Sta 4 (2) STA 9613456.0625 0041870

AUG 03 1995

ENGINEERING DATA TRANSMITTAL

1. EDT № 612172

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Characterization Plans, Coordination, and Reports	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Tank 241-TY-104/Waste Management/CPCR/Technical Basis Characterization	6. Cog. Engr.: G. W. Ryan	7. Purchase Order No.: N/A
8. Originator Remarks: This document is being released into the Supporting Document System for retrievability purposes.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: Tank Farms
11. Receiver Remarks: For release.		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: July 28, 1995

AUG 1995 RECEIVED EDMC

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-ER-481		0	Tank Characterization Report for Single-Shell Tank 241-TY-104	N/A	2	1	1

16. KEY

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

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

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. G. W. Ryan	G.W. Ryan	8/2/95		Mgr. FeCN Sfty.Prog. R. L. Cash	R L Cash	8-2-95		1	1
1	1	Cog. Mgr. J. G. Kristofzski	John Kristofzski	8/2/95							
		QA NA				Mgr. Organic Sfty. Prog. D.A.Turner	D A Turner	8-2-95		1	
		Safety NA									
		Env. NA									

18.	19.	20.	21. DOE APPROVAL (if required)
C. A. Boothe C A Boothe 7/25/95 Signature of EDT Originator Date	Authorized Representative for Receiving Organization Date	John Kristofzski 8/2/95 J. G. Kristofzski Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (04/94) GEF097

BD-7400-172-1

INSTRUCTIONS FOR COMPLETION OF THE ENGINEERING DATA TRANSMITTAL

(USE BLACK INK OR TYPE)

BLOCK	TITLE	
(1)*	EDT	• Pre-assigned EDT number.
(2)	To: (Receiving Organization)	• Enter the individual's name, title of the organization, or entity (e.g., Distribution) that the EDT is being transmitted to.
(3)	From: (Originating Organization)	• Enter the title of the organization originating and transmitting the EDT.
(4)	Related EDT No.	• Enter EDT numbers which relate to the data being transmitted.
(5)*	Proj./Prog./Dept./Div.	• Enter the Project/Program/Department/Division title or Project/Program acronym or Project Number, Work Order Number or Organization Code.
(6)*	Cognizant Engineer	• Enter the name of the individual identified as being responsible for coordinating disposition of the EDT.
(7)	Purchase Order No.	• Enter related Purchase Order (P.O.) Number, if available.
(8)*	Originator Remarks	• Enter special or additional comments concerning transmittal, or "Key" retrieval words may be entered.
(9)	Equipment/Component No.	• Enter equipment/component number of affected item, if appropriate.
(10)	System/Bldg./Facility	• Enter applicable system, building or facility number, if appropriate.
(11)	Receiver Remarks	• Enter special or additional comments concerning transmittal.
(12)	Major Assm. Dwg. No.	• Enter applicable drawing number of major assembly, if appropriate.
(13)	Permit/Permit Application No.	• Enter applicable permit or permit application number, if appropriate.
(14)	Required Response Date	• Enter the date a response is required from individuals identified in Block 17 (Signature/Distribution).
(15)*	Data Transmitted	
	(A)* Item Number	• Enter sequential number, beginning with 1, of the information listed on EDT.
	(B)* Document/Drawing No.	• Enter the unique identification number assigned to the document or drawing being transmitted.
	(C)* Sheet No.	• Enter the sheet number of the information being transmitted. If no sheet number, leave blank.
	(D)* Rev. No.	• Enter the revision number of the information being transmitted. If no revision number, leave blank.
	(E) Title or Description of Data Transmitted	• Enter the title of the document or drawing or a brief description of the subject if no title is identified.
	(F)* Approval Designator	• Enter the appropriate Approval Designator (Block 15). Also, indicate the appropriate approvals for each item listed, i.e., SQ, ESQ, etc.
	(G) Reason for Transmittal	• Enter the appropriate code to identify the purpose of the data transmittal (see Block 16).
	(H) Originator Disposition	• Enter the appropriate disposition code (see Block 16).
	(I) Receiver Disposition	• Enter the appropriate disposition code (see Block 16).
(16)	Key	• Number codes used in completion of Blocks 15 (G), (H), and (I), and 17 (G), (H) (Signature/Distribution).
(17)	Signature/Distribution	
	(G) Reason	• Enter the code of the reason for transmittal (Block 16).
	(H) Disposition	• Enter the code for the disposition (Block 16).
	(J) Name	• Enter the signature of the individual completing the Disposition 17 (H) and the Transmittal.
	(K)* Signature	• Obtain appropriate signature(s).
	(L)* Date	• Enter date signature is obtained.
	(M)* MSIN	• Enter MSIN. Note: If Distribution Sheet is used, show entire distribution (including that indicated on Page 1 of the EDT) on the Distribution Sheet.
(18)	Signature of EDT Originator	• Enter the signature and date of the individual originating the EDT (entered prior to transmittal to Receiving Organization). If the EDT originator is the cognizant engineer, sign both Blocks 17 and 18.
(19)	Authorized Representative for Receiving Organization	• Enter the signature and date of the individual identified by the Receiving Organization as authorized to approve disposition of the EDT and acceptance of the data transmitted, as applicable.
(20)*	Cognizant Manager	• Enter the signature and date of the cognizant manager. (This signature is authorization for release.)
(21)*	DOE Approval	• Enter DOE approval (if required) by signature or control number that tracks the approval to a signature, and indicate DOE action.

