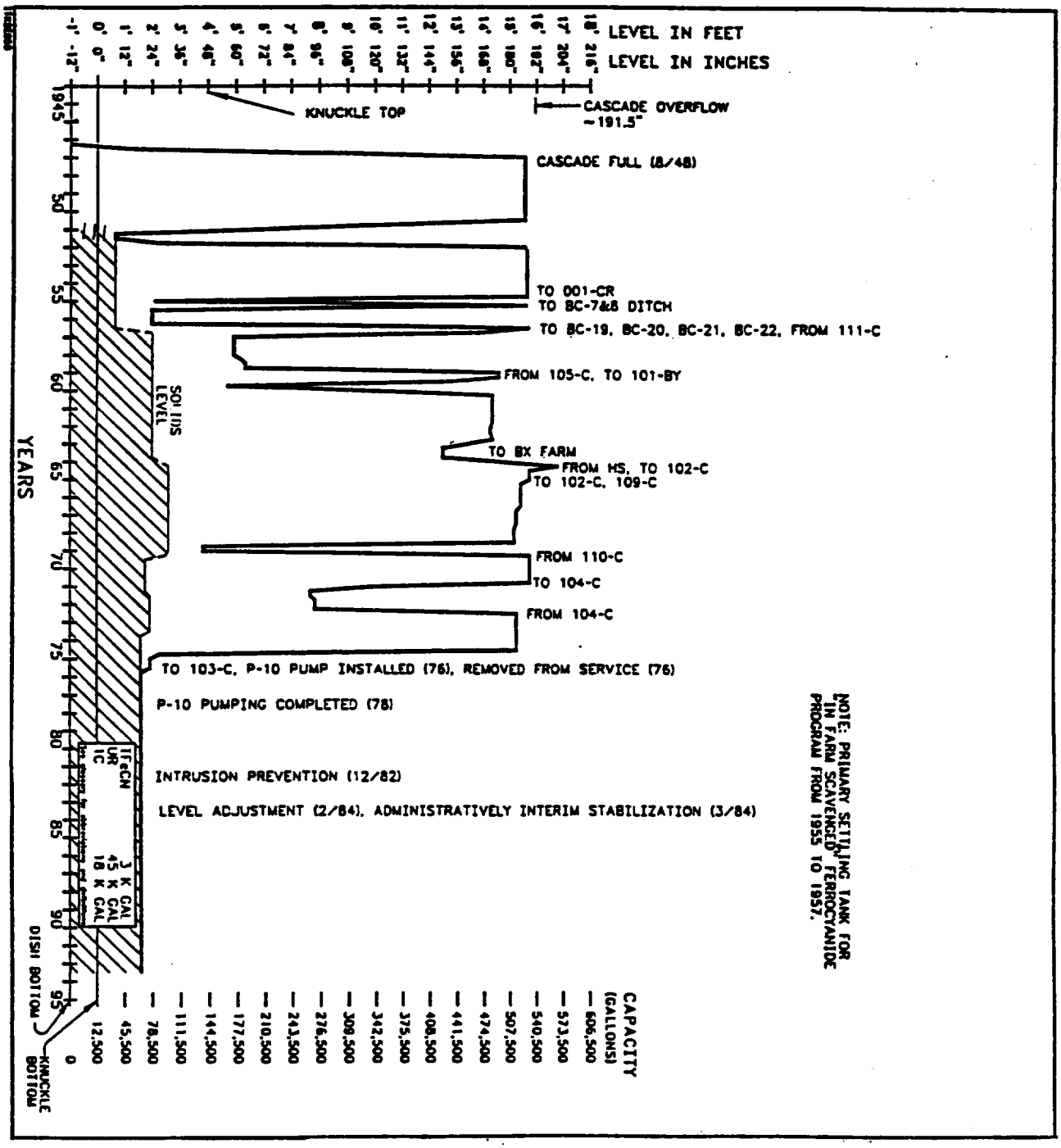
This section presents an estimate of the contents of tank 241-C-108 based on historical transfer data. The historical data used for the estimate is the Waste Status and Transaction Record Summary (WSTRS) (Agnew et al. 1994), the Hanford Defined Waste (HDW) document (Agnew 1995), and the Tank Layer Model (TLM) from the Historical Tank Content Estimate (HTCE) (Brevick et al. 1994a). WSTRS is a compilation of available

Table 2-3. Tank 241-C-108 Waste Transfer Summary.[1, 2]

Waste	Time period	Volume kL (kgal)
First-cycle decontamination waste received	1947 to 1948	4,090 (1,080)
First-cycle decontamination waste cascaded or removed	1948 to 1952	3,940 (1,040)
Uranium recovery waste received	1952 to 1956	3,780 (999)
Uranium recovery waste removed	1952 to 1956	3,750 (991)
Waste added during ferrocyanide scavenging campaign	1956 to 1958	9,840 (2,600)
Waste removed during ferrocyanide scavenging campaign	1956 to 1958	9,310 (2,460)
PUREX cladding waste and cladding waste supernate added	1960 to 1964	3,060 (808)
Supernate removed	1960 to 1965	2,320 (614)
Hot Semiworks waste and supernate added	1965 to 1969	924 (244)
Waste removed	1965 to 1969	1,900 (501)
Supernate received from Tanks 241-C-110 and 241-C-104	1970 to 1972	2,420 (640)
Waste removed	1970 to 1976	2,720 (718)
Unknown gains	1959 to 1993	458 (121)
Unknown losses	1959 to 1993	386 (102)

PUREX = Plutonium-Uranium Extraction (Facility)
[1]Brevick, et al. 1994a
[2]Brevick, et al. 1994b

Figure 2-3. Tank 241-C-108 Level History.



waste transfer and volume status data. The HDW provides the assumed typical compositions for 50 separate waste types. In some cases, the available data are incomplete, reducing the usability and the modeling results derived therefrom. The TLM takes the WSTRS data, models the waste deposition processes, and using additional data from the HDW (which may introduce more error) generates an estimate of the tank contents. Thus, these model predictions can only be considered an estimate requiring further evaluation using analytical data.

Based on the TLM, tank 241-C-108 contains 68 kL (18 kgal) of first cycle decontamination (1C) waste, 170 kL (45 kgal) of uranium recovery (UR) waste, and 11 kL (3 kgal) of in-farm ferrocyanide scavenging (TFeCN) waste. Figure 2-4 is a graphic representation of the estimated waste type and volumes for the tank layers. The bottom waste layer (1C waste) should contain large amounts of bismuth. The UR waste above the 1C waste should be richer in sulfate and uranium. In addition to cyanide, large quantities of nickel should be present in the top layer. The PUREX cladding waste, if present, would be near the top of the waste and rich in aluminum. If significant quantities of HS waste were present, the total organic carbon, strontium-90 (^{90}Sr), and possible levels of lead should be higher.

The presence of organic wash waste may be suggested by an increase in the manganese concentration because permanganate was used to wash the PUREX solvent. The CWP, HS waste, and organic wash wastes are not identified as significant contributors in the HTCE for this tank. Table 2-4 contains an estimate of the concentrations of waste constituents.

2.4 SURVEILLANCE DATA

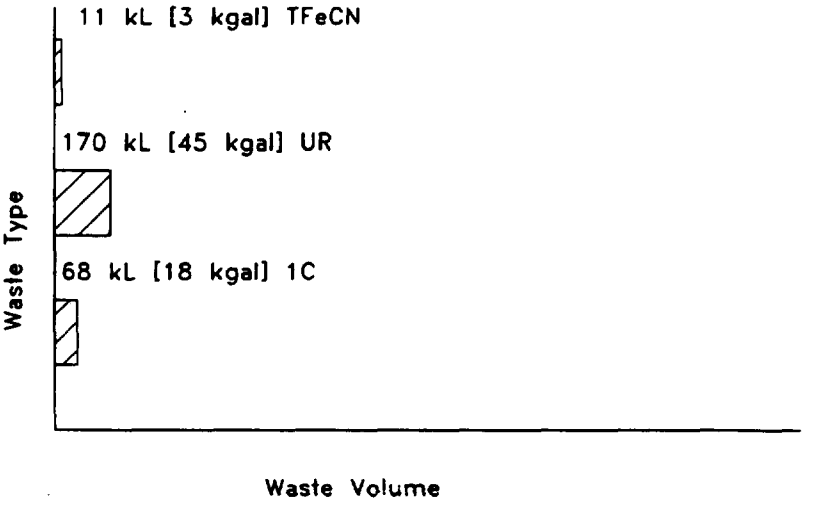
Tank 241-C-108 surveillance consists of surface-level measurements, temperature monitoring inside the tank, and leak detection dry well monitoring for radioactivity outside the tank. The data are relevant because they provide the basis for determining tank integrity.

Surface-level measurements are used to detect major intrusions into the tank. Dry wells located around the perimeter of the tank are used to detect increased radioactivity from a possible leak to the soil.

2.4.1 Surface-Level Readings

The surface level of the waste is monitored quarterly using a manual tape through riser 8. A surface-level measurement of 48.3 cm (19 in.) was obtained on July 2, 1995. Surface level has been measured as being between 33.7 cm (13.3 in.) and 50.8 cm (20 in.) from January 1991 to January 1995. The baseline surface level has been established at 49.5 cm (19.5 in.) (Barnes 1993). There is no criterion for a decrease in level, and a 5.1 cm (2-in.) maximum increase is allowed. Quarterly surface-level measurements from when the tank became active through 1994 are depicted in Figure 2-3.

Figure 2-4. Tank 241-C-108 Tank Layer Model.



2.4.2 Internal Tank Temperatures

Temperature data for tank 241-C-108 are recorded by 16 thermocouples on a thermocouple tree inserted into the tank in riser 5. A second thermocouple tree was installed at riser 1 in July 1993. The first thermocouple in each tree is about 45 cm (1.5 ft) from the bottom of the tank. Thermocouples 1 through 9 are evenly spaced 60 cm (2 ft) apart on the thermocouple tree. Thermocouples 9 through 11 are spaced 1.2 m (4 ft) apart (see Tran [1993] for thermocouple elevations). Because this tank is on the Ferrocyanide Watch List, temperature readings from both thermocouple trees are recorded continuously by the Tank Monitoring and Control System (TMACS). On August 24, 1995, temperatures from thermocouples on the riser 1 tree ranged from 25 °C (77 °F) to 26 °C (79 °F); temperatures from thermocouples on the riser 5 tree ranged from 24 °C (75 °F) to 25 °C (77 °F).

The historical data for the riser 5 tree show similar temperature readings for the first 11 thermocouples. Thermocouple 12 has five recorded data points spanning from 1989 to 1993. Thermocouples 13 through 16 have only two recorded data points. The mean temperature for probes 1 through 11 for the recorded data is 27 °C (81 °F), the minimum temperature is 17 °C (63 °F), and the maximum temperature is 33 °C (91 °F). Plots of the riser 5 thermocouple readings for tank 241-C-108 can be found in *Supporting Document for the Northeast Quadrant Historical Tank Content Estimate for C Tank Farm* (Brevick et al. 1994b). A graphical representation of the weekly high temperature from the riser 5 thermocouples can be found in Figure 2-5.

Table 2-4. Tank 241-C-108 Historical Tank Content Estimate.[1] (sheet 1 of 2)

Solids Composite Inventory Estimate			
Physical properties			
Total waste	3.51E+05 kg (250 kL)		
Heat load	0.104 kW (355 Btu/h)		
Bulk density	1.40 g/cm^3		
Void fraction	0.701		
Water (wt%)	59.7		
Total organic carbon (wt% C [wet])	0.082		
Chemical constituents	**mol/L**	**ppm**	**kg**
Na^{+}	4.76	7.81E+04	2.74E+04
Al^{+3}	0.380	7.30E+03	2.56E+03
Fe^{+3} (total Fe)	1.81	7.20E+04	2.52E+04
Cr^{+3}	5.73E-03	212	74.4
Bi^{+3}	2.53E-02	3.77E+03	1.32E+03
La^{+3}	0	0	0
Ce^{+3}	0	0	0
Zr (as $ZrO(OH)_2$)	2.81E-03	183	64.0
Pb^{+2}	0	0	0
Ni^{+2}	8.63E-02	3.61E+03	1.27E+03
Sr^{+2}	0	0	0
Mn^{+4}	0	0	0
Ca^{+2}	0.149	4.26E+03	1.49E+03
K^{+}	0	0	0
OH^{-}	7.34	8.89E+04	3.12E+04
NO_3^{-}	1.63	7.19E+04	2.52E+04
NO_2^{-}	3.89E-02	1.28E+03	447
CO_3^{-2}	0.238	1.02E+04	3.57E+03
PO_4^{-3}	0.452	3.06E+04	1.07E+04
SO_4^{-2}	0.679	4.65E+04	1.63E+04
Si (as SiO_3^{-2})	4.13E-02	827	290
F^{-}	0.11	1.49E+03	523
Cl^{-}	5.64E-02	1.43E+03	500

Table 2-4. Tank 241-C-108 Historical Tank Content Estimate.[1] (sheet 2 of 2)

Solids Composite Inventory Estimate			
Chemical constituents	**mol/L**	**ppm**	**kg**
$C_6H_5O_7^{-3}$	0	0	0
$EDTA^{-4}$	0	0	0
$HEDTA^{-3}$	0	0	0
NTA^{-3}	0	0	0
$glycolate^{-}$	0	0	0
$acetate^{-}$	0	0	0
$oxalate^{-2}$	0	0	0
DBP	0	0	0
NPH	0	0	0
CCl_4	0	0	0
hexone	0	0	0
$Fe(CN)_6^{-4}$	1.62E-02	4.06E+03	1.10E+03
Radiological constituents			
Pu	--	2.83E-03 (μCi/g)	1.65E-02 (kg)
U	0.108 (M)	1.83E+04 (μg/g)	6.41E+03 (kg)
Cs	8.41E-02 (Ci/L)	59.9 (μCi/g)	2.10E+04 (Ci)
Sr	3.38E-03 (Ci/L)	2.41(μCi/g)	845 (Ci)

[1]Brevick, C. H., L. A. Gaddis, and W. W. Pickett, 1995, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Areas, ICF Kaiser Hanford Company*, WHC-SD-WM-ER-349, Rev.0A, ECN 617835, ICF Kaiser Hanford Company, Richland, Washington.

Ci = Curies
Ci/L = Curies per liter
μCi/g = microcuries per gram
DBP = Dibutylphosphate
EDTA = Ethylenediametetraacetic acid
μg/g = micrograms per gram
HEDTA = N-(hydroxyethyl)-ethylenediaminetriacetic acid
kg = kilograms
M = molarity
mol/L = moles per liter
NPH = Normal paraffin hydrocarbon
NTA = Nitrilotriacetate
ppm = parts per million
wt% = weight percent

Review of the tank 241-C-108 level history indicates that thermocouple 1 is located in or near the solids level for the thermocouple tree in riser 5. The newer thermocouple tree in riser 1, however, was purposely designed so that the bottom two thermocouples are in the waste. The remaining thermocouples are in the vapor space. These temperature data for tank 241-C-108 are therefore presented in this report with no attempt to conclude the phase of material which they are monitoring.

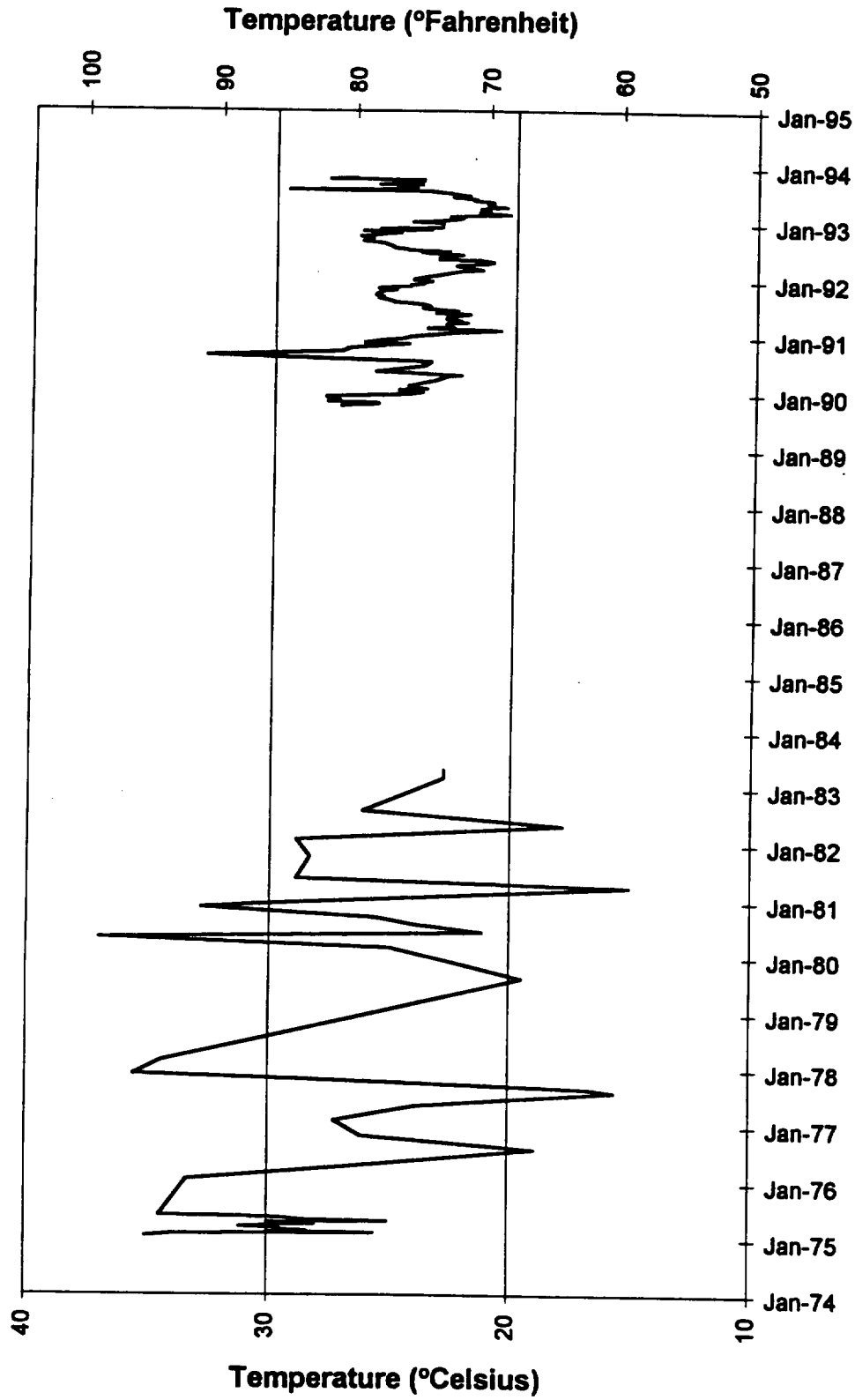
2.4.3 Dry-Well Surveillance

Three leak-detection dry wells are associated with tank 241-C-108. Monitoring with a scintillation probe identified increased radioactivity in dry well 30-08-02 in 1974 (Welty 1988). This increase was attributed to the lateral movement of existing contamination. From a peak of 50,000 counts per second in 1974, readings decreased to 450 counts per second by 1986. A graph representing the dry well data from January 1990 to the present can be found in WHC-SD-WM-ER-313 (Brevick et al. 1994b).