*Asterisk denote the required minimum items check by Configuration Documentation prior to release; these are the minimum release requirements.

9613456.0626

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-ER-481, REV 0
Document Title:	Tank Characterization Report for Single-Shell Tank 241-TY-104
Release Date:	8/2/95

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz 8/2/95

Kara M. Broz

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy. Printed in the United States of America. To obtain copies of this report, contact:

Westinghouse Hanford Company - Document Control Services
P.O. Box 1970, Mailstop H6-08, Richland, WA 99352
Telephone: (509) 372-2420; Fax: (509) 376-4989

THIS PAGE INTENTIONALLY
LEFT BLANK

9613456.0627

SUPPORTING DOCUMENT	1. Total Pages 82

2. Title	3. Number	4. Rev No.
Tank Characterization Report for Single-Shell Tank 241-TY-104	WHC-SD-WM-ER-481	0

5. Key Words	6. Author
Waste Characterization; Single-Shell Tank; TY-104; Tank Characterization Report; TY Farm; Waste Inventory; TPA Milestone M-44; TCR; 241-TY-104	Name: G. W. Ryan G. W. Ry 7/26/95 Signature Name: L. C. Amato, LATA L. C. Amato 7/26/95 Signature Organization/Charge Code 75310/N4162

7. Abstract

This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in tank 241-TY-104. This report supports the requirements of Tri-Party Agreement Milestone M-44-08.

8. RELEASE STAMP

OFFICIAL RELEASE BY WHC (2)
DATE AUG 03 1995
Sta 4.

A-6400-073 (08/94) WEF124

THIS PAGE INTENTIONALLY
LEFT BLANK

9613456.0628

WHC-SD-WM-ER-481
Revision 0

Tank Characterization Report for Single-Shell Tank 241-TY-104

Date Published
July 1995

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse Hanford Company
P.O Box 1970
Richland, Washington

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

THIS PAGE INTENTIONALLY
LEFT BLANK

EXECUTIVE SUMMARY

This tank characterization report summarizes information concerning the historical uses of tank 241-TY-104, its status, recent sampling efforts, and the results of analysis of the waste which it contains. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-08 (Ecology et al. 1994) and Ferrocyanide Tank Safety Program Milestone T2B-95-123 (Jordan 1994).

Tank 241-TY-104 is one of six single-shell tanks located in the TY Tank Farm in the Hanford Site's 200 West Area. It is the second tank in a two-tank cascade with tank 241-TY-103. Tank 241-TY-104 went into service in 1953 with receipt of tributyl phosphate waste (also called uranium recovery waste) through the cascade line. Later, tank 241-TY-103 also received ferrocyanide scavenged first cycle waste. The only other waste received by tank 241-TY-104 was supernatant from other tanks in the TY and TX Tank Farms. The tank was removed from service in 1974 and categorized as an assumed leaker in 1981. Interim stabilization (1983) and intrusion prevention (1982) have since been completed. The tank is included on both the Ferrocyanide and Organic Watch Lists.