2.4.4 Tank 241-C-108 Photographs

The most recent in-tank photograph for tank 241-C-108 was obtained in 1974, and the waste transfers that have occurred since then make them obsolete. A videotape was obtained on November 17, 1974, however, and is available as needed.

Figure 2-5. Tank 241-C-108 Weekly High Temperature Plot.



3.0 TANK SAMPLING OVERVIEW

This section describes the sampling efforts associated with tank 241-C-108, which is on the Ferrocyanide Watch List. The sampling and analytical needs associated with ferrocyanide tanks and the safety screening of all tanks have been identified through the data quality objective (DQO) process. The Ferrocyanide Safety DQO (Meacham et al. 1994) was used for the analyses completed on this tank. The requirements for screening waste tanks for unidentified safety issues can be found in the Safety Screening DQO (Babad and Redus 1994). In addition, tank 241-C-108 was vapor sampled in accordance with the *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution, March 7, 1994* (Osborne et al. 1994). The characterization effort for tank 241-C-108 is directed by the *Tank 241-C-108 Tank Characterization Plan* (Schreiber 1994a, 1994b) and the *Vapor and Gas Sampling of Single-Shell Tank 241-C-108 Using the Vapor Sampling System* (WHC 1995).

A push-mode core sample was obtained for analysis on June 2, 1994, following the requirements of the Ferrocyanide Safety DQO (Meacham et al. 1994). However, the amount of sample recovered was deemed to be inadequate; therefore, an auger sampling event was planned and performed. Two auger samples were collected from the tank on November 18, 1994, and a third was collected on December 12, 1994. Sample handling and reported results from the push-mode and auger sampling events may be found in WHC-SD-WM-DP-082, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61* (Esch 1995). Sample handling and reported results from the vapor sampling event may be found in WHC-SD-WM-ER-423, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report* (Huckaby 1995a). General discussion of sampling and analytical procedures can be found in the *Tank Characterization Reference Guide* (De Lorenzo et al. 1994) and WHC-SD-WM-ER-430, *Waste Tank Headspace Gas and Vapor Characterization Reference Guide* (Huckaby 1995b).

3.1 DESCRIPTION OF CORE AND AUGER SAMPLING EVENTS (1994)

A push-mode sample (core 61) was acquired from riser 3 of tank 241-C-108 on June 2, 1994, and shipped to the 222-S Laboratory that same day. As a result of pre-sampling analysis (Schreiber 1994a), a 15.2-cm (6-in.) segment of waste was expected. However, upon extrusion, it was discovered that only 2.5 cm (1 in.) of sample material was obtained.

Because of the small amount of sample recovered was too small, it was determined that additional sampling should take place. To fulfill this requirement, three auger samples were collected from tank 241-C-108 (Schreiber 1994b). Two of the samples were acquired from riser 7 on November 18, 1994. These samples were identified as samples 94-AUG-012 and 94-AUG-014. Sample 94-AUG-012 was collected using a 25-cm (10-in.) auger sample, while sample 94-AUG-014 was obtained using a 51-cm (20-in.) auger sample. A third sample, 94-AUG-015, was obtained on December 12, 1994, from riser 4 using a 51-cm (20-in.) auger sample.

A description of the samples obtained from tank 241-C-108 are presented in Table 3-1. This description includes a sample identification number assigned to the sample upon arrival in the laboratory; the riser from which the sample was obtained; the mass of each sample; the radiological dose rate recorded on the chain-of-custody record; the percent recovery of each sample; and a brief description of the sample.

3.1.1 Sample Handling

The push-mode core sample from riser 3 was received by the 222-S Laboratory on June 2, 1994, and identified as sample K222. The sample was extruded on June 3, 1994, and was to be used to fulfill the Ferrocyanide Safety DQO (Meacham et al. 1994) and Safety Screening DQO (Babad and Redus 1994) requirements. Because the amount of recovery for this waste sample was so small, guidance was requested from the Characterization Program. Based on the recommendation by the Characterization Program, a decision was made to homogenize sample K222 (core 61) and to perform the safety screening analyses on the homogenized sample (Bratzel 1994).

On November 18, 1994, two auger samples were obtained from riser 7. The samples were obtained such that auger sample 94-AUG-012 was sampled directly above auger sample 94-AUG-014 as shown in Figure 3-1. The 25-cm (10-in.) auger sample was taken first. The 51-cm (20-in.) auger sample was then inserted into the hole created by the first auger sample to sample the remaining waste. Ideally, the auger samples would sample different wastes. However, it is not known if waste collapsed back into the hole after removal of the first auger sample.

The two auger samples from riser 7 were received by the 222-S Laboratory on November 21, 1994. Extrusion of the samples took place on November 22, 1994. Decisions concerning how to break down the auger samples were made in conjunction with the Ferrocyanide Safety Program representatives who were present during sample extrusion. Following the extrusion of the two auger samples, the material was split into quarter segments as required by the tank characterization plan (TCP), and safety screening analyses were run on each of the quarter segments. Material from auger sample 94-AUG-012 was divided into two unequal portions and identified as the upper two quarter segments (quarter segments A1 and A2) from riser 7. Portions of these two quarter segments were then composited and identified as the upper half segment from riser 7. Material from auger sample 94-AUG-014 was similarly divided into two unequal portions, which were identified as the lower two quarter segments (quarter segments B and C) from riser 7. Portions of these two quarter segments were also composited and identified as the lower half segment from riser 7. These two half segments (upper and lower) were subsequently composited to form the riser 7 auger composite sample. Sample breakdown procedures for the half segments and the composite sample from riser 7 are presented in Table 3-2.

Table 3-1. Tank 241-C-108 Sampling Summary.[1] (sheet 1 of 2)

Sample identification	Riser number	Sample mass (g)	Dose rate as measured through drill string at time of sample removal from tank (R/h)	Percent recovery[2]	Sample description
Core 61	3	20.9	0.4	17.5	The sample contained no drainable or liner liquid. Upon extrusion, the sample was dark brown in color, clay-like in consistency, and appeared homogeneous. 15 cm (6 in.) of waste was expected to be recovered; however, only 2.5 cm (1 in.) was obtained.
94-AUG-012	7	95	1	33	The sample contained no drainable liquid. Upon extrusion, the sample was yellow to brown in color and crumbly in texture. The sample was deposited along the entire length of the auger sample, with the greatest accumulation on flutes 1 and 2.
94-AUG-014	7	349	8	100	The sample contained no drainable liquid. The solid material was tan in color, and more moist and paste-like in appearance than the 94-AUG-012 sample. The sample was deposited on all the flutes, with the exception of flutes 1 and 2. The greatest accumulation was found on flutes 10 through 19.

Table 3-1. Tank 241-C-108 Sampling Summary.[1] (sheet 2 of 2)

Sample identification	Riser number	Sample mass (g)	Dose rate as measured through drill string at time of sample removal from tank (R/h)	Percent recovery[2]	Sample description
94-AUG-015	4	295	2	Not calculated	The sample contained no drainable or liner liquid. The solid material was tan in color, moist, and paste-like in appearance, and it had an off-white material embedded throughout. The sample was distributed along the entire length of the auger sample. The off-white chunks were hard and could not be homogenized. If this material represented a discrete layer, then a significant amount of mixing occurred during the sampling process.

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
[2]See reference in footnote 1 for "percent recovery" definition.

g = grams
R/h = roentgens per hour

Figure 3-1. Auger Sampling Procedure for Riser 7.

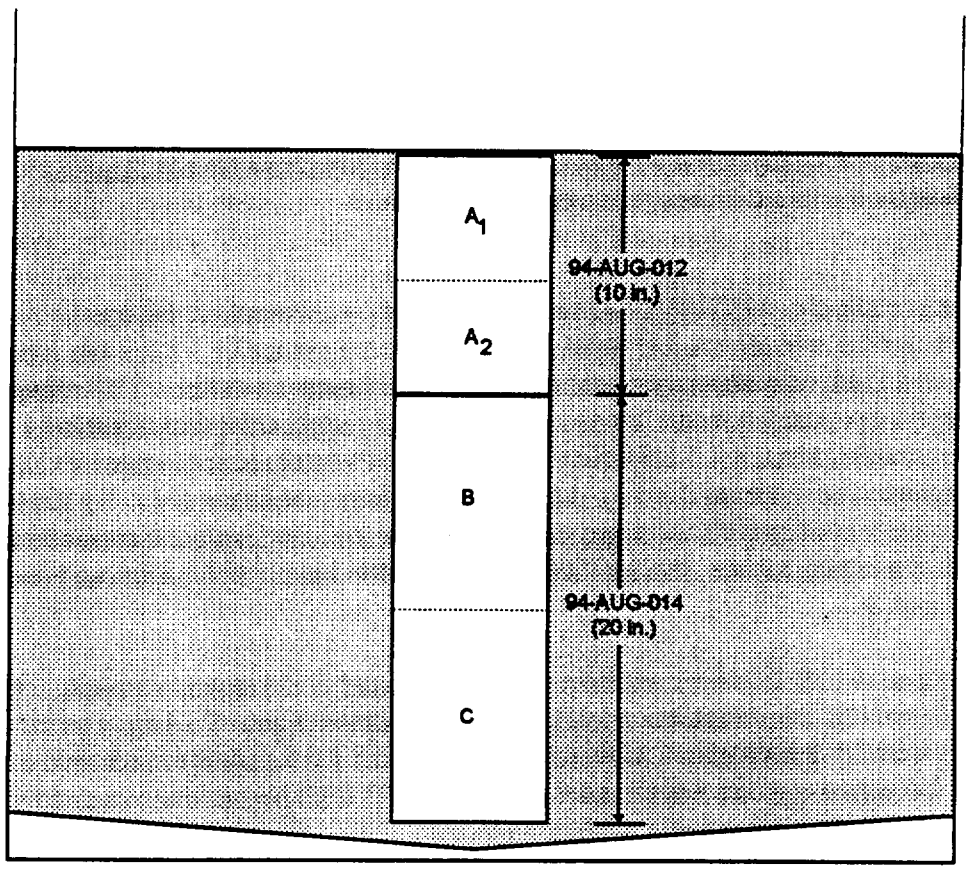


Table 3-2. Tank 241-C-108 Riser 7 Auger Samples Breakdown.[1]

Sample identification	Quarter segment	wt%	Segment portion
Segment level			
94-AUG-012	A_1 (flutes 1-2)	15.8	Upper half
	A_2 (flutes 3-9)	84.2	
94-AUG-014	B (flutes 3-13)	67.4	Lower half
	C (flutes 14-19)	32.6	
Composite level			
Sample identification	**Half segment**	**wt%**	**Auger composite**
94-AUG-012	Upper half	22.8	Riser 7
94-AUG-014	Lower half	77.2	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

The single auger sample 94-AUG-015, taken from riser 4, was received by the 222-S Laboratory on December 14, 1994, and extruded the next day. Following extrusion, the material was split into quarter segments for safety screening analyses. The upper two quarter segments (segments A and B) were subsequently composited and identified as the upper half segment from riser 4. Similarly, the lower two segments (segments C and D) were also composited and identified as the lower half segment from riser 4. As with riser 7, these two half segments were then composited to form the riser 4 auger composite sample. Sample breakdown procedures for the half segments and for the riser 4 composite sample are presented in Table 3-3.

The subsampling and multiple compositing procedures used for the auger samples were intended to maximize the information yielded by the sampled waste. To help clarify the methodology, Figure 3-2 provides a visual representation of the sample breakdown and compositing for the two auger samples taken from riser 7. The procedures used for the single auger sample taken from riser 4 were similar.

3.1.2 Sample Preparation and Analysis

Following the requirements of the TCP, the analyses to be performed were prioritized with the safety screening analyses (differential scanning calorimetry [DSC], thermogravimetric analysis [TGA], and total alpha) receiving the highest priority. These analyses were followed by those delineated for the Ferrocyanide Safety Program (gamma energy analysis

Table 3-3. Tank 241-C-108 Riser 4 Auger Sample Breakdown.[1]

Sample identification	Quarter segment	wt%	Segment portion
Segment level			
94-AUG-015	A (flutes 1-4)	65.3	Upper half
	B (flutes 5-9)	34.7	
94-AUG-015	C (flutes 10-14)	53.6	Lower half
	D (flutes 15-19)	46.4	
Composite level			
Sample identification	**Half segment**	**wt%**	**Auger composite**
94-AUG-015	Upper half	36.8	Riser 4
	Lower half	63.2	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[GEA], inductively coupled plasma [ICP], total organic carbon [TOC], total inorganic carbon [TIC], cyanide, and strontium). Core and auger information, sample identification, digestion method, and analyses performed are summarized in Table 3-4.

Figure 3-3 is a flowchart of the steps taken to analyze the waste samples from tank 241-C-108. All the analyses were performed at the 222-S Laboratory following the procedures outlined in the TCPs (Schreiber 1994a, 1994b) and as required by the relevant DQOs at that time (Meacham et al. 1994; Babad and Redus 1994). The analytical methods and procedures are listed in Appendix A.

3.2 DESCRIPTION OF VAPOR SAMPLING EVENT (1994)

Headspace gas and vapor samples were collected from tank 241-C-108 on August 5, 1994, by the Westinghouse Hanford Company (WHC) Sampling Mobile Laboratory (WHC 1995). Sample collection and analysis were performed as directed by the sample and analysis plan (WHC 1995). The tank headspace temperature was determined to be 25 °C (77 °F). Air from tank 241-C-108 headspace was withdrawn via a 7.0-m (23-ft) long heated sampling probe mounted in riser 4 and transferred via heated tubing to the vapor sampling system sampling manifold. All heated zones of the vapor sampling system were maintained at approximately 50 °C (122 °F).

Figure 3-2. Sample Auger Breakdown and Compositing Procedure.

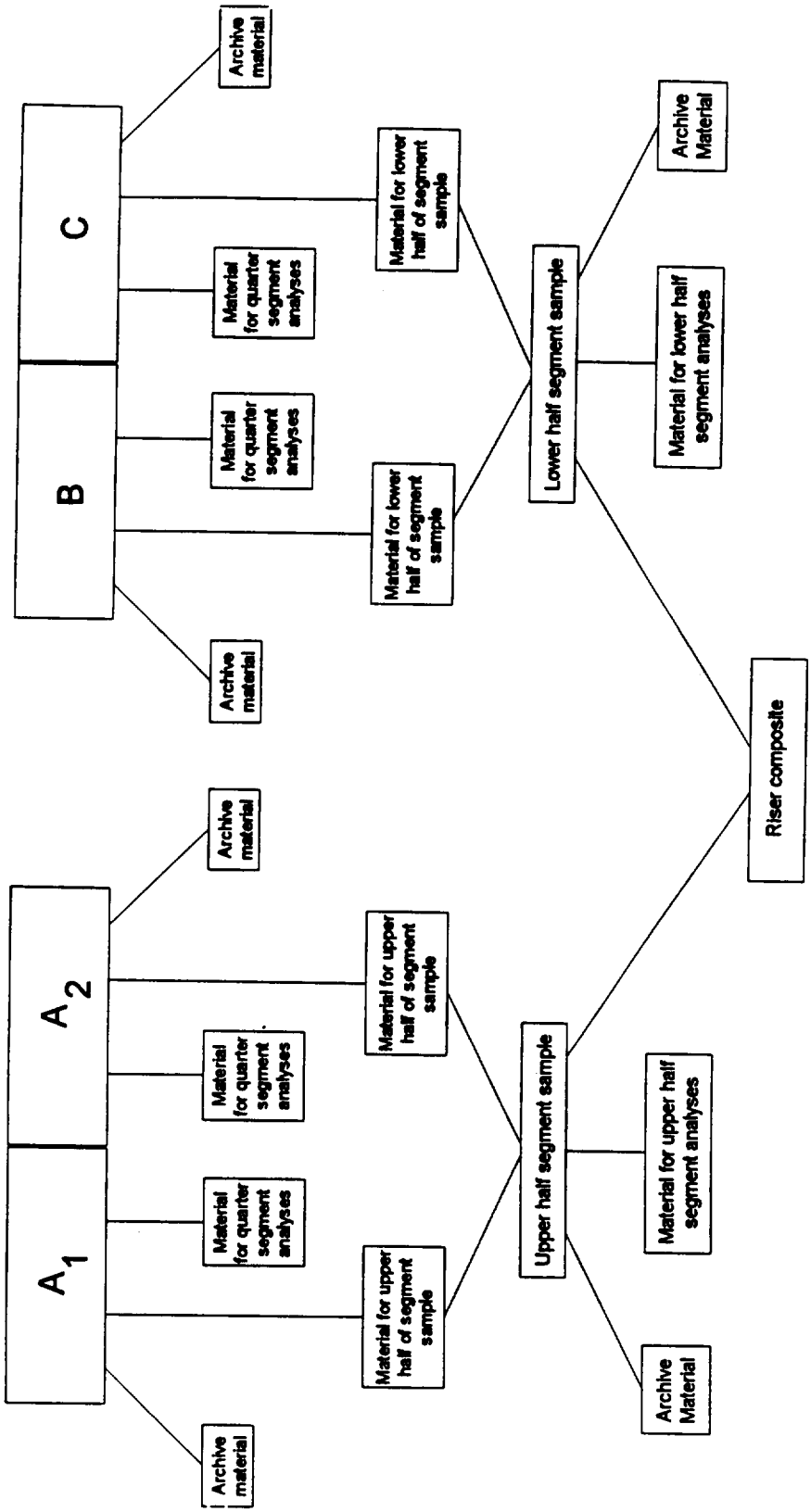


Table 3-4. Tank 241-C-108 Sample Data Summary.[1] (sheet 1 of 2)

Sample identification	Sample number	Segment	Digestion method	Analyses
Core 61	K222	1	Fusion	Total alpha, GEA, ICP, $^{89/90}Sr$
			Acid	ICP, $^{89/90}Sr$
			Direct	DSC, TGA, TOC, cyanide
94-AUG-015	S94T000384	Upper	Fusion	GEA, $^{89/90}Sr$
	S94T000399		Acid	GEA, $^{89/90}Sr$
	S94T000401		Direct	TOC, cyanide
	S94T000385	Lower	Fusion	GEA, $^{89/90}Sr$
	S94T000400		Acid	GEA, $^{89/90}Sr$
	S94T000402		Direct	TOC, cyanide
94-AUG-012	S94T000331	Upper	Fusion	GEA, $^{89/90}Sr$
	S94T000335		Acid	GEA, $^{89/90}Sr$
	S94T000337		Direct	TOC, cyanide
94-AUG-014	S94T000332	Lower	Fusion	GEA, $^{89/90}Sr$
	S94T000336		Acid	GEA, $^{89/90}Sr$
	S94T000338		Direct	TOC, cyanide
94-AUG-015	S94T000367	A	Fusion	ICP
	S94T000361		Direct	DSC, TGA
	S94T000367			Total alpha
	S94T000368	B	Fusion	ICP
	S94T000362		Direct	DSC, TGA
	S94T000368			Total alpha
	S94T000369	C	Fusion	ICP
	S94T000363			DSC, TGA
	S94T000369			Total alpha
94-AUG-015	S94T000370	D	Fusion	ICP
	S94T000364		Direct	DSC, TGA
	S94T000370			Total alpha

Table 3-4. Tank 241-C-108 Sample Data Summary.[1] (sheet 2 of 2)

Sample identification	Sample number	Segment	Digestion method	Analyses
94-AUG-012	S94T000301	A_1	Fusion	ICP
	S94T000288		Direct	DSC, TGA
	S94T000289			Total alpha
	S94T000302	A_2	Fusion	ICP
	S94T000290		Direct	DSC, TGA
	S94T000296			Total alpha
94-AUG-014	S94T000304	B	Fusion	ICP
	S94T000292		Direct	DSC, TGA
	S94T000298			Total alpha
	S94T000303	C	Fusion	ICP
	S94T000291		Direct	DSC, TGA
	S94T000297			Total alpha
94-AUG-015	S94T000403	Composite	Fusion	ICP, U, ^{241}Am, ^{238}Pu, $^{239/240}$Pu
	S94T000404		Acid	Total beta, GEA
	S94T000387		Direct	TOC, TIC
	S94T000405		Water	IC
94-AUG-012/014	S94T000339	Composite	Fusion	ICP, U, ^{241}Am, ^{238}Pu, $^{239/240}$Pu
	S94T000340		Acid	Total beta, GEA
	S94T000334		Direct	TOC, TIC
	S94T000341		Water	IC
	S94T001181			

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

DSC = Differential scanning calorimetry
GEA = Gamma energy analysis
IC = Ion chromatography
ICP = Inductively coupled plasma
TGA = Thermogravimetric analysis
TIC = Total inorganic carbon
TOC = Total organic carbon

Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratory, Pacific Northwest Laboratory (PNL), and the Oregon Graduate Institute of Science and Technology (OGIST) through a contract with Sandia National Laboratory (SNL). The 39 tank air samples and two ambient air control samples collected are listed in Table 3-5 by analytical laboratory. Table 3-5 also lists the 18 trip blanks provided by the laboratories.

A general description of vapor sampling and sample analysis methods is given by Huckaby (1995a). The sampling equipment, sample collection sequence, sorbent trap sample air flow rates and flow times, chain of custody information, and a discussion of the sampling event are presented in WHC (1995).

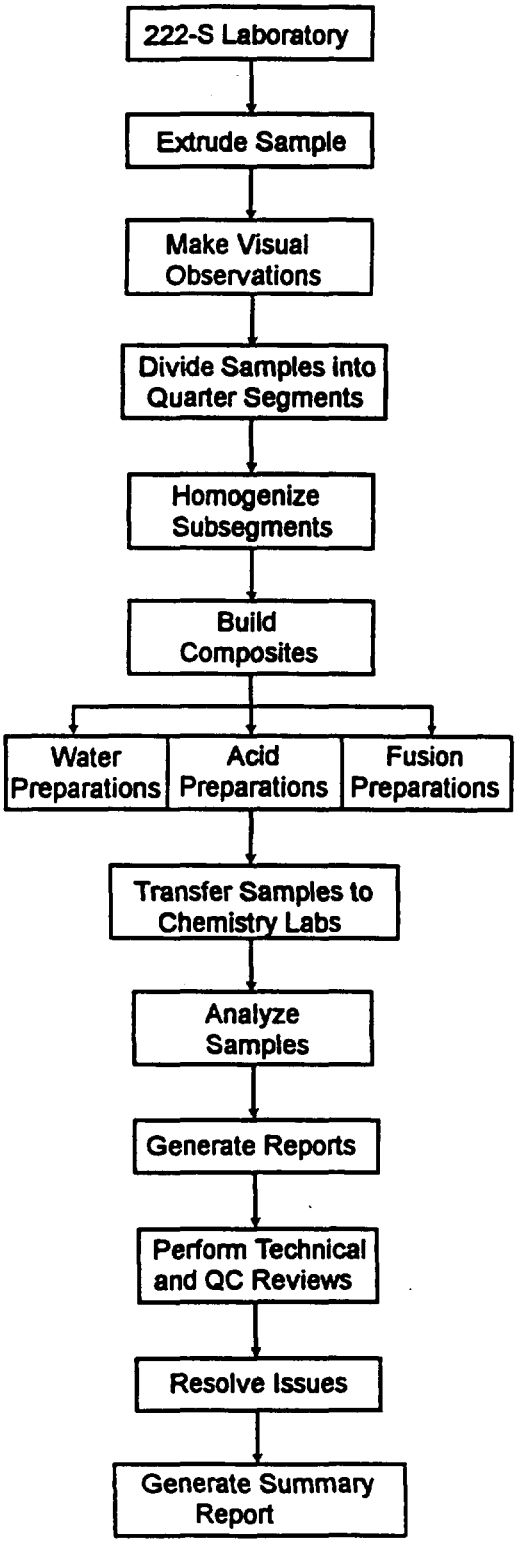
Table 3-5. Tank 241-C-108 Gas and Vapor Sample Type and Number

Laboratory	Sampling device	Nominal sample volume (L)	Target analytes
Oak Ridge National Laboratory	Triple sorbent trap	2.0 and 4.0	Organic vapors
Oregon Graduate Institute of Science and Technology	SUMMA[2] canister	[6.0][3]	Hydrogen, nitrous oxide, carbon dioxide, carbon monoxide
Pacific Northwest Laboratory	Acidified carbon sorbent trap	3.0	Ammonia
	Triethanolamine sorbent trap	3.0	Nitrogen dioxide
	Oxidation bed + triethanolamine sorbent trap	3.0	Nitric oxide
	Silica gel sorbent trap	3.0	Water vapor
	SUMMA[2] canister	6.0	Organic vapors
WHC 222-S Laboratory	Silica gel sorbent trap	1.0	Tritium-substituted water vapor

[1]WHC, 1995, *Vapor and Gas Sampling of Single-Shell Tank 241-C-108 Using the Vapor Sampling System*, WHC-SD-WM-RPT-110, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
[2]SUMMA is a trademark of Molectrics, Inc.
[3] [ ] indicate that because OGIST did not follow the WHC QC procedure, this data is only allowed to be used as secondary data.

WHC = Westinghouse Hanford Company

Figure 3-3. Flowchart for Data Collection and Preparation.



4.0 ANALYTICAL RESULTS

4.1 OVERVIEW

Section 4.0 presents the analytical results associated with the sampling of tank 241-C-108. The analyses are based on the DQO process. The DQOs that governed the sampling and subsequent sample analysis for tank 241-C-108 at that time were the Ferrocyanide Safety Program DQO (Meacham et al. 1994) and the Safety Screening DQO (Babad and Redus 1994). In addition, tank 241-C-108 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution, March 7, 1994* (Osborne et al. 1994).

The headspace gas and vapor samples for tank 241-C-108 were collected and analyzed to determine the potential risks to tank farm personnel if fugitive emissions are released from the tank. The sample collection and subsequent analyses were performed as directed in *Vapor and Gas Sampling of Single-Shell Tank 241-C-108 Using the Vapor Sampling System* (WHC 1995).

The Ferrocyanide and Safety Screening DQOs have determined that the samples were to be analyzed on the quarter-segment level. Furthermore, the analytes identified in the Safety Screening DQO effort for the various safety issues are subsets of the suite of analyses identified in the Ferrocyanide Safety Program DQO (Meacham et al. 1994), with the exception of analytes measured for the criticality safety issue. Two TCPs were generated to outline the characterization process for tank 241-C-108. The first TCP (Schreiber 1994a) delineates the analyses to be performed on the core sample, while the second TCP (Schreiber 1994b) deals with the auger samples. Table 4-1 presents the analyses prescribed by the TCPs for tank 241-C-108.

In addition to the analyses outlined in the TCPs as primary analyses, secondary and tertiary analyses were performed and reported in the 216-day data report (Esch 1995). These additional analyses are listed in Table 4-2.

An overall mean was calculated for all analytes. This mean was obtained by averaging concentration values for the auger samples obtained from the two different risers. For example, when sample means for riser 4 (sample 94-AUG-015) and riser 7 (samples 94-AUG-012 and 94-AUG-014) are available, the means of the riser 7 samples are averaged, and this result is then averaged with the mean from riser 4 so that each riser is weighted equally. Individual sample results and their respective duplicate results are reported in Appendix B of this report, while only a mean value for each sample is reported in this section. The core sample from riser 3 (core 61) was not used in the calculation of an overall mean for two reasons: (1) the small amount of sample recovered (2.5 cm [1 in.]), and (2) the close proximity of riser 3 to riser 4 (from which a full 51-cm [20-in.] auger sample was collected).

Table 4-1. Analyses Requested for Tank 241-C-108.

Analysis	Analyte
DSC	Total fuel
Thermogravimetric analysis	Percent moisture
Alpha proportional counting	Total alpha
Inductively coupled plasma	Nickel, uranium, iron, manganese (this analysis required only if total alpha exceeds the notification limit)
Microdistillation	Cyanide
Hot persulfate	Total organic carbon
Gamma energy analysis	Cesium-137
Separation/beta proportional counting	Strontium-90
Separation/alpha proportional counting	Plutonium-239/240 (this analysis required only if total alpha exceeds the notification limit)
Radioactive system screening tool (adiabatic calorimetry)	Energetics (performed only if DSC exceeds the notification limit)

DSC = Differential scanning calorimetry

Table 4-2. Secondary and Tertiary Analyses Performed for Tank 241-C-108.

Analysis	Analyte
Gamma energy analysis	Cobalt-60, europium-154, europium-155
Inductively coupled plasma	Aluminum, calcium, iron, sodium, phosphorus
Ion chromatography	Chloride, fluoride, nitrite, nitrate, phosphate
Phosphorescence	Uranium
Beta	Total beta
Extraction	Americium-241
Ion exchange	Plutonium-238, plutonium-239/240
Acid/coulometry	Total inorganic carbon

In addition to the overall mean, a projected tank inventory was calculated for any analytes with results above the analytical instrument's calibrated detection limit. The projected inventory is the product of the concentration of the analyte and the amount of waste in the tank in grams. The overall waste mass, 3.5×10^8 g, is derived by multiplying the waste volume of 250 kL by the estimated density of 1.40 g/mL. As there were no direct measurements of density for any of the wastes from this tank, the density value of 1.40 g/mL taken from Brevick et al. (1994a) was used. It is believed that this value is fairly accurate because of the similar density values of the other two tanks in the same cascade, and tank 241-C-108 being the middle tank of the cascade.

4.2 TOTAL ALPHA

The total alpha analyses were performed on a fusion-digested sample on an alpha proportional counter according to procedure LA-508-101 (Fitzgerald 1994). All total alpha results were well below the Safety Screening DQO notification limit of 43.9 μCi/g, with the highest observed value of any sample or duplicate being less than 1.4 μCi/g. The majority of the results were below the analytical instrument's calibrated detection limit. This is primarily caused by the very high beta to alpha activity ratio in these samples (Esch 1995). Large dilutions were necessary to reduce the beta activity on the sample mount to acceptable levels. Samples S94T000296 and S94T000298 each had one result above the detection limit.

The TCP requested total alpha analysis on a half-segment level; however, the results in Appendix B are provided on a quarter-segment level to make use of existing fusion preparations used for other analyses. Table 4-3 presents the overall mean for total alpha derived from the auger samples. No quality control data, such as matrix spikes or serial dilutions, are listed.

4.3 THERMODYNAMIC ANALYSES

Tank 241-C-108 samples were evaluated according to the Safety Screening DQO (Babad and Redus 1994) and the Ferrocyanide Safety Program DQO (Meacham et al. 1994); therefore, the only physical analyses required were TGA and DSC. In DSC and TGA, the thermal stability or reactivity of a material is determined. Density, percent solids, particle size, and rheology were neither requested nor performed.

4.3.1 TGA

In TGA, the mass of a sample is measured while its temperature is increased at a constant rate. A gas, such as nitrogen or air, is passed over the sample during the heating to remove any gaseous matter. Any decrease in the sample weight represents a loss of gaseous matter from the sample either through evaporation or through a reaction that forms gas phase products.

Table 4-3. Tank 241-C-108 Analytical Data: Total Alpha.[1]

Analyte	Overall mean (μCi/g)	Projected inventory (Ci)
Total alpha	<0.0511	<17.9

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μCi/g = microcuries per gram
Ci = Curies

Weight percent water by TGA was performed under a nitrogen purge using procedure LA-560-112 (Frye 1994a). Analytical results satisfied the Safety Screening DQO requirement of >17 percent moisture for all samples with the exception of samples S94T000288 and S94T000290. These samples were derived from sample 94-AUG-012. Sample S94T000288 had primary, duplicate, and rerun results of 15.4, 2.99, and 6.01% H_2O, respectively. Sample S94T000290 demonstrated much of the same behavior. The primary, duplicate, and rerun results were 9.94, 27.7, and 12.0% H_2O, respectively. As mentioned previously, primary and duplicate results for the individual samples are listed in Appendix B of this report, while only the overall percent water mean based on the auger samples is listed in Table 4-4. These widely varying data are indicative of heterogeneous waste and therefore the 38.8% H_2O value reported in Table 4-4 should be used with caution.

Four samples (S94T000288, S94T000290, S94T000292, and S94T000361) exceeded the TCP ±10 percent precision criteria for relative percent difference (RPD) between the primary samples and their respective duplicates. A rerun was requested and performed for sample S94T000288; the rerun substantiated the apparent heterogeneous nature of the sample. The remaining samples were not rerun because of their high dose rates, the heterogeneous nature of the samples, and the low probability of improving the results resulting from the small amount of sample used (10 to 20 mg).

Table 4-4. Thermogravimetric Analysis Results for Tank 241-C-108.[1]

Analyte	Overall mean	RSD
% H_2O	38.8	29.0

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

RSD = Relative standard deviation of the mean:

Standard deviation divided by mean times 100 (expressed as a percentage)

The core 61 sample contained an average value of 21% H_2O. This was at the low end of the expected range for a typical ferrocyanide sludge sample. The RPD and the percent water criteria outlined in the TCP were not exceeded. The core TGA result was not included in the calculation of the overall percent water mean.

4.3.2 DSC

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

Analyses by DSC for the auger samples were performed under a nitrogen atmosphere using procedure LA-514-113 (Frye 1994b), and a Mettler* Model 20 differential scanning calorimeter. The core 61 sample DSC was performed with the same procedure except under an air purge. There were no results that exceeded the safety screening notification action limit of 481 J/g. Two samples (S94T000291 and S94T000292) from sample 94-AUG-014 exceeded the TCP limit for precision. No rerun was requested or performed because of the small exotherm in each case, the radiological dose rate of the samples, and the heterogenous behavior of these samples. All samples met the TCP accuracy criteria.

The DSC results are presented in Table 4-5. The temperature range, temperature at maximum enthalpy change, and the magnitude of the enthalpy change are provided for each transition. The first transition represents the endothermic reaction associated with the evaporation of free and interstitial water. The second transition probably represents the energy (heat) required to remove bound water from hydrated compounds such as aluminum hydroxide or to melt salts such as sodium nitrate.

4.4 ICP

The ICP analyses were performed using procedure LA-505-151 (Ball 1995) and procedure LA-505-161 (Parong 1995). The latter procedure was not referenced in the TCP because the new ICP was not operational at the time the TCP was written.

*Mettler is a trademark of Mettler Electronics.

Table 4-5. Differential Scanning Calorimetry Results for Tank 241-C-108.[1] (sheet 1 of 2)

Sample number	Sample location	Run	Sample weight	Transition 1 temperature range		Transition 2 temperature range		Transition 3 temperature range	
			mg	Peak (°C)	ΔH (J/g)	Peak (°C)	ΔH (J/g)	Peak (°C)	ΔH (J/g)
S94T000288	94-AUG-012: top ¼ segment	1	12.5	110	454	286	658	---	---
		2	20.0	113	366	279	744	---	---
S94T000290		1	18.5	123	713	278	440	---	---
		2	14.9	112	397	286	643	---	---
S94T000292	94-AUG-014: second ¼ segment	1	28.6	127	1,050	279	172	330	-25.2
		2	25.0	119	774	283	255	328	-19.2
		3	19.9	129	895	287	217	329	-33.7
		4	19.9	121	931	285	282	329	-21.6
S94T000291	94-AUG-014: third ¼ segment	1	24.8	125	950	284	140	326	-55.4
		2	20.9	119	1,072	278	115	320	-62.5
S94T000361	94-AUG-015: top ¼ segment	1	11.1	124	847	288	205	---	---
		2	10.4	122	894	284	158	---	---
S94T000362	94-AUG-015: second ¼ segment	1	16.1	127	1,138	264	129	---	---
		2	12.4	126	880	282	135	---	---
S94T000363	94-AUG-015: third ¼ segment	1	35.4	113	952	---	---	---	---
		2	23.1	113	1,215	---	---	---	---

Table 4-5. Differential Scanning Calorimetry Results for Tank 241-C-108.[1] (sheet 2 of 2)

Sample number	Sample location	Run	Sample weight	Transition 1 temperature range		Transition 2 temperature range		Transition 3 temperature range	
			mg	Peak (°C)	ΔH (J/g)	Peak (°C)	ΔH (J/g)	Peak (°C)	ΔH (J/g)
S94T000364	94-AUG-015: bottom ¼ segment	1	33.5	113	953	265	75.1	---	---
		2	36.2	113	884	263	75.4	---	---
K222	Core 61: segment 1	1	19.1	No exotherm					
		2	17.6						

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

J/g = joules per gram
C = Celsius
ΔH = change in enthalpy
mg = milligrams

Nickle offers analytical evidence that ferrocyanide once existed in the tank. This is important for resolving the ferrocyanide safety issue because it verifies that the correct tanks were identified and corroborates that aging has occurred. Confirmation of aging is necessary before the quarter/half segment analytical requirement can be relaxed to half/full segments.