A description and status of tank 241-TY-104 are summarized in Table ES-1 and Figure ES-1. The tank, which has an operational capacity of 2,870 kL (758 kgal), presently contains 174 kL (46 kgal) of waste, 163 kL (43 kgal) of which is existing as sludge and 11.4 kL (3 kgal) as supernatant (Hanlon 1995).

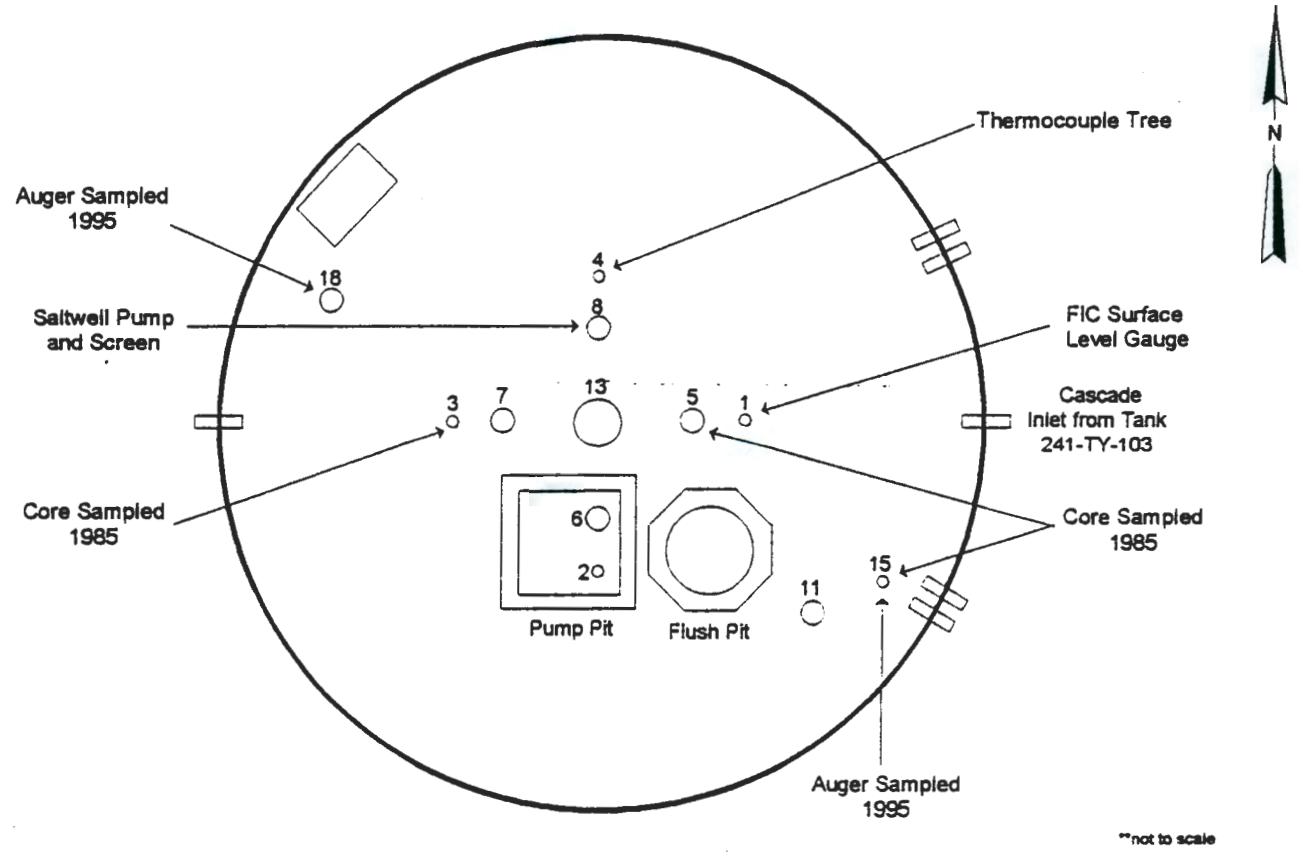
Table ES-1. Description and Status of Tank 241-TY-104.