Nickel is a signature analyte of the nickel ferrocyanide scavenging process (the only source of added nickel). Nickel was determined on the auger quarter segments using a fusion preparation in a zirconium crucible, and on the core sample using both a fusion digestion and an acid digestion. The TCP criterion for accuracy was not met by one of four spikes conducted, and the precision criterion was exceeded by five of eight samples. Such occurrences were thought to be caused by the heterogeneous nature of the sample.

The auger composite samples were analyzed for tertiary analytes including aluminum, calcium, iron, phosphorus, and sodium using a fusion digestion in a nickel crucible. Tertiary data are required for a variety of purposes in the Ferrocyanide Safety Program. Chemical analyses are necessary to validate waste aging models and to confirm waste transfer histories. It is important to confirm waste transfer histories because they were used to identify which tanks belonged on the Ferrocyanide Watch List.

Several tertiary analytes failed to meet the TCP ± 10 percent criterion for precision. However, no rerun samples were requested or performed because of the heterogeneous nature of the samples and because analyses of the samples indicated there was not a safety issue (ferrocyanide or organic) with this tank.

Table 4-6 presents the average ICP data for the auger samples as calculated from the data in Appendix B.

Table 4-6. Tank 241-C-108 Inductively Coupled Plasma Results.[1]

Analyte	Overall mean (μg/g)	RSD (%)	Estimated inventory (kg)
Aluminum	52,100	24.2	18,200
Calcium	12,700	33.5	4,450
Iron	7,170	24.5	2,510
Nickel	8,410	23.7	2,940
Phosphorus	26,800	35.0	9,380
Sodium	94,100	22.7	32,900

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μg/g = micrograms per gram
kg = kilograms
RSD = Relative standard deviation of the mean

4.5 ANIONS

Cyanide is an analyte of secondary interest in the Ferrocyanide Safety Program DQO (Meacham et al.1994). The total cyanide analysis provides corroborative evidence of the total fuel content of the waste. The cyanide analysis was performed on the auger half segment composite samples using procedure LA-695-102 (Schroeder 1995). All analytical sample results were far below the TCP notification limit of 39,000 μg/g. Table 4-7 presents the cyanide overall mean for tank 241-C-108 on a wet weight basis.

A dry weight-based cyanide result was calculated from the wet weight listed in Table 4-7 using the percent water determined by TGA for each respective sample. The percent water was determined on the auger quarter-segment level, while the cyanide wet weight was determined on the auger half-segment level. Therefore, to obtain the appropriate percent water value for the dry weight-based cyanide determination, a half-segment percent water result was calculated using a weighted average of the percent water results for the corresponding quarter segments. The wet cyanide result was divided by the quantity 1 - (percent water/100) to obtain the dry weight-based cyanide result. An example of the calculation is as follows:

Riser 4: upper-half segment equals 65.3 percent quarter segment A plus 34.7 percent quarter segment B. The average percent water for quarter segment A was 49.33 percent, and 49.51 percent for quarter segment B.

Average percent water (upper-half segment) = [(49.33) (0.653) + (49.51) (0.347)] = 49.39%

Average cyanide concentration on a dry weight basis = CN^-(wet μg/g)/(1 - 0.4939)
= 1,030/0.5061
= 2,040 μg/g (dry)

Table 4-8 presents the overall means for tank 241-C-108 on a dry weight basis.

Table 4-7. Tank 241-C-108 Cyanide Analytical Data (wet weight basis).[1]

Analyte	Overall mean (μg/g)	RSD (%)	Projected inventory (kg)
Microdistillation/Spectrophotometric CN^-	1,980	51.6	693

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μg/g = micrograms per gram
kg = kilograms
Microdist/spec. = microdistillation/spectrophotometric
RSD = Relative standard deviation of the mean

Table 4-8. Tank 241-C-108 Cyanide Analytical Data (dry weight basis).[1]

Analyte	Overall mean μg/g	RSD (%)	Projected inventory (kg)
Microdistillation/Spectrophotometric CN^-	3,370	51.6	1,180

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μg/g = micrograms per gram
kg = kilograms
Microdist/spec. = microdistillation/spectrophotometric
RSD = Relative standard deviation of the mean

The data in Appendix B indicate that the material from riser 7 (94-AUG-012 and 94-AUG-014) shows a stratification of cyanide, with the highest concentration in the lower portion of the tank. However, the appearance of the material that was obtained (as described in Section 3.0) from riser 4 indicated that there was a possibility that mixing occurred during the sampling process. This mixing would explain the reasonable consistency of the results obtained from this riser (Esch 1995). Table 4-9 presents the average concentration of cyanide obtained from the two risers.

The tertiary analysis for anions was performed by ion chromatography (IC) on the auger composite samples using procedure LA-533-105 (Frye 1994c), with a water digested preparation. Table 4-10 presents the results for the tertiary analyses for anions.

4.6 RADIOCHEMICAL

Strontium-90 and cesium-137 (^{137}Cs) are major heat-producing radionuclides present in the Hanford Site waste tanks. The ^{90}Sr and ^{137}Cs analyses offer confirmation of heat load and hot spot models developed for the Ferrocyanide Safety Program. Hot spot and heat load models are used as part of the technical basis for moving a tank from the conditionally safe category to the unsafe category (Postma et al. 1994).

The ^{90}Sr analysis was performed using procedure LA-220-101 on both a fusion and acid digested preparation. The analytical results suggest that ^{90}Sr is equally soluble by both methods. All samples met the required criteria for the TCP accuracy standards. However, the results for samples S94T000335, S94T000336, and S94T000401 did not meet the required precision criteria of ± 10 RPD. Two of the samples (S94T000336 and S94T000401) were reanalyzed to verify the results. The repeated analysis confirmed the first results and substantiated the heterogeneous nature of the sample. No further reruns were requested or performed.

Table 4-9. Tank 241-C-108 Average Cyanide Concentration.[1]

Riser	Upper half[2] (µg/g)	Lower half[2] (µg/g)
4	2,040	2,180
7	944	8,310

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
[2]Concentrations based on dry weight.

Table 4-10. Tank 241-C-108 Ion Chromatography Results.[1]

Analyte	Overall mean (µg/g)	RSD (%)	Estimated inventory (kg)
Chloride	725	1.6	254
Fluoride	3,770	35.8	1,320
Nitrate	44,600	7.4	15,600
Nitrite	24,700	6.7	8,650
Phosphate	80,600	33.2	28,200

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = micrograms per gram
kg = kilograms
RSD - Relative standard deviation of the mean

The GEA for ^{137}Cs was performed in conjunction with analyses for cobalt-60 (^{60}Co), europium-154 (^{154}Eu), and ^{155}Eu. As expected, ^{137}Cs was the dominant gamma-emitting isotope in the waste. Cobalt and europium isotope concentrations were detected below the calibrated limits of the analytical instruments used. The analytical results suggest that the majority of ^{137}Cs in the waste is not dissolved by the acid digestion.

Table 4-11 provides the ^{90}Sr and ^{137}Cs overall means for the auger segments and auger composite samples from tank 241-C-108. The results for the remaining non-detected GEA analyses can be found in Appendix B of this report.

Additional analyses were conducted for the tertiary analytes. These tertiary analyses include uranium by phosphorescence, americium-241 (^{241}Am) by extraction, plutonium-238 (^{238}Pu) and $^{239/240}Pu$ by ion exchange, and total beta determination.

Table 4-11. Tank 241-C-108 Cesium-137 and Strontium-90 Results.[1]

Analyte	Data source	Overall mean (μCi/g)	RSD (%)	Estimated inventory (Ci)
^{137}Cs (fusion)	Segment results	259	30.3	90,700
^{137}Cs (acid)	Segment results	22.3	78.5	7,810
^{137}Cs (acid)	Composite results	118	88.9	41,300
^{90}Sr (fusion)	Segment results	27.0	28.0	9,450
^{90}Sr (acid)	Segment results	24.1	34.6	8,440

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μCi/g = microcuries per gram
Ci = Curies
RSD = Relative standard deviation of the mean

The ^{238}Pu and $^{239/240}$Pu analyses were performed on the auger composite samples from risers 4 and 7 using procedure LA-503-156 (Fritts 1994) on a fusion-prepared sample. The ^{238}Pu samples did not exhibit results above the analytical instrument's calibrated detection limit, and are presented in Appendix B only.

The $^{239/240}$Pu analysis results for sample S94T000403 exceeded the TCP precision criteria of ±15 RPD. This may be a result of the presence of the analyte at levels only slightly above the detection limit. The counting statistics in this region are historically poor, contributing significantly to a lack of precision. A reanalysis was not requested or performed because the results were only slightly high, and because of the known heterogeneous nature of the samples. The $^{239/240}$Pu analysis results are given in Table 4-12.

The uranium analysis was performed on the auger composite samples from risers 4 and 7 using procedure LA-925-009 (Slippern 1995) on a fusion-prepared sample. The procedure referenced in the TCP was superseded by the above procedure. The accuracy and precision criteria were met for both samples in this analysis. The uranium analysis results are tabulated in Table 4-12. As the table indicates, notable concentrations of uranium were found in these samples.

The total beta analysis was performed on the auger composite samples from risers 4 and 7 on an acid digested sample using procedure LA-508-101 (Fitzgerald 1994). One beta analysis exceeded the TCP criteria of ±20 RPD. The auger composite sample from riser 4 (S94T000404) was rerun once, but the results did not change. No further reruns were requested or performed. The total beta analysis results are given in Table 4-12.

Table 4-12. Tank 241-C-108 Plutonium-239/240, Uranium, and Total Beta Results.[1]

Analyte	Data source	Overall mean	RSD	Estimated inventory
		μCi/g	%	Ci
$^{239/240}$Pu	Composite results	0.00936	20.2	3.28
Total beta	Composite results	200	45.8	70,000
		μg/g	%	kg
Uranium	Composite results	421	15.3	147

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μCi/g = microcuries per gram
Ci = Curies
μg/g = micrograms per gram
kg = kilograms
RSD = Relative standard deviation of the mean

The ^{241}Am analysis was performed on the auger composite samples from risers 4 and 7 using procedure LA-953-103 (Fritts 1995) on fusion-prepared samples. The procedure referenced in the TCP (LA-503-156) was superseded by this new procedure. The method uses a tracer element, so no spikes were performed. Both ^{241}Am samples were below the analytical instrument's detection limit, and are presented only in Appendix B of this report.

Cobalt-60, ^{154}Eu, and ^{155}Eu analyses were performed by GEA using procedure LA-548-121 on fusion- and acid-prepared samples. None of these analyses resulted in the analytes being above the analytical instrument's detection limit. The results for these analyses are tabulated in Appendix B of this report.

4.7 TOTAL CARBON

TOC is an analyte of secondary interest in the Safety Screening DQO (Babad Redus 1994). The TOC concentration provides corroborative evidence of the total fuel content of the waste. The TOC and TIC analyses were performed using procedure LA-342-100 (Schroeder 1994). All analytical sample results were below the TCP notification limit of 30,000 μg/g.

The total carbon test was not available when these samples were delivered to the laboratory. However, the TOC and TIC tests were performed on the auger composite samples from risers 4 and 7, and an estimated total carbon value can be obtained by summing the TOC and TIC results from these locations. This value is only an estimate because, by procedure, any volatile organic carbon would have been purged from the sample during the TOC analysis.

In addition, the estimated inventory value, as with the TIC value, was obtained using the auger composite sample results for risers 4 and 7. Table 4-13 summarizes the total carbon results for tank 241-C-108.

4.8 INORGANIC GASES AND VAPORS (Huckaby 1995a)

Analytical results of sorbent trap and SUMMA[1] canister tank air samples for selected inorganic gases and vapors are shown in Table 4-14 in parts per million by volume (ppmv). Inorganic analyte sorbent traps were prepared and analyzed by PNL. SUMMA canisters were analyzed for inorganic analytes by OGIST. Reports by PNL (Lucke et al. 1995) and SNL/OGIST (Rasmussen 1994a, 1994b, 1994c, 1994d) describe sample preparation and analyses.

The small relative standard deviations (RSD) of the results (shown in the last column in Table 4-14), indicate that the precision of the reported results is good. Relative standard deviations range from 0.3 percent for nitrous oxide results to 30 percent for carbon monoxide results. The larger RSD of the carbon monoxide results is based on the fact that it is near the analytical method's limit of quantitation. The precision reported depends both on sampling parameters (e.g., sample flow rate and flow time for sorbent traps) and analytical parameters (e.g., sample preparation, dilutions, etc.), and the small RSDs suggest a high degree of control was maintained in the field and in the laboratories.

Table 4-13. Tank 241-C-108 Total Carbon Results.[1]

Analyte	Data source	Overall mean (μg/g)	RSD (%)	Estimated inventory (kg)
Total organic carbon	Segment results	945	30.6	331
	Composite results	1,250	29.3	438
Total inorganic carbon	Composite results	2,380	0.84	833
Total carbon (estimated)	Composite results	3,630	10.1	1,270

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μg/g = micrograms per gram
kg = kilograms
RSD = Relative standard deviation of the mean

[1]SUMMA is a trademark of Molectrics, Inc.

Table 4-14. Tank 241-C-108 Inorganic Gas and Vapor Concentrations.[1]

Compound	CAS number	Sample type	Number of samples	Average (ppmv)	Standard deviation (ppmv)	RSD (%)
Ammonia	7664-41-7	Sorbent trap[2]	6	2.7	0.3	11
Carbon dioxide	124-38-9	SUMMA[3]	3	[16.3][4]	1.5	9
Carbon monoxide	630-08-0	SUMMA[3]	3	[0.10][4]	0.03	30
Hydrogen	1333-74-0	SUMMA[3]	3	[15.3][4]	1.2	8
Nitric oxide	10102-43-9	Sorbent trap	6	0.24	0.01	4
Nitrogen dioxide	10102-44-0	Sorbent trap	6	≤0.04	---	---
Nitrous oxide	10024-97-2	SUMMA[3]	3	[344][4]	1	0.3
Water vapor	7732-18-5	Sorbent trap	6	24,300	2,100	10

[1]Huckaby, J. L., 1995a, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-423, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
[2]Sorbent trap results by Pacific Northwest Laboratory (Lucke, R. B., M. W. Ligotke, K. H. Pool, T. W. Clauss, A. K. Sharma, B. D. McVeety, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-C-108: Results from Samples Collected Through the Vapor Sampling System on 8/5/94*, PNL-10351, Pacific Northwest Laboratory, Richland, Washington).
[3]SUMMA (trademark of Molectric, Inc.) canister results by Oregon Graduate Institute of Science and Technology (Rasmussen, R. A., 1994a, *Oregon Graduate Institute Vapor Analysis Results, Tank 241-C-108, August 1994*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon).
[4][ ] indicate that because OGIST did not follow the WHC QC procedure, this data is only allowed to be used as secondary data.

CAS = Chemical Abstracts Service
RSD = Relative standard deviation (of the data)
ppmv = Parts per million by volume

4.8.1 Ammonia, Hydrogen, and Nitrous Oxide

The reported ammonia concentration, 2.7 ppmv, is lower than ammonia concentrations typically observed in the waste tank headspaces. The relatively low ammonia concentration may be related to the fact that only a small quantity of relatively cool waste is stored in tank 241-C-108.

Hydrogen and nitrous oxide are commonly detected gases in the waste tanks. Believed to be products of chemical reactions and radiolysis of the waste, they have been found above the 1 ppmv level in virtually all the tank headspaces sampled to date. In general, hydrogen is of concern as a fuel. However, the measured 15.3 ppmv of hydrogen in tank 241-C-108 represents only about 0.04 percent of the lower flammability limit for hydrogen in air, and it is not a flammability concern at this level.

4.8.2 Carbon Dioxide and Carbon Monoxide

The average measured headspace carbon dioxide concentration, 16.3 ppmv, is considerably lower than normal ambient air concentrations of about 400 ppmv. Few data on waste tank headspace carbon dioxide concentrations are available, but lower than ambient concentrations are expected. Carbon dioxide introduced by air exchange with the atmosphere is readily absorbed by caustic supernatant and interstitial liquids of the waste tanks, and converted to carbonate in solution. It is reasonable to expect the level of carbon dioxide in a tank headspace will therefore depend on the tank's breathing rate, the pH, and surface area of aqueous waste (i.e., supernate, interstitial liquid, and condensate) in the tank. For comparison, the carbon dioxide concentrations of the cascaded tanks 241-BY-104, 241-BY-105, and 241-BY-106 are 10.5 ppmv, 94 ppmv, and 47.6 ppmv, respectively (Rasmussen 1994b, 1994c, 1994d).

Carbon monoxide in the tank 241-C-108 headspace, at approximately 0.10 ppmv, is about the same as in ambient air, where it typically ranges from 0.05 to 0.15 ppmv. Elevated waste tank headspace carbon monoxide concentrations are common (e.g., carbon monoxide concentration in tank 241-C-103 was 26.7 ppmv (Huckaby and Story 1994) and are thought to result from the decomposition of organic waste in the tanks. The relatively low carbon monoxide in tank 241-C-108 may be attributed to the fact that the tank has a relatively small, cool, waste inventory.

4.8.3 Nitric Oxide, Nitrogen Dioxide, Water and Tritium

Nitric oxide and nitrogen dioxide concentrations in the tank 241-C-108 headspace were determined to be 0.24 ppmv and $\leq$0.04 ppmv, respectively. These are both acid gases that would have very low equilibrium concentrations above the high pH sludge in tank 241-C-108. The measurable presence of nitric oxide may be caused by its formation from oxygen and nitrogen in the radiation field of the headspace.

The water vapor concentration of tank 241-C-108 was determined to be about 17.5 mg/L at the tank headspace temperature of 25 °C (77 °F) and pressure of 990 mbar (743 torr) (WHC 1995). This corresponds to a water vapor partial pressure of 24.1 mbar (18.1 torr), to a dew point of 20.5 °C (68.9 °F), and to a relative humidity of 76 percent.

Silica gel sorbent traps were used to test for tritium. It is assumed that tritium produced by the waste combines with hydroxide ions to form tritium-substituted water. Evaporation of the tritium-substituted water would then result in airborne radioactive contamination. Silica gel sorbent traps adsorb virtually all (normal and tritium-substituted) water vapor from the sampled tank air, and are analyzed at the WHC 222-S Laboratory. Analysis of the silica gel, which would have trapped approximately 20 mg of water vapor, indicated the total activity of the sample to be below the method detection limit of 50 pCi (WHC 1995).

4.9 ORGANIC VAPORS

Organic vapors in the tank 241-C-108 headspace were sampled using SUMMA canisters, which were analyzed at PNL, and triple sorbent traps (TST), which were analyzed by Oak Ridge National Laboratory (ORNL). None of the positively or tentatively identified organic analytes were at or above levels of concern. Both laboratories used gas chromatography and mass spectrometry to separate, identify, and quantitate the analytes. Descriptions of sample device cleaning, sample preparations, and analyses are given by Jenkins et al. (1994) and Lucke et al. (1995). A quantitative measurement of the total organic vapor concentration by the U.S. Environmental Protection Agency (EPA) task order 12 (TO-12) method was also performed by OGIST (EPA 1988; Rasmussen 1994a).

SUMMA sample results should be considered to be the primary organic vapor data for tank 241-C-108. Analyses of TST samples from this and other waste tanks generally agree with, support, and augment the SUMMA sample results. However, because certain WHC quality assurance requirements were not satisfied by ORNL, the quality assurance assessment of ORNL by Hendrickson (1995) should be reviewed before results unique to the TST samples are used for decision making purposes.

4.9.1 Positively Identified Organic Analytes

Oak Ridge National Laboratory positively identified and quantitated 17 of 27 analytes selected by WHC (10 analytes were below detection limits). These analytes and their average concentrations from the analysis of five TSTs are given in Table 4-15. The 27 TST target analytes for tank 241-C-108 were based on the tank 241-C-103 target analytes, which were selected by a PNL panel of toxicology experts as being of potential toxicological concern (Mahlum et al. 1994). Of the 17 analytes positively identified by ORNL, only acetone was within the calibration range of the method. The other 16 positively identified analytes were at concentrations lower than the calibration range, and their concentrations should be considered to be estimates.

Also given in Table 4-15 are the organic compounds positively identified and quantitated in SUMMA canister samples by PNL and OGIST. Pacific Northwest Laboratory performed analyses according to the EPA TO-14 methodology (EPA 1988; Lucke et al. 1995). Only 2 of the 40 TO-14 analytes were observed to be above the 0.002 ppmv quantitation limit of the analyses (the complete TO-14 analyte list can be found in Lucke et al. 1995), and one of these analytes--1,1,2-trichloro-1,2,2-trifluoroethane--is thought to be a contaminant of analysis. The results for methane are those of OGIST (Rasmussen 1994a). Averages reported are from analyses of three SUMMA canister samples except where noted.

Three target analytes were common to the ORNL and PNL analyses: dichloromethane, benzene, and toluene. Neither ORNL nor PNL detected dichloromethane. Oak Ridge National Laboratory detected trace amounts of benzene and toluene, but these were below the limit of detection of PNL (0.002 parts per billion by volume).

Table 4-15. Tank 241-C-108 Positively Identified Organic Carbon Compound Average Concentration.[1] (sheet 1 of 2)

Compound	CAS number	Sample type	Average (ppmv)	Standard deviation (ppmv)	RSD (%)
Methane	74-82-8	SUMMA[2,3]	0.67	0.01	0.1
Trichlorofluoromethane	75-69-4	SUMMA	0.0095	1.4E-04	2
1,1,2-Trichloro-1,2,2-trifluoroethane[4]	76-13-1	SUMMA	0.0087	6.0E-04	7
Ethanenitrile[5] (acetonitrile)	75-05-8	TST[6]	0.0052	0.0032	61
Propanone (acetone)	67-64-1	TST	0.018	0.019	110
n-Hexane[5]	110-54-3	TST	2.9E-04	6.4E-04	224
Benzene[5]	71-43-2	TST SUMMA	3.8E-04 <0.002	3.0E-04 ---	79 ---
1-Butanol[5]	71-36-3	SUMMA	4.9E-04	6.0E-04	121
n-Heptane[5]	142-82-5	TST	1.3E-04	3.0E-04	224
Toluene[5]	108-88-3	TST SUMMA	2.4E-04 <0.002	4.7E-04 ---	192 ---
2-Hexanone[5]	591-78-6	TST	1.2E-04	2.4E-04	193
n-Octane[5]	111-65-9	SUMMA	1.4E-04	2.8E-04	201
2-Heptanone[5]	110-43-0	TST	1.6E-04	2.8E-04	174
n-Nonane[5]	111-84-2	TST	2.1E-04	2.8E-04	136
Octanenitrile[5]	124-12-9	TST	1.2E-05	2.6E-05	224
Nonanenitrile[5]	2243-27-8	TST	8.1E-05	7.7E-05	95
n-Dodecane[5]	112-40-3	TST	5.3E-04	5.8E-04	110
n-Tridecane[5]	629-50-5	TST	0.0011	0.0011	97
Dibutyl butylphosphonate[5]	75-46-4	TST	8E-06	4.0E-06	55
Tributyl phosphate[5]	126-73-8	TST	7.5E-05	6.9E-05	92

Table 4-15. Tank 241-C-108 Positively Identified Organic Carbon Compound Average Concentration.[1] (sheet 2 of 2)

Compound	CAS number	Sample type	Average (ppmv)	Standard deviation (ppmv)	RSD (%)
Sum of nonmethane positively identified compounds			0.045	---	---

[1]Huckaby, J. L. 1995a, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-423, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
[2]Methane analyses by Oregon Graduate Institute of Science and Technology (Rasmussen, R. A., 1994a, *Oregon Graduate Institute Vapor Analysis Results, Tank 241-C-108, August 1994*, Oregon Graduate Institute of Science and Technology, Beaverton, Oregon), all other SUMMA (trademark of Molectrics, Inc.) canister results by Pacific Northwest Laboratory (Lucke, R. B., M. W. Ligotke, K. H. Pool, T. W. Clauss, A. K. Sharma, B. D. McVeety, M. McCulloch, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-C-108: Results from Samples Collected Through the Vapor Sampling System on 8/5/94*, PNL-10351, Pacific Northwest Laboratory, Richland, Washington).
[3]SUMMA canister results based on analyses of three samples.
[4]Suspect contamination.
[5]Two or more samples fell outside of calibration range.
[6]TST results are based on five samples, except where noted.

CAS = Chemical Abstracts Service
RSD = Relative standard deviation (of the data)
ppmv = Parts per million by volume
TST = Triple sorbent tube

The two most abundant analytes in Table 4-15 are methane and acetone. At 0.67 ppmv, the methane concentration in tank 241-C-108 is at about the same level as ambient air. Elevated methane concentrations have been observed in other waste tank headspaces, and methane is probably formed during the chemical and radiolytic degradation of organic wastes. Acetone, at 0.018 ppmv, presents virtually no flammable or toxicological risks.

4.9.2 Tentatively Identified Organic Analytes

In addition to targeted analytes, both ORNL and PNL analytical procedures allow the tentative identification of other organic vapors. By the nature of the samples and their analysis, virtually all 3 to 15 carbon organic compounds present in the tank headspace above analytical detection limits are observable. The PNL list of tentatively identified compounds, with estimated concentrations, is given in Table 4-16, and the ORNL list of tentatively identified compounds and their estimated concentrations is given in Table 4-17. Estimated concentrations are in milligrams per cubic meter (mg/m^3) based on dry air at 0 °C (32 °F) and 1.01 bar.

Table 4-16. Tank 241-C-108 Tentatively Identified Organic Compounds in SUMMA[1] Samples.[2]

Compound	CAS number	Average (mg/m^3)	Standard deviation[3] (mg/m^3)
Ethanenitrile (acealdehyde)	75-07-0	0.10	0.02
Propanone (acetone)	67-64-1	0.09	0.03
Sum of tentatively identified compounds		0.19	---

[1]SUMMA is a trademark of Molectrics, Inc.
[2]Huckaby, J. L., 1995a, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-423, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
[3]Standard deviation of the data.

CAS = Chemical Abstracts Service
mg/m^3 = milligrams per cubic meter

Oak Ridge National Laboratory and PNL tentatively identify analytes by comparing the mass spectrometry (MS) molecular fragmentation patterns with a library of known MS fragmentation patterns. This method allows an organic analyte to be identified (with reasonable certainty) as an alkane, a ketone, an aldehyde, etc., and also determines its molecular weight (which specifies the number of carbon atoms in the molecule). However, the method usually does not allow the unambiguous identification of structural isomers, and this ambiguity increases with analyte molecular weight. This point is illustrated by the entries in Table 4-17, particularly near the bottom of the table where the analytes have higher molecular weights.

The PNL and ORNL methods used to tentatively identify and estimate concentrations are described by Jenkins et al. (1994) and Lucke et al. (1995), respectively, and should be reviewed before these data are used for decision-making purposes. Results in Tables 4-16 and 4-17 are presented in terms of observed peaks, and are not adjusted for the occurrence of split chromatographic peaks (e.g., compound number 30 and 32 in Table 4-17). In these instances, the estimated concentration of a compound appearing as a doublet or triplet is simply the sum of the individual peak estimates.

Concentrations given in Tables 4-16 and 4-17 should be considered to be rough estimates. The proper quantitation of all observed analytes is outside the scope and budget of these analyses, and the estimation of concentrations involves several important assumptions. The validity of each assumption depends on the analyte and such factors as the specific configuration of the analytical instrumentation.

4.9.3 Total Nonmethane Organic Compounds

The OGIST measured the total nonmethane organic compound concentration in three SUMMA canister samples using the EPA TO-12 method (Rasmussen 1994a). The sample mean was 0.35 mg/m^3, with a standard deviation (of the data) of 0.02 mg/m^3. Although data

Table 4-17. Tank 241-C-108 Tentatively Identified Organic Compounds in Triple Sorbent Tube Samples.[1] (sheet 1 of 3)

Compound	CAS number	Average (mg/m³)
1-Butene	106-98-9	0.038
Methane, trichlorofluoro	75-69-4	0.042
Acetic acid	64-19-7	0.083
Acetic acid	64-19-7	0.038
Propanoic acid	79-09-4	0.003
Hexanal	66-25-1	0.010
Cyclotrisiloxane, hexamethyl	541-05-9	0.026
Alkanone	--	0.012
Heptanal	111-71-7	0.009
4H-1,2,4-Triazol-3-amine, 4-ethyl	42786-06-1	0.004
Ethanol, 2-Butoxy	111-76-2	0.001
Cyclobutane, 1,1,2,3,3-pentamethyl	57905-86-9	0.002
Cyclotetrasiloxane, octamethyl	556-67-2	0.020
Benzene, (1-methylethenyl)-	98-83-9	0.001
Octanal	124-13-0	0.016
1-Hexanol, 2-Ethyl	104-76-7	0.006
1-Octanol	111-87-5	0.004
Ethanone, 1-phenyl	98-86-2	0.001
Benzenemethanol, a,a-dimethyl	617-94-7	0.006
Nonanal	124-19-6	0.018
Benzoic acid, 2-[(trimethylsilyl)oxy]-trimethylsilyl ester	3789-85-3	0.002
1-nonanol	143-08-8	0.002
Decanal	112-31-2	0.011
Benzenamine, N-phenyl	122-39-4	0.001
1,3,5,7-Tetraazatricyclo[3.3.1.13,7]decane	100-97-0	0.001
2,5-Pyrrolidinedione, 1-methyl	1121-07-9	0.001
Undecanal	112-44-7	<0.001
Decanoic acid	334-48-5	<0.001
Alkane	--	<0.001
Butanoic acid, butyl ester and siloxane	--	<0.001
Alkane	--	0.002

Table 4-17. Tank 241-C-108 Tentatively Identified Organic Compounds in Triple Sorbent Tube Samples.[1] (sheet 2 of 3)

Compound	CAS number	Average (mg/m³)
Butanoic acid, butyl ester	109-21-7	<0.001
Tetradecane	629-59-4	0.002
Dodecanal	112-54-9	<0.001
Mixture	--	<0.001
Decane, 1,1'-oxybis	2456-28-2	<0.001
5,9-Undecadien-2-one, 6,10-dimethyl-,(Z)-	3879-26-3	0.002
2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)	719-22-2	<0.001
Alkanol and alkyl benzene	--	0.001
C12-Alkene	--	0.003
Alkene	--	<0.001
2,5-Cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)	719-22-2	0.002
Hexadecane	544-76-3	0.001
Tetradecanoic acid	544-63-8	0.002
Decanoic acid	334-48-5	<0.001
Dodecanoic acid	143-07-7	0.010
Tetradecane	629-59-4	<0.001
Dodecane, 2-methyl-6-propyl	55045-08-4	0.003
Propanoic acid, 2-methyl-1(1,1-dimethylethyl-2-methyl-1,3-propanediyl) ester	74381-40-1	0.017
Benzenamine, N-phenyl	122-39-4	0.009
Hexadecanamide	629-54-9	0.001
N-Hexyl-benzene-sulfonamide	--	0.003
para-T-Butyl Benzoic acid, methyl ester	--	0.002
1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester	117-81-7	0.001
Octadecanoic acid	57-11-4	0.001
Mixture	--	0.001
1-Hexadecanoil and others	--	0.002
Mixture (alkane and alkanoic acid)	--	0.002
Mixture	--	0.002
9-Octadecenoic acoid, (Z)-	112-80-1	0.003

Table 4-17. Tank 241-C-108 Tentatively Identified Organic Compounds in Triple Sorbent Tube Samples.[1] (sheet 3 of 3)

Compound	CAS number	Average (mg/m^3)
1,1'-Biphenyl, 2,2-diethyl	13049-35-9	0.001
Tetradecenoic acid	544-63-8	0.055
Benzenesufonamide, N-butyl	3622-84-2	0.1312
Tetradecanoic acid, 12-methyl, (S)	5746-58-7	0.005
Cyclohexanol, 1,1'-dioxybis-and others	--	<0.001
Pentadecanoic acid	1002-84-2	0.023
C14-Alkene	--	0.016
1-Hexadecanol	36653-82-4	0.012
Alkanol	--	0.001
Hexadecane	544-76-3	0.001
Alkane	--	0.004
9-Hexadecenoic acid	2091-29-4	0.062
Hexadecanoic acid	57-10-3	0.120
1,2-Benzenedicarboxylic acid, butyl 2-methyl propyl ester	17851-53-5	0.004
Alkanol	--	<0.001
1-Hexadecanol	36653-82-4	0.001
1-Hexadecanol, acetate	629-70-9	0.002
1-Hexadecanol, 2-methyl	2490-48-4	0.002
Hexadecanoic acid	57-10-3	0.002
Hexadecanoic acid, 1-methylethyl ester	142-91-6	0.007
Sum of tentatively identified compounds		0.881

[1]Huckaby, J. L., 1995a, *Tank 241-C-108 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-423, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

CAS = Chemical Abstracts Service
mg/m^3 = milligrams per cubic meter

on other tanks is limited, this value is low compared to most other waste tanks sampled to date. For comparison, the total nonmethane organic compound concentration in clean ambient air may range from 0.030 to 0.100 mg/m^3.

4.9.4 Discussion of Organic Analytes

In general, the organic analytes observed in the waste tank headspaces are indicative of the types of organic waste that have been stored in each tank. Examination of the data provides clues to both the current organic constituents and the chemical reactions which they undergo.

Some of the compounds listed in Tables 4-15, 4-16, and 4-17 were introduced to the tank with process waste streams, and are detected in the headspace because the original inventory has not been completely evaporated or degraded. Examples of these are tributyl phosphate, which was used as an extractant in several Hanford Site processes; dibutyl butylphosphonate, which was a contaminant of tributyl phosphate; and the semivolatile normal paraffin hydrocarbons (NPH) (i.e., n-undecane, n-dodecane, n-tridecane, and n-pentadecane) that were used as a diluent for tributyl phosphate.

Notably absent from the tank 241-C-108 headspace are the semivolatile cyclic alkanes (e.g., methylated decahydronaphthalenes, cyclopentanes, and cyclohexanes) that have been observed in the 241-BY Tank Farm. This suggests that, like tank 241-C-103, the semivolatile organic waste in tank 241-C-108 may be from the PUREX process, which in the late 1960's used a relatively pure form of semivolatile NPHs as a process diluent.

Most of the compounds in Tables 4-15, 4-16, and 4-17 are believed to be chemical reaction and radiolytic reaction products of the semivolatile or nonvolatile organic waste stored in the tank. For example, 1-butanol is known to be formed by the hydrolysis of tributyl phosphate, and it has been suggested that the alcohols, aldehydes, ketones, nitriles, alkenes, and short-chain alkanes are all degradation products of NPHs.

There is an apparent correlation between acetone and 1-butanol in the waste tank headspaces, and tanks that have higher than average organic vapor concentrations tend to have both high acetone and high 1-butanol concentrations. In tank 241-C-108, however, the 1-butanol concentration is only about 3 percent of the acetone concentration.

Examination of the compounds listed in Tables 4-15, 4-16, and 4-17 suggests that many of the volatile species (presumed to be degradation products of the NPHs) have functional groups on the molecule's first or second carbon atom. For example, most alkenes listed have their double bond between the first and second carbon atoms, and ketones generally have the double bonded oxygen atom on the second carbon atom.

Though their concentrations are not significant, many alcohols and acids were tentatively identified by ORNL (Table 4-17). These have generally not been observed to be as numerous in other NPH-rich tank headspaces, which tend to be dominated by aldehydes, ketones, and alkenes.

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5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

The purpose of this section is to evaluate the overall quality and consistency of the available results for tank 241-C-108 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. Some consistency checks were limited in scope because of the lack of certain analyses, and some checks were not possible at all. For example, the assessment of data quality made by the calculation of a mass and charge balance was limited in that several analytes that could have had some impact on the results were not measured. Also, a comparison between the ICP and IC results for sulfur/sulfate was not possible because neither were analyzed. Finally, a direct examination of data reliability through a comparison of analytical results taken from a common riser was not possible. Although two auger samples were taken from riser 7, they were obtained from different depths; i.e., they did not sample the same waste.

5.1.1 Field Observations

The core 61 sample was taken from riser 3 and consisted of 2.5 cm (1 in.) of sludge. Considering the very poor sample recovery from core 61 and its close proximity to riser 4 (in which good recovery was achieved from a full 51-cm [20-in.] auger sample), it was decided not to include any of the core 61 data in the estimates of data consistency or overall analyte concentration. The heterogeneous appearance of the auger samples and their resistance to being fully homogenized before sample analysis was noted by the hot-cell chemist. This heterogeneity caused many problems in the quality control estimates of data accuracy and precision, leading to uncertainty regarding the reliability of the data.

5.1.2 Quality Control Assessment

The usual quality control assessment includes an evaluation of the appropriate blanks, duplicates, spikes, and standards that are performed in conjunction with the chemical analyses. All the pertinent quality control tests were conducted with the 1994 core and auger samples, allowing a full assessment regarding the accuracy and precision of the data.