Tank description	
Type	Single-shell
Constructed	1951-1952
In-service	1953
Diameter	22.9 m (75 ft)
Usable depth	7 m (23 ft)
Capacity	2,870 kL (758 kgal)
Bottom shape	Dished
Ventilation	Passive
Tank status (as of May 1995)[a]	
Total waste volume	174 kL (46 kgal)
Sludge volume	163 kL (43 kgal)
Drainable interstitial liquid	45.6 kL (12 kgal)
Supernatant volume	11.4 kL (3 kgal)
Waste surface level by FIC (6/21/95)	59.9 cm (23.6 in)[b]
Temperature (1/76 to 1/94)	34 °C (94 °F) to 12 °C (53 °F)
Integrity	Assumed leaker
Watch list	Ferrocyanide; Organic
Sampling dates	
Auger sampled	February 1995
Core sampled	August 1985
Service status	
Removed from service	1974
Interim stabilized	1983
Intrusion prevention	1982

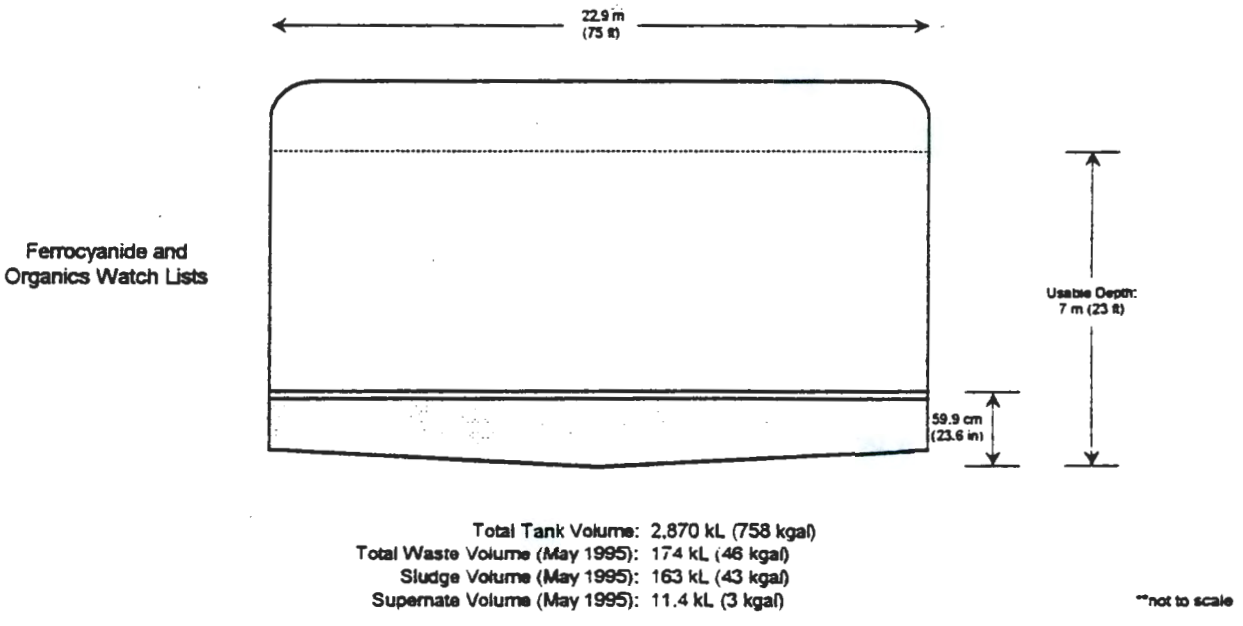
[a]All tank status data from Hanlon (1995).

[b]Zip cord readings performed prior to February 1995 auger sampling show the waste surface level at approximately 30.5 cm (12 in.). The discrepancy between surface readings may be attributed to the FIC probe contacting a pool of liquid waste under Riser 1 or possibly an uneven (non-level) waste surface.

Figure ES-1. Tank 241-TY-104.