The standard and spike results provide an estimate of the accuracy of the analysis. If a standard or spike is above or below the criterion, then the analytical results may be biased high or low, respectively. The accuracy criterion varies from 90 to 110 percent recovery to 80 to 120 percent recovery, depending on the analyte (Schreiber 1994a; 1994b). Of the standards conducted on the 1994 core and auger samples, the only violations occurred in the

composite sample from riser 4. Americium-241 had standard recovery of 125.3 percent (criterion = 80 to 120 percent recovery) and $^{239/240}$Pu had a standard recovery of 116.9 percent (criterion = 85 to 115 percent recovery) (Esch 1995). Regarding spike recoveries, cyanide had two of three spikes slightly outside the 90 to 110 limits (116 and 111 percent recovery). This deviation was explained as problems with sample heterogeneity. For the ICP metals, the criterion was also 90 to 110 percent recovery. Nickel had one of four spikes outside the limits (116.6 percent recovery); aluminum had one of one outside (124.3 percent recovery); calcium and iron had one of two outside (112 and 110.2 percent recovery, respectively); and phosphorus had two of two outside (53.7 and 89.4 percent recovery). The sample results for sodium and the other aluminum sample were greater than four times the spike added, therefore, the spike recovery was not applicable (Esch 1995). Also, one of three spike recoveries for chloride and fluoride was slightly below the criterion of 90 to 110 percent recovery (89.5 and 83.9 percent recovery, respectively).

Primary and duplicate samples were also available for evaluation from all of the 1994 auger sampling events. The criterion for precision varies from ± 10 to ± 20 percent, depending on the analyte. This precision requirement is calculated by the RPD between primary and duplicate samples. The RPD is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred. As mentioned in Section 3.0, the material from the three auger samples was heterogeneous in nature, as observed and photographed by the hot-cell chemist. Most of the samples consisted of a paste-like solid with crumbly, hard chunks of material embedded throughout. This chunky material could not be homogenized with the rest of the sample in preparation for chemical analysis, making it difficult to meet the accuracy and precision requirements defined in the TCP (Schreiber 1994a, 1994b). In many cases, reruns were not requested because of the known heterogeneous nature of the samples (Esch 1995). For example, 4 of 8 RPDs for percent water exceeded the precision requirement of 10 percent. Some reruns were conducted, but the results gave no improvement. Further reruns were not requested because of the high dose rate of the samples, the homogeneity problems, and the low probability of improving the results. Similar reasons were given for not conducting reruns on the two DSC samples in which exotherms were detected and in which precision requirements were not met. The heterogeneity problem was also frequently mentioned by laboratory personnel regarding many other analytes when the precision requirement was not met. Precision results were especially poor for all the IC analytes, TIC, TOC, nickel, and all the other ICP metals, except sodium.

Preparation blanks are used to identify any sample contamination that was introduced in the laboratory during the process of sample breakdown, digestion, and dilution. All blanks were either not detected or were < 10 percent of the average of the primary and duplicate sample, with the exception of one TOC result from riser 7 (13 percent of the average). Thus, contamination was not a serious problem for any of the analytes.

In summary, the reliability of the analytical results may be suspect for those analytes that failed to meet the accuracy and precision requirements. However, the many violations of the precision criterion probably overstates the problem because of the lack of homogeneous samples available for the chemical analyses.

5.1.3 Data Consistency Checks

Data consistency checks help to assess the overall consistency of the results. Inconsistencies can show that the data are unreliable. The following checks have been performed in this section: comparison between the ICP phosphorus value and the IC phosphate number, comparisons of total alpha and total beta to the sum of their individual emitters, and a mass and charge balance.

5.1.3.1 Comparison of Phosphate and Phosphorus. The ICP phosphorus result from Table 4-6 was compared with the IC phosphate value from Table 4-10. The 26,800 μg/g of phosphorus converted to 82,100 μg/g of phosphate. The analytical phosphate result was 80,600 μg/g. The excellent agreement between the two values was evidenced by the low RPD of 1.8 percent.

5.1.3.2 Comparison of Total Alpha and Total Beta with the Sum of the Individual Isotopes. This evaluation can be used to ascertain the performance of the radiochemical separation methods or as an indicator that other isotopes may be present in significant quantities. The sum of the beta emitters was calculated according to the following equation:

$$\text{Sum of beta emitters} = (1.42) \times (2 \times {}^{90}\text{Sr}) + (1.51) \times {}^{137}\text{Cs}.$$

The factor of 2 in the equation accounts for the yttrium-90 (^{90}Y) daughter product, and the factors of 1.42 and 1.51 account for the detector efficiencies calibrated to ^{60}Co. The comparison is presented in Table 5-1. The resulting RPD of 80.2 percent indicates a relatively poor correlation between the two results.

A comparison was also performed between the measured total alpha activity and the sum of the individual alpha emitters. The sum of the alpha emitters was determined according to the following equation:

$$\text{Sum of alpha emitters} = {}^{241}\text{Am} + {}^{238}\text{Pu} + {}^{239/240}\text{Pu}.$$

Table 5-1. Comparison of Total Beta Activity with the Sum of the Individual Activities.

Analyte	Half-life (years)	Result (μCi/g)
^{90}Sr	28.6	27.0
^{137}Cs	30.17	259
Sum of beta emitters	---	468
Total beta result	---	200
Relative percent difference (%)	---	80.2

μCi/g = microcuries per gram

The total alpha comparison is provided in Table 5-2. The ^{241}Am and ^{238}Pu values were taken from Appendix B. The total alpha result was obtained from Table 4-3. As evident in Table 5-2, there was good correlation between the two results with an RPD of only 20.5 percent.

5.1.3.3 Mass and Charge Balance. The principle objective in performing a mass and charge balance is to determine if the measurements are self-consistent. Because of the limited number of analyzed metals and anions, all results from the auger samples were used in the calculations.

With the exception of sodium, all cations listed in Table 5-3 were assumed to be present in their most common hydroxide or oxide forms, and the concentrations of the assumed species were calculated stoichiometrically (from the data in Table 4-6). There may be some argument about whether certain species are hydroxides or oxides, but the difference in molecular weight has a minimal effect on the overall mass balance. Although smaller concentrations of other forms of the species are probably present in the waste, they are not included in order to keep the mass and charge balance calculations simple and consistent. The cyanide in the tank is assumed to be present as the precipitate $Na_2NiFe(CN)_6$. The amounts of Fe and Ni in that compound were determined and deleted from the cation mass balance, since they are already being included in the anion balance through the cyanide assumed species calculation. These amounts are shown in column four of Table 5-3.

Because precipitates are neutral species, all positive charge was attributed to the sodium cation. All anions listed in Table 5-4 (taken from Table 4-10) were assumed to be present as soluble or insoluble sodium salts, and were expected to balance the positive charge.

Table 5-2. Comparison of Total Alpha Activity with the Sum of the Individual Activities.

Analyte	Half-life (years)	Result (μCi/g)
^{241}Am	458	<0.0294
^{238}Pu	86	<0.00282
$^{239/240}Pu$	24,400	0.00936
Sum of alpha emitters	---	0.0416
Total alpha result	---	<0.0511
Relative percent difference (%)	---	20.5

μCi/g = microcuries per gram

Table 5-3. Cation Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed species	Amount of analyte in assumed species[1] (μg/g)	Concentration of assumed species (μg/g)	Charge (μmol/g)	RSD (%)
Al	52,100	$Al(OH)_3$	---	151,000	0	24.2
Ca	12,700	CaO	---	17,800	0	33.5
Fe	7,170	$Na_2NiFe(CN)_6$	709	--	0	--
		FeO(OH)	---	10,300	0	24.5
Ni	8,410	$Na_2NiFe(CN)_6$	745	--	0	--
		NiO	---	9,750	0	23.7
U	421	U_3O_8	---	496	0	15.3
Na	94,100	Na^+	---	94,100	4,090	22.7
Totals				283,000	4,090	15.2[2]

[1]This column contains the amounts of iron and nickel in $Na_2NiFe(CN)_6$. These numbers were listed separately and not included in the mass balance so their amounts would not be counted twice as they are included in Table 5-4 in the cyanide calculation.
[2]For an example of this calculation refer ahead to Table 5-5.

μg/g = micrograms per gram
μmol/g = micromoles per gram
RSD = Relative standard deviation of the mean

Table 5-4. Anion Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed species	Concentration of assumed species (μg/g)	Charge (μmol/g)	RSD (%)
NO_3^-	44,600	---	44,600	719	7.4
NO_2^-	24,700	---	24,700	537	6.7
PO_4^{3-}	80,600	---	80,600	2,550	33.2
F^-	3,770	---	3,770	198	35.8
Cl^-	725	---	725	20.4	1.6
TOC	945	$C_2H_3O_2^-$	2,320	39.3	30.6
TIC	2,380	CO_3^{2-}	11,900	397	0.84
CN^-	1,980	$Na_2NiFe(CN)_6$	4,020	0	51.6
Totals			173,000	4,460	15.7[1]

[1]For an example of this calculation refer ahead to Table 5-5.

μg/g = microgram/gram
μmol/g = micromole/gram
RSD = Relative standard deviation of the mean

The concentrations of the assumed species in Table 5-3, the anionic species in Table 5-4, and the percent water were used to calculate the mass balance. The mass balance was calculated from the following formula.

$$\text{Mass balance} = \% \text{ water} + 0.0001 \times \{\text{total analyte concentration}\}$$
$$= \% \text{ water} + 0.0001 \times \{Al(OH)_3 + CaO + FeO(OH) + NiO + Na^+ + U_3O_8 + NO_3^- + NO_2^- + PO_4^{3-} + F^- + Cl^- + C_2H_3O_2^- + CO_3^{2-} + Na_2NiFe(CN)_6\}$$

(The factor 0.0001 is the conversion factor from μg/g to weight percent.)
The total analyte concentration calculated from the above equation was 456,000 μg/g. The mean weight percent water obtained from TGA reported in Table 4-4 was 38.8 percent, or 388,000 μg/g. The mass balance obtained from adding the percent water to the total analyte concentration is 844,000 μg/g, or 84.4 percent (shown in Table 5-5). A perfect mass balance would have yielded a balance of 100 percent. The 14.6 percent RSD results in a target mass balance of 85.4 to 114.6 percent (100 $\pm$ 14.6) which places the 84.4 percent just slightly off the mark. These results indicate that one or more analytes, which constitute a portion of the waste, may not have been detected during analysis. All three waste types predicted by the TLM to be present in the tank contain hydroxide and sulfate, two anions not analyzed (Agnew et al. 1994b). The first-cycle waste, believed to be the bottom waste layer, should contain relatively large amounts of bismuth and minor amounts of chromium and zirconium. It is presumed that these analytes make up the majority of the missing 156,000 μg/g.

Table 5-5. Mass Balance Totals.

	Concentrations (μg/g)	RSD (%)[1]
Cation total from Table 5-3	283,000	15.2
Anion total from Table 5-4	173,000	15.7
Water	388,000	29.0
Grand total	844,000	14.6

[1]This value is derived by back-calculating each individual RSD to its variance, summing the variances for each analyte in the table, and then recalculating an overall RSD by using the total concentration as the divisor instead of a mean.

As an example, the overall RSD of 14.6 percent is calculated as follows:

$$\left(\frac{\sqrt{\left[\frac{15.2}{100}\ (283{,}000)\right]^2 + \left[\frac{15.7}{100}\ (173{,}000)\right]^2 + \left[\frac{29.0}{100}\ (388{,}000)\right]^2}}{844{,}000} \right) * 100$$

μg/g = micrograms per gram
RSD = Relative standard deviation

The charge balance is the ratio of total cations (micro equivalents) to total anions (micro equivalents) with respect to the species listed below, which were assumed to be water soluble:

Total cations (micro equivalents) = $Na^+/23.0$
The total cation charge, 4,090 μmol/g, is presented in Table 5-3.

Total anions (micro equivalents) = $NO_3^-/62.0 + NO_2^-/46.0 + PO_4^{3-}/31.7 + F^-/19 + Cl^-/35.5 + C_2H_3O_2^-/59 + CO_3^{2-}/30$
The total anion charge, 4,460 μmol/g, is derived in Table 5-4.

The ratio of total cation micro equivalents to total anion micro equivalents (+/-) was 0.917; a perfect charge balance would yield a ratio of 1.00. However, it appears that this charge balance is not truly representative of the tank contents for some of the major waste constituents which would likely have an impact on the charge balance, were not analyzed.

5.2 COMPARISON OF RESULTS FROM DIFFERENT SAMPLING EVENTS

Comparisons between the latest analytical results and historical data were not performed. The only historical sampling results available were from a drainable liquid sample in 1975. Because tank 241-C-108 no longer contains drainable liquid (Hanlon 1995), the 1975 results are no longer representative of the tank contents.

5.3 TANK WASTE PROFILE

Throughout the service life of tank 241-C-108, many waste types were received, including 1C waste, UR waste, ferrocyanide waste, PUREX cladding waste, HS waste, organic wash waste, and ion exchange waste. Because of transfers out of the tank throughout its history, the TLM reports that only three waste layers currently exist in the tank. The upper layer consists of ferrocyanide sludge, the middle and largest layer is UR waste, and the bottom layer is comprised of 1C waste (Agnew et al. 1994b). It is possible that residual amounts of the other waste types are still in the tank. Also, because of the large number of transfers into and out of the tank, it is unlikely that there are distinct transitions between the waste layers (Schreiber 1994b).

The riser 4 and riser 7 auger sampling events that took place in late 1994 met the TCP requirement of sampling from two risers located approximately 180° apart and near the outer edge of the tank (Schreiber 1994b). The sampling analysis from these risers provided information on the horizontal and vertical distribution of many of the analytes, allowing a statistical analysis of these data.

A statistical procedure known as the analysis of variance (ANOVA) was conducted on the 1994 auger samples to determine if there were any horizontal or vertical differences in analyte concentrations. Two different ANOVA models were utilized in these analyses: a one-way ANOVA was used on the riser 7 and riser 4 core composite-level data to make inferences about the horizontal distribution of the waste, and a random effects nested model was used on the riser 7 and riser 4 half-segment level data to make inferences about the horizontal and vertical distribution of the waste (see Subsection 3.1.1 for a full explanation on sample breakdown). Two assumptions were made while conducting these tests: (1) the population from which these samples were drawn was normally distributed, and (2) the samples used in making the comparisons had equal variances. The ANOVA generates a p-value, which is compared with a standard significance level ($\alpha = 0.05$). If a p-value is below 0.05, there is sufficient evidence to conclude that the sample means are significantly different.

However, if a p-value is above 0.05, there is not sufficient evidence to conclude that the samples are significantly different. Only analytes in which all values were detected were utilized in these analyses.

Composite-level data were available for the metals, the anions, TIC, total beta, and $^{239/240}Pu$. The results of the one-way ANOVA tests for these analytes indicated that significant horizontal differences existed for 7 of the 14 analytes tested. The segment-level tests were conducted on nickel, cyanide, TOC, ^{137}Cs, $^{89/90}Sr$, and percent water. The results of these ANOVA tests showed a significant horizontal difference only for percent water. However, there was a significant vertical difference in the concentrations of all six analytes, the general trend being increasing analyte concentration as a function of depth. Given that only 8 of 20 analytes showed horizontal differences, and 6 of 6 showed vertical differences, it could probably be concluded that tank 241-C-108 has a strong vertical heterogeneity and shows some horizontal heterogeneity.

The visual descriptions of the auger samples described the obvious heterogeneity of the samples with regard to the color (off-white to brown); texture (crumbly to paste-like); and the varying degrees of hard, chunky material embedded throughout the samples. This evidence also strongly implies some heterogeneity within the tank.

5.4 COMPARISON OF TRANSFER HISTORY AND ANALYTICAL INFORMATION

Analytical data from the 1994 auger sampling events are compared to the HTCE projections based on the tank's process history in Table 5-6. The HTCE values in column two are the same as those reported in Table 2-5. The analytical results presented in column three are taken from Section 4.0. Conversions have been made when needed so that units and chemical compounds are comparable.

The comparisons revealed that the HTCE values and the analytical data agree quite poorly. Several instances deserve mention. The ^{137}Cs comparison is closer if the core composite sample mean of 41,300 Ci is used. For ^{90}Sr, the data result was much higher than the predicted number. This may be indicative of the presence of HS waste, which the tank received between 1965 and 1969. The TLM (Agnew et al. 1995) does not predict that HS waste is still present in the tank, consequently, the HTCE ^{90}Sr value is low. On the other hand, HTCE predictions for uranium and iron were substantially higher than their analytical results. The TLM predicts that two-thirds of the sludge in tank 241-C-108 is composed of UR waste, which is rich in both uranium and iron. It is possible that UR waste constitutes a smaller proportion of the waste, which would account for the lower analytical values.

5.5 EVALUATION OF PROGRAM REQUIREMENTS

The core and auger samples taken in 1994 were acquired to meet the requirements of the Ferrocyanide Safety Program DQO (Meacham et al. 1994) and the Safety Screening DQO (Babad and Redus 1994). Evaluation of data in terms of operational, environmental, or process development requirements was not required. The Tank Vapor Sampling DQO was also evaluated against the August 5, 1994 sampling event. The requirement that the vaporspace be below 25 percent of the LFL was met in this case.

5.5.1 Safety Evaluation

Data criteria identified in the Ferrocyanide Safet DQO (Meacham et al. 1994) and the Safety Screening DQO (Babad and Redus 1994) are used to assess the safety of the waste in tank 241-C-108. For a proper safety assessment, both DQOs require samples from two widely spaced risers. The Ferrocyanide Safety Program DQO identifies two primary data requirements for tanks on the Ferrocyanide Watch List: total fuel and moisture content. Total fuel content is measured by DSC, and the decision limit is 8 wt%, or -481 J/g. Moisture content is measured by TGA, and the safety limit is dependent on the fuel content.

If the fuel content is below 8 wt%, the moisture content is not a concern for the ferrocyanide safety issue. Above 8 wt% fuel, the decision threshold for percent water is determined according to the equation: 4/3 (fuel content - 8).

Table 5-6. Comparison of Historical Tank Content Estimate and Analytical Data.

Analyte	HTCE	Analytical result
Heat load	104 W (355 Btu/h)	492 W (1,680 Btu/h)
Water (wt%)	59.7	38.8
TOC (wt% C [wet])	0.082	0.0945
Metals	**kg**	**kg**
Na	27,400	32,900
Al	2,560	18,200
Fe	25,200	2,510
Ni	1,270	2,940
Ca	1,490	4,450
Ions	**kg**	**kg**
NO_3^-	25,200	15,600
NO_2^-	447	8,650
CO_3^{2-}	3,570	4,170
PO_4^{3-}	10,700	28,200
F^-	523	1,320
Cl^-	500	254
[1]$Fe(CN)_6^{4-}$	1,100	941
Radiological constituents		
^{137}Cs	21,000 Ci	90,700 Ci
^{90}Sr	845 Ci	9,450 Ci
$^{239/240}Pu$	1.02 Ci	3.28 Ci
U	6,410 kg	147 kg

[1]Wet weight basis

HTCE = Historical Tank Content Estimate
W = watts
Btu/hr = British thermal units/hour
kg = kilograms
Ci = Curies

All differential scanning calorimetric analyses were endothermic with two exceptions: exothermic reactions were observed in both the primary and duplicate runs for subsamples S94T000292 and S94T000291. The energy content of the largest exotherm (on a wet weight basis) from subsample S94T000292 was -33.7 J/g, while the highest for subsample S94T000291 was -62.5 J/g. The respective corresponding dry weight results are -50.3 J/g and -116.3 J/g, clearly satisfying the -481 J/g criterion. Because the required moisture content is dependent on the fuel content, an estimate of the fuel as $[Na_2NiFe(CN)_6]$ based on the average dry weight cyanide value (from Table A-20) was calculated. The 3,370 μg/g of cyanide is equal to a fuel content weight percent of 0.684. Because the fuel content is <8 wt%, the moisture content is inconsequential for the ferrocyanide issue. Because cyanide is known to degrade, the $Na_2NiFe(CN)_6$ inventory that was estimated to have been placed in the tank, 7,950 kg (Borsheim and Simpson 1991), was compared to the inventory estimate of 2,400 kg based on the 1994 analytical data. These calculations indicate that more than two-thirds of the ferrocyanide that was originally placed in the tank has degraded.

The requirements of the Safety Screening DQO (Babad and Redus 1994) were met in all but one respect: the moisture content in two of the subsamples from sample 94-AUG-012 was below the 17 wt% criterion. The primary TGA result for subsample S94T000288 was 15.35% H_2O and the duplicate was 2.995, for an average of 9.17 wt%. A rerun exhibited a percent water of 6.01. Although the average weight percent water between primary and duplicate results for subsample S94T000290 was 18.8, the primary result was 9.94% H_2O. The rerun was also below 17 percent, with a result of 12.0 percent. The overall tank average was 38.8 wt% H_2O. The criticality issue is assessed using the total alpha concentration; the safety screening criterion is 1 g/L. Because the laboratory reports total alpha in units of μCi/g, the 1 g/L threshold can be converted into 43.9 μCi/g using the tank density of 1.40 g/mL. All of the results were far below this limit.

The final analyte required by the Safety Screening DQO (Babad and Redus 1994) was the gas composition of the tank headspace. The established safety limit for gas concentration is 25 percent of each gas's lower flammability limit. None of the gases of concern exceeded this 25 percent limit.

Table 5-7 lists the analyses required by the Safety Screening DQO, the sampling points, and the analytical results.

The ferrocyanide DQO identifies six secondary data requirements that, although not directly involved in determining the safety category of the tank, will expedite final resolution of the Ferrocyanide Safety Issue. In addition to total cyanide (discussed previously), measurements of the tank temperature and the nickel, TOC, ^{137}Cs, and ^{90}Sr concentrations are required. Decision limits were not established for these analytes.

The nickel concentration is measured because nickel is a signature analyte of the nickel ferrocyanide scavenging process (the only source of added nickel); the presence of nickel offers analytical evidence that ferrocyanide once existed in the tank (Meacham et al. 1994). The 8,410 μg/g nickel concentration shows that tank 241-C-108 did receive ferrocyanide waste.

Total organic carbon analyses provide information on fuel characterization and the fuel content of the waste. The auger sampling tank characterization plan established a notification limit of 30,000 μg/g of TOC (Schreiber 1994b). All results were well below this limit, ranging from 188 μg/g to 1,840 μ/g.

Determination of the ^{90}Sr and ^{137}Cs concentrations is necessary to estimate the heat load of the tank waste. Heat is generated in the tanks from radioactive decay, primarily from these radionuclides. Table 5-8 displays the head load estimation using the results of the fusion digested samples for ^{137}Cs and $^{89/90}Sr$ and including the contribution from $^{239/240}Pu$. Fusion digestion yielded the largest analytical values, which in turn will provide the most conservative heat load estimate. As can be seen in Table 5-8, the heat load was 492 W (1,680 Btu/h). This value is well below the 40,000 Btu/h criterion used to distinguish a high-heat tank from a low-heat tank (Bergmann 1991). For comparison: (1) the HTCE heat load estimate was 104 W (355 Btu/h), (2) (Kummerer, 1994) 5,960 Btu/hr, (3) (McLaren, 1994) 1.8 kw, (4) (Grigsby, 1992) 0.3 kw. Recorded tank temperatures have ranged between 17 °C (63 °F) and 33 °C (91 °F), with a mean temperature of 27 °C (81 °F).

Table 5-7. Safety Screening Data Quality Objective Decision Variables and Criteria. (sheet 1 of 2).

Safety issue	Primary decision variable	Decision criteria threshold	Auger or segment location[1]	Analytical value
Core 61				
Ferrocyanide/ organic	Total fuel content	481 J/g (115 cal/g)	Segment 1	No exothermic reactions observed
Organic	Percent moisture	17 wt%	Segment 1	21.0%
Criticality	Total alpha	43.9 μCi/g (1 g/L)[1]	Segment 1	<1.15 μCi/g
Riser 7 (94-AUG-012 and 94-AUG-014)				
Ferrocyanide/ organic	Total fuel content	481 J/g (115 cal/g)	Top ¼ segment S94T00288 and S94T000290	No exothermic reactions observed
			Second ¼ segment S94T000292	-33.7 J/g
			Third ¼ segment S94T000291	-62.5 J/g
Organic	Percent moisture	17 wt%	Top ¼ segment S94T000288	9.17 wt%
			Top ¼ segment S94T000290	18.8 wt%
			Second ¼ segment S94T000292	36.1 wt%
			Third ¼ segment S94T000291	46.0 wt%
Criticality	Total alpha	43.9 μCi/g (1 g/L)[1]	Top ¼ segment S94T000289	<0.0486 μCi/g
			Top ¼ segment S94T000296	0.0834 μCi/g
			Second ¼ segment S94T000298	0.0453 μCi/g
			Third ¼ segment S94T000297	<0.0317 μCi/g

Table 5-7. Safety Screening Data Quality Objective Decision Variables and Criteria. (sheet 2 of 2).

Safety issue	Primary decision variable	Decision criteria threshold	Auger or segment location[2]	Analytical value
Riser 4 (94-AUG-015)				
Ferrocyanide/ organic	Total fuel content	481 J/g (115 cal/g)	Whole segment	No exothermic reactions observed
Organic	Percent moisture	17 wt%	Top ¼ segment S94T000361	49.3 wt%
			Second ¼ segment S94T000362	49.5 wt%
			Third ¼ segment S94T000363	52.7 wt%
			Bottom ¼ segment S94T000364	48.5 wt%
Criticality	Total alpha	43.9 μCi/g (1 g/L)[1]	Top ¼ segment S94T000367	<0.0341 μCi/g
			Second ¼ segment S94T000368	<0.0326 μCi/g
			Third ¼ segment S94T000369	<0.0363 μCi/g
			Bottom ¼ segment S94t000370	<0.0958 μCi/g
Tank Headspace				
Flammable gas	Flammable gas	25% of the LFL	Headspace below riser 4	No gases exceeded criteria

[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. 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. Assuming a tank density of 1.40 and using the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criterion may be converted to 43.9 μCi/g as shown:

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

J/g = joules per gram
cal/g = calories per gram
μCi/g = microcuries per gram
DQO = Data Quality Objective
g/L = grams per liter
LFL = lower flammability limit

Table 5-8. Tank 241-C-108 Projected Heat Load.

Radionuclide	Curies	Watts
^{137}Cs	90,700	428
$^{89/90}Sr$	9,450	63.3
$^{239/240}Pu$	3.28	0.744
Total	--	492

The remaining analytes measured in the tank 241-C-108 waste samples were tertiary data requirements of the ferrocyanide DQO. Radiological and chemical analyses were necessary to validate waste aging models and to confirm waste transfer histories (Meacham et al. 1994). Confirmation of waste transfer histories is important because histories were used to identify which tanks belonged on the Ferrocyanide Watch List. No notification limits were established for these analytes.

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6.0 CONCLUSIONS AND RECOMMENDATIONS

The characterization of tank 241-C-108 presented in this TCR is based on several sampling and analysis events. The tank was sampled using the push mode core method in June 1994. However, because of insufficient recovery, three auger samples were obtained in November and December 1994. The tank headspace was also sampled in August 1994.

The two primary data requirements for the Ferrocyanide Safety Program DQO (Meacham et al. 1994) were satisfied. No exothermic reactions were observed, and the moisture content was inconsequential because the fuel weight percent was below 8 percent. Calculations indicate that more than two-thirds of the ferrocyanide that was originally placed in the tank has degraded.

With the exception of the TGA results of two subsamples of the auger sample 94-AUG-012, all safety screening analytes were within the limits specified in the tank 241-C-108 TCP (Schreiber 1994a). Vapor sampling demonstrated that none of the tank headspace gases exceeded 25 percent of their lower flammability limit. Additionally, the heat load from the radioactive decay of radionuclides is much lower than the 11,700 W (40,000 Btu/h) limit which separates high-heat tanks from low-heat tanks.

As discussed in Section 5.4, the auger sampling analytical results were compared to the HTCE (Brevick et al. 1994a). The results compared poorly. The disparities may be the result of the failure of the TLM to account for an amount of HS waste, or possibly overestimating the amount of waste from the UR process.

The tank 241-C-108 headspace was sampled in August 1994 for gases and vapors to address flammability and industrial hygiene concerns. Collection and analysis of samples has been reported. It was determined that no headspace constituents exceeded the flammability or industrial hygiene notification limits specified in WHC-EP-0562, *Program Plan for the Resolution of Tank Vapor Issues* (Osborne and Huckaby 1994).

The analytical data do not suggest a safety problem with tank 241-C-108, and the amount of waste present in the tank is small; for these reasons, further sampling and analysis are not recommended.

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APPENDIX A

TANK 241-C-108 ANALYTICAL METHODS AND PROCEDURES

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Table A-1. Tank 241-C-108 Analytical Methods and Procedure Numbers. (sheet 1 of 2)

Method	Analyte	Procedure number
Inductively coupled plasma	Aluminum, calcium, iron, sodium, phosphorus, nickel	LA-505-151, Rev.D-1 LA-505-151, Rev. D-2 LA-505-161, Rev. A-1
Phosphorescence	Uranium	LA-925-009, Rev. A-0
Extraction	Americium-241	LA-953-103, Rev. A-1
Gamma energy analysis	Cesium-137, cobalt-60, europium-154, europium-155	LA-548-121, Rev. D-1
Ion exchange	Plutonium-238, plutonium-239/240	LA-503-156, Rev. D-1
High level	Strontium-90	LA-202-101, Rev. D-1
Beta	Total beta	LA-508-101, Rev D-2
Ion chromatography	Chloride, fluoride, nitrate, nitrite, phosphate	LA-533-105, Rev. C-2
Microdistillation/ spectrophotometric	Cyanide	LA-695-102, Rev. C-0
Persulfate/coulmetry	Total organic carbon, total inorganic carbon	LA-342-100, Rev. A-0
Thermogravimetric analysis	Percent moisture	LA-560-112, Rev. A-2
Differential scanning calorimetry	Fuel content	LA-514-113, Rev. B-1

Table A-1. Tank 241-C-108 Analytical Methods and Procedure Numbers. (sheet 2 of 2)

Method	Analyte	Procedure number
Total alpha	Alpha (criticality)	LA-508-101, Rev. D-2

Ball, J. W. 1995, *Inductively Coupled Plasma (ICP) Emission Spectrometric Method for the Applied Research Laboratories (ARL) Model 3580*, LA-505-151, Rev. D-3, Westinghouse Hanford Company, Richland, Washington.

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Slippern, J. L., 1995, *Determination of Uranium by Kinetic Phosphorescence*, LA-925-009, Rev. A-1, Westinghouse Hanford Company, Richland, Washington.

N/A = Not applicable

APPENDIX B

TANK 241-C-108 ANALYTICAL DATA RESULTS

CONTENTS

LIST OF TABLES

APPENDIX B

TANK 241-C-108 ANALYTICAL DATA RESULTS

B.1 INTRODUCTION

Appendix B presents the chemical and radiological characteristics of the waste in tank 241-C-108 in terms of the specific concentrations of metals, ions, radionuclides, and total carbon.

The data table for each analyte lists a laboratory sample number, the auger or core sample number, a description of where the sample was obtained, an analytical data result, the result of the duplicate analysis, a mean value for the sample (sample + duplicate divided by the number of samples), and an overall analyte mean. The data are listed in standard notation for values >0.001 and $<100{,}000$. Values outside these limits are listed in scientific notation.

B.2 COLUMN HEADINGS

The "Analyte" column contains, in addition to the abbreviation of analyte or physical characteristic, information about the method of measurement, and where applicable, information about the method of sample digestion. The analyte and method are presented as follows: "method.analyte," or, (where applicable) "method.digestion.analyte." For example, the specific concentration of aluminum was determined by the inductively coupled plasma method and digested by fusion. This analyte is denoted as ICP.f.Al.

The "Sample Number" column lists the laboratory sample from which the analyte was measured; this identification number is different from the number assigned to the samples at the tank farm. Sampling rationale, locations, and descriptions of sampling events are contained in Section 3.0 of the TCR.

Column three describes the auger sample from which the segment samples were obtained. Samples from core 61 are also noted.

Column four indicates which auger segment or portion of the segment was measured or whether the sample was a composite sample.

The "Result" column lists the specific concentration of the analyte determined at the different sampling points. This is followed by the "Duplicate" column, which lists the results of the duplicate analyses on the individual samples.

The next column shows the "mean", which is the average of the values listed in the "result" and "duplicate" columns. This information may be obtained in the data package for tank 241-C-108, WHC-SD-WM-DP-082, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61* (Esch 1995).

Column 8 lists the overall mean, which is obtained by averaging concentration values from the auger samples for the two different risers. For example, when sample means for 94-AUG-012 (riser 7), 94-AUG-014 (riser 7), and 94-AUG-015 (riser 4) are available, the means of the first two samples (both from riser 7) are averaged, and this result is then averaged with the mean from the second riser (riser 4) such that each riser is weighted equally. Results from analysis of the core sample were not used in any of the overall mean calculations. They are presented in Appendix B for informational purposes only.

The last column lists an error estimate, relative standard deviation (RSD) of the mean. This is defined as the standard deviation divided by the mean, multiplied by 100. Relative standard deviations were calculated only for those analytes in which all values were detected, and only on the preferred data sets used to derive the reported analytical mean for a given analyte.

Numbers preceded by a less than symbol (<) indicate that the analyte was noted, but was below the analytical instrument's calibrated detection limit for the sample. The values listed are the detection limit; they are used in all calculations except error estimates.

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Table B-1. Tank 241-C-108 Analytical Data: ALUMINUM.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
ICP.f.Al	S94T000339	94-AUG-012/014	Composite	65,600	63,700	64,700	52,100	24.2
	S94T000403	94-AUG-015	Composite	27,000	51,900	39,500		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
ICP = Inductively coupled plasma
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-2. Tank 241-C-108 Analytical Data: CALCIUM.[1]

Analyte	Sample Number	Sample Location	Portion of Segment	Result	Duplicate	Mean	Overall Mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
ICP.f.Ca	S94T000339	94-AUG-012/014	Composite	15,600	18,300	17,000	12,700	33.5
	S94T000403	94-AUG-015	Composite	8,790	8,070	8,430		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
ICP = Inductively coupled plasma
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-3. Tank 241-C-108 Analytical Data: IRON.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
ICP.f.Fe	S94T000339	94-AUG-012/014	Composite	8,790	9,050	8,920	7,170	24.5
	S94T000403	94-AUG-015	Composite	5,030	5,790	5,410		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
ICP = Inductively coupled plasma
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-4. Tank 241-C-108 Analytical Data: NICKEL.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
ICP.f.Ni	S94T000301	94-AUG-012	Top ¼: A_1	738	647	693	8,410	23.7
	S94T000302	94-AUG-012	Top ¼: A_2	1,830	1,480	1,660		
	S94T000304	94-AUG-014	Second ¼: B	6,550	10,700	8,630		
	S94T000303	94-AUG-014	Third ¼: C	18,100	19,200	18,700		
	S94T000367	94-AUG-015	Top ¼: A	9,360	9,500	9,430		
	S94T000368	94-AUG-015	Second ¼: B	11,500	9,620	10,600		
	S94T000369	94-AUG-015	Third ¼: C	11,000	10,300	10,700		
	S94T000370	94-AUG-015	Bottom ¼: D	7,620	6,430	7,030		
	K222	Core 61	1	11,400	11,100	11,300	11,300	
ICP.a.Ni	K222	Core 61	1	9,830	9,710	9,770	9,770	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
ICP = Inductively coupled plasma
f = Fusion digestion
a = Acid digestion
RSD = Relative standard deviation of the mean

Table B-5. Tank 241-C-108 Analytical Data: PHOSPHORUS.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
ICP.f.P	S94T000339	94-AUG-012/014	Composite	18,700	16,100	17,400	26,800	35.0
	S94T000403	94-AUG-015	Composite	38,700	33,600	36,200		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
ICP = Inductively coupled plasma
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-6. Tank 241-C-108 Analytical Data: SODIUM.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
ICP.f.Na	S94T000339	94-AUG-012/014	Composite	75,400	70,000	72,700	94,100	22.7
	S94T000403	94-AUG-015	Composite	1.20E+05	1.11E+05	1.16E+05		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
ICP = Inductively coupled plasma
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-7. Tank 241-C-108 Analytical Data: URANIUM.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
Phosph.f.U	S94T000339	94-AUG-012/014	Composite	353	360	357	421	15.3
	S94T000403	94-AUG-015	Composite	511	460	486		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
Phosph = Laser phosphorence
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-8. Tank 241-C-108 Analytical Data: AMERICIUM-241.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean
		Auger		µCi/g	µCi/g	µCi/g	µCi/g
Extract.f.^{241}Am	S94T000399	94-AUG-012/014	Composite	<0.0169	<0.0139	<0.0154	<0.0294
	S94T000403	94-AUG-015	Composite	<0.0122	<0.0747	<0.0435	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
Extract = Extraction
f = Fusion digestion