Waste Profile of Tank 241-TY-104



This report summarizes two sampling and analysis events. The waste composition is based on six core samples obtained in 1985 and two auger samples acquired in 1995. The data from the 1985 sampling event are considered to be a best estimate since there have been no transfers to or from the tank since 1974. The information obtained from this sampling event is the best available data because a more recent analysis of the chemical and radiochemical constituents has not been performed. The 1995 sampling and analysis were performed according to three data quality objectives (DQO): *Tank Safety Screening Data Quality Objective* (Babad and Redus 1994), *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue Developed through the Data Quality Objectives Process* (Babad et al. 1994), and *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objectives Process* (Meacham et al. 1994).

None of the notification thresholds of the applicable DQOs were exceeded. The headspace flammability, as measured by combustible gas meter, was less than 1% of the lower flammability limit (Meacham 1995a). The fuel content of the sludge was measured on the 1995 auger samples by differential scanning calorimetry. No exothermic reactions were found.

The lack of energetics and the high nickel concentrations (Table ES-2) indicate that this ferrocyanide has degraded. A hot persulfate analysis for total organic carbon (TOC) found 867 micrograms of carbon per gram (μg C/g) (wet weight). Since the energy equivalent of this result was <75 percent of the differential scanning calorimetry value, a secondary analysis for TOC using the furnace oxidation method was performed (Miller 1995b). Results

Table ES-2. Concentrations and Inventories for Major Analytes and Analytes of Concern in Tank 241-TY-104 Sludge.

Physical properties	Results	
Density[a]	1.69 g/mL	
Percent water (weight)[b]	51.8	
Heat load[a]	325 W (1,110 Btu/hr)	
Chemical constituents	Sludge concentration[a]	Sludge inventory
Metals	(μg/g)	(kg)
Aluminum	9,080	2,670
Bismuth	17,800	5,230
Chromium	1,410	415
Iron	32,600	9,580
Phosphorus	26,200	7,700
Lead	576	169
Nickel	1,490	438
Sodium	113,000	33,200
Uranium	19,500	5,730
Anions	(μg/g)	(kg)
NO_3^- (Nitrate)	46,600	13,700
NO_2^- (Nitrite)	12,200	3,590
Total carbon	(μg C/g)	(kg)
Total inorganic carbon	6,040[b]	1,770
Total organic carbon	3,620[b]	1,060
Radionuclides	(μCi/g)	(Ci)
^{137}Cs	45.4	13,300
$^{239/240}Pu$	0.180	52.9
^{90}Sr	132	38,800

[a]Based on analysis of 1985 core samples.
[b]Based on analysis of 1995 auger samples.
1 Ci = 3.7 E+10 Bq.

using this method were higher (6,370 μg C/g) (wet weight), but were substantially less than the 30,000 μg C/g limit specified in the Organic DQO (Babad et al. 1994). Also, TOC determinations for the 1985 core samples found 1,930 μg C/g in the sludge and 2,110 μg C/g in the drainable liquid which are comparable with the 1995 TOC hot persulfate results. None of these results show TOC concentrations at levels of concern or that significant fuel might be present.

The sludge was found to contain an average of 51.8 percent water (by weight) from a thermogravimetric analysis on the 1995 auger samples. Total alpha activity results from both sampling events were well below the Safety Screening DQO decision limit of 1 g/L (or 36.4 μCi/g). The 1995 total alpha result was 0.145 μCi/g, while the 1985 value was 0.319 μCi/g. The heat generated by the radioactivity in the sludge is 1,110 Btu/hr (325 W). This value is much less than the 40,000 Btu/hr limit separating high heat from low heat tanks. Since 1976, temperatures have ranged from 12 °C (54 °F) to 34 °C (93 °F). Based on the analytical results, the waste does not appear to have any immediate safety concerns:

The concentration and tank inventories for the major constituents and analytes of concern in the sludge are summarized in Table ES-2. Because the sludge is from uranium recovery, it can be expected to contain high concentrations of water, uranium, sodium, iron, hydroxide, nitrate, carbonate, and sulfate. However, only the analytical results for water, sodium, and uranium were close to the expected levels. Hanlon (1995) and Borsheim (1991) report 12,000 g moles of ferrocyanide were originally placed in the tank in the 1950's. Interestingly, based on the Tank Layer Model, no organic