Table B-9. Tank 241-C-108 Analytical Data: CESIUM-137.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µCi/g	µCi/g	µCi/g	µCi/g	%
GEA.f.^{137}Cs	S94T000335	94-AUG-012	Upper ½	47.8	49.6	48.7	259	30.3
	S94T000336	94-AUG-014	Lower ½	401	425	413		
	S94T000399	94-AUG-015	Upper ½	332	339	336		
	S94T000400	94-AUG-015	Lower ½	237	243	240		
	K222	Core 61	1	469	469	469	469	
GEA.a.^{137}Cs	S94T000337	94-AUG-012	Upper ½	2.03	2.04	2.04	22.3	78.5
	S94T000338	94-AUG-014	Lower ½	73.6	75.0	74.3		
	S94T000401	94-AUG-015	Upper ½	1.15	1.76	1.46		
	S94T000402	94-AUG-015	Lower ½	22.0	0.718	11.4		
	S94T000340	94-AUG-012/014	Composite	226	219	223	118	88.9
	S94T000404	94-AUG-015	Composite	13.1	12.3	12.7		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Ci/g = Microcurie per gram
GEA = Gamma energy analysis
f = Fusion digestion
a = Acid digestion
RSD = Relative standard deviation of the mean

Table B-10. Tank 241-C-108 Analytical Data: COBALT-60.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean
		Auger		µCi/g	µCi/g	µCi/g	µCi/g
GEA.f.^{60}Co	S94T000335	94-AUG-012	Upper ½	<0.00862	<0.00779	<0.00821	<0.0137
	S94T000336	94-AUG-014	Lower ½	<0.0100	<0.00943	<0.00972	
	S94T000399	94-AUG-015	Upper ½	<0.0163	<0.0180	<0.0172	
	S94T000400	94-AUG-015	Lower ½	<0.0223	<0.0174	<0.0199	
GEA.a.^{60}Co	S94T000337	94-AUG-012	Upper ½	<0.00284	<0.00418	<0.00351	<0.00410
	S94T000338	94-AUG-014	Lower ½	<0.00585	<0.00714	<0.00650	
	S94T000401	94-AUG-015	Upper ½	<0.00298	<0.00282	<0.00290	
	S94T000402	94-AUG-015	Lower ½	<0.00328	<0.00372	<0.00350	
	S94T000340	94-AUG-012/014	Composite	<0.00688	<0.00718	<0.00703	<0.00498
	S94T000404	94-AUG-015	Composite	<0.00256	<0.00331	<0.00294	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
GEA = Gamma energy analysis
f = Fusion digestion
a = Acid digestion

Table B-11. Tank 241-C-108 Analytical Data: EUROPIUM-154.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean
		Auger		µCi/g	µCi/g	µCi/g	µCi/g
GEA.f.^{154}Eu	S94T000335	94-AUG-012	Upper ½	<0.0294	<0.0295	<0.0295	<0.0533
	S94T000336	94-AUG-014	Lower ½	<0.0437	<0.0485	<0.0461	
	S94T000399	94-AUG-015	Upper ½	<0.0826	<0.0783	<0.0805	
	S94T000400	94-AUG-015	Lower ½	<0.0685	<0.0460	<0.0573	
GEA.a.^{154}Eu	S94T000337	94-AUG-012	Upper ½	<0.0135	<0.0132	<0.0134	<0.0141
	S94T000338	94-AUG-014	Lower ½	<0.0185	<0.0224	<0.0205	
	S94T000401	94-AUG-015	Upper ½	<0.0123	<0.0115	<0.0119	
	S94T000402	94-AUG-015	Lower ½	<0.0124	<0.00903	<0.0107	
	S94T000340	94-AUG-012/014	Composite	<0.0465	<0.0455	<0.0460	<0.0279
	S94T000404	94-AUG-015	Composite	<0.00948	<0.0102	<0.00984	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
GEA = Gamma energy analysis
f = Fusion digestion
a = Acid digestion

Table B-12. Tank 241-C-108 Analytical Data: EUROPIUM-155.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean
		Auger		µCi/g	µCi/g	µCi/g	µCi/g
GEA.f.^{155}Eu	S94T000335	94-AUG-012	Upper ½	<0.0690	<0.0708	<0.0699	<0.241
	S94T000336	94-AUG-014	Lower ½	<0.193	<0.197	<0.195	
	S94T000399	94-AUG-015	Upper ½	<0.0494	<0.504	<0.277	
	S94T000400	94-AUG-015	Lower ½	<0.421	<0.424	<0.423	
GEA.a.^{155}Eu	S94T000337	94-AUG-012	Upper ½	<0.0240	<0.0237	<0.0239	<0.0463
	S94T000338	94-AUG-014	Lower ½	<0.103	<0.106	<0.105	
	S94T000401	94-AUG-015	Upper ½	<0.0224	<0.0216	<0.0220	
	S94T000402	94-AUG-015	Lower ½	<0.0473	<0.0222	<0.0348	
	S94T000340	94-AUG-012/014	Composite	<0.189	<0.186	<0.188	<0.112
	S94T000404	94-AUG-015	Composite	<0.0352	<0.0366	<0.0359	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
GEA = Gamma energy analysis
f = Fusion digestion
a = Acid digestion

Table B-13. Tank 241-C-108 Analytical Data: PLUTONIUM-238.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean
		Auger		µCi/g	µCi/g	µCi/g	µCi/g
Ion Exch.f.^{238}Pu	S94T000399	94-AUG-012/014	Composite	<0.00246	<0.00296	<0.00271	<0.00282
	S94T000403	94-AUG-015	Composite	<0.00249	<0.00338	<0.00294	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
Ion Exch = Ion exchange
f = Fusion digestion

Table B-14. Tank 241-C-108 Analytical Data: PLUTONIUM-239/240.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µCi/g	µCi/g	µCi/g	µCi/g	%
Ion Exch.f.$^{239/240}$Pu	S94T000399	94-AUG-012/014	Composite	0.0113	0.0112	0.0113	0.00936	20.2
	S94T000403	94-AUG-015	Composite	0.00676	0.00817	0.00747		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
Ion Exch = Ion exchange
f = Fusion digestion
RSD = Relative standard deviation of the mean

Table B-15. Tank 241-C-108 Analytical Data: STRONTIUM-89/90.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µCi/g	µCi/g	µCi/g	µCi/g	%
HiLev.f.$^{89/90}$Sr	S94T000335	94-AUG-012	Upper ½	15.7	18.2	17.0	27.0	28.0
	S94T000336	94-AUG-014	Lower ½	22.1	21.7	21.9		
	S94T000399	94-AUG-015	Upper ½	28.5	29.7	29.1		
	S94T000400	94-AUG-015	Lower ½	40.7	39.1	39.9		
	K222	Core 61	1	884	852	868	868	
HiLev.a.$^{89/90}$Sr	S94T000337	94-AUG-012	Upper ½	13.4	13.2	13.3	24.1	34.6
	S94T000338	94-AUG-014	Lower ½	18.3	18.2	18.3		
	S94T000401	94-AUG-015	Upper ½	30.4	24.2	27.3		
	S94T000402	94-AUG-015	Lower ½	37.8	37.2	37.5		
	K222	Core 61	1	878	881	880	880	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
Hi Lev = High level
f = Fusion digestion
a = Acid digestion
RSD = Relative standard deviation of the mean

Table B-16. Tank 241-C-108 Analytical Data: TOTAL ALPHA.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean
		Auger		µCi/g	µCi/g	µCi/g	µCi/g
APC.d.Total Alpha	S94T000289	94-AUG-012	Top ¼: A1 Top ¼: A2	<0.0470	<0.0501	<0.0486	<0.0511
	S94T000296			<0.0588	0.108	<0.0834	
	S94T000298	94-AUG-014	Second ¼: B	0.0481	<0.0425	<0.0453	
	S94T000297		Third ¼: C	<0.0317	<0.0317	<0.0317	
	S94T000367	94-AUG-015	Top ¼: A	<0.0341	<0.0341	<0.0341	
	S94T000368		Second ¼: B	<0.0290	<0.0361	<0.0326	
	S94T000369		Third ¼: C	<0.0363	<0.0362	<0.0363	
	S94T000370		Bottom ¼: D	<0.167	<0.0264	<0.0967	
APC.f.Total Alpha	K222	Core 61	1	<1.38	<0.925	<1.15	<1.15

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µCi/g = Microcurie per gram
APC = Alpha proportional counting

Table B-17. Tank 241-C-108 Analytical Data: TOTAL BETA.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		μCi/g	μCi/g	μCi/g	μCi/g	%
Beta.a.Total Beta	S94T000340	94-AUG-012/014	Composite	295	288	292	200	45.8
	S94T000404	94-AUG-015	Composite	124	92.7	108		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μCi/g = Microcurie per gram
a = Acid digestion
RSD = Relative standard deviation of the mean

Table B-18. Tank 241-C-108 Analytical Data: CHLORIDE.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		μg/g	μg/g	μg/g	μg/g	%
IC.w.Cl^-	S94T000341	94-AUG-012/014	Composite	610	387	499	725	1.6
	S94T001188	94-AUG-012/014	Composite	1,100	854	977		
	S94T000405	94-AUG-015	Composite	683	742	713		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

μg/g = Microgram per gram
IC = Ion chromatography
w = Water digestion
RSD = Relative standard deviation of the mean

Table B-19. Tank 241-C-108 Analytical Data: CYANIDE.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
Microdist/ Spec.CN^-	S94T000331	94-AUG-012	Upper ½	795	766	781	1,980	51.6
	S94T000332	94-AUG-014	Lower ½	4,990	5,100	5,050		
	S94T000384	94-AUG-015	Upper ½	1,010	1,050	1,030		
	S94T000385		Lower ½	1,030	1,120	1,080		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.
[2]dry weight basis

µg/g = Microgram per gram
Microdist/spec. = Microdistillation/spectrophotometric
RSD = Relative standard deviation of the mean

Table B-20. Tank 241-C-108 Analytical Data: CYANIDE (dry calculated).[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
Calc.CN^-	S94T000331	94-AUG-012	Upper ½	961	926	944	3,370	51.6
	S94T000332	94-AUG-014	Lower ½	8,220	8,400	8,310		
	S94T000384	94-AUG-015	Upper ½	2,000	2,080	2,040		
	S94T000385		Lower ½	2,090	2,280	2,190		
	K222	Core 61	1	4,120	4,170	4,150	4,150	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
Calc = Calculated with thermogravimetric analysis percent water
RSD = Relative standard deviation of the mean

Table B-21. Tank 241-C-108 Analytical Data: FLUORIDE.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
IC.w.F^-	S94T000341	94-AUG-012/014	Composite	3,470	12,600	8,040	3,770	35.8
	S94T001188	94-AUG-012/014	Composite	1,720	3,020	2,370		
	S94T000405	94-AUG-015	Composite	1,970	2,710	2,340		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
IC = Ion chromatography (Dionex)
w = Water digestion
RSD = Relative standard deviation of the mean

Table B-22. Tank 241-C-108 Analytical Data: NITRATE.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
IC.w.NO_3^-	S94T000341	94-AUG-012/014	Composite	35,700	23,000	29,400	44,600	7.4
	S94T001188	94-AUG-012/014	Composite	56,300	49,300	52,800		
	S94T000405	94-AUG-015	Composite	46,300	49,800	48,000		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
IC = Ion chromatography (Dionex)
w = Water digestion
RSD = Relative standard deviation of the mean

Table B-23. Tank 241-C-108 Analytical Data: NITRITE.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
IC.w.NO_2^-	S94T000341	94-AUG-012/014	Composite	19,800	12,500	16,200	24,700	6.7
	S94T001188	94-AUG-012/014	Composite	32,200	27,200	29,700		
	S94T000405	94-AUG-015	Composite	26,200	26,700	26,500		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
IC = Ion chromatography (Dionex)
w = Water digestion
RSD = Relative standard deviation of the mean

Table B-24. Tank 241-C-108 Analytical Data: PHOSPHATE.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
IC.w.PO_4^{3-}	S94T000341	94-AUG-012/014	Composite	36,600	1.18E+05	77,300	80,600	33.2
	S94T001188	94-AUG-012/014	Composite	22,400	31,700	27,100		
	S94T000405	94-AUG-015	Composite	1.05E+05	1.13E+05	1.09E+05		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
IC = Ion chromatography (Dionex)
w = Water digestion
RSD = Relative standard deviation of the mean

Table B-25. Tank 241-C-108 Analytical Data: TOTAL ORGANIC CARBON.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
Persulf/Coul .TOC	S94T000331	94-AUG-012	Upper ½	188	379	284	945	30.6
	S94T000332	94-AUG-014	Lower ½	1,540	1,840	1,690		
	S94T000384	94-AUG-015	Upper ½	805	1,130	968		
	S94T000385		Lower ½	923	758	841		
	S94T000334	94-AUG-012/014	Composite	1,460	1,770	1,620	1,250	29.3
	S94T000387	94-AUG-015	Composite	1,270	493	882		
	K222	Core 61	1	3,550	3,400	3,480	3,480	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
Persulf/Coul = Persulfate/Coulometry
RSD = Relative standard deviation of the mean

Table B-26. Tank 241-C-108 Analytical Data: TOTAL INORGANIC CARBON.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		µg/g	µg/g	µg/g	µg/g	%
Acid/Coul. TIC	S94T000334	94-AUG-012/014	Composite	2,640	2,080	2,360	2,380	0.84
	S94T000387	94-AUG-015	Composite	3,390	1,410	2,400		

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

µg/g = Microgram per gram
Acid/Coul. = Acid/coulometry
RSD = Relative standard deviation of the mean

Table B-27. Tank 241-C-108 Analytical Data: THERMOGRAVIMETRIC ANALYSIS.[1]

Analyte	Sample number	Sample location	Portion of segment	Result	Duplicate	Mean	Overall mean	RSD
		Auger		%	%	%	%	%
Mettler.TGA (% H_2O)	S94T000288	94-AUG-012	Top ¼: A1	15.4	2.99	9.20[2]	38.8	29.0
	S94T000290		Top ¼: A2	9.94	27.7	18.8[2]		
	S94T000292	94-AUG-014	Second ¼: B	33.0	39.2	36.1		
	S94T000291		Third ¼: C	45.8	46.3	46.1		
	S94T000361	94-AUG-015	Top ¼: A	51.9	46.8	49.4		
	S94T000362		Second ¼: B	48.6	50.5	49.6		
	S94T000363		Third ¼: C	53.0	52.4	52.7		
	S94T000374		Bottom ¼: D	47.8	49.2	48.5		
	K222	Core 61	1	22.1	19.9	21.0	21.0	

[1]Esch, R. A., 1995, *216-Day Final Report for Tank 241-C-108, Auger Samples 94-AUG-012, 94-AUG-014, 94-AUG-015 and Push Mode, Core 61*, WHC-SD-WM-DP-082, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

[2]Triplicates were reported for S94T000288 and S94T000290 of 6.01 and 12.0, respectively, because the RPDs between results and duplicates were >10%. The triplicate results have not been included in calculation of mean and overall mean.

RPD = Relative percent difference
TGA = Thermogravimetric analysis
RSD = Relative standard deviation of the mean

APPENDIX C

TANK 241-C-108 SELECTED THERMOGRAVIMETRIC AND DIFFERENTIAL SCANNING CALORIMETRY GRAPHS

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Figure C-1. Typical Thermogravimetric Analysis Graph.

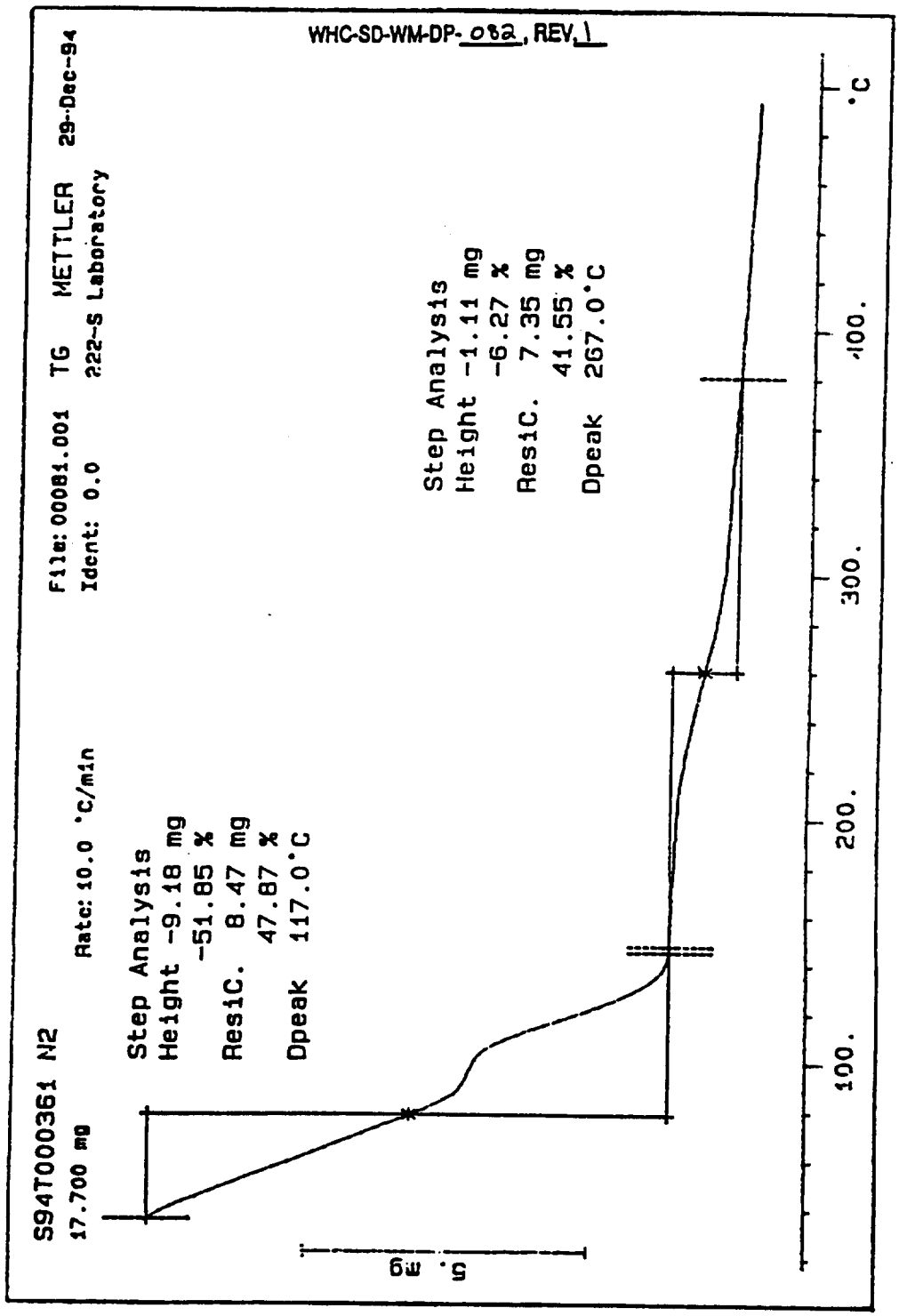

Figure C-2. Typical Differential Scanning Calorimetry Graph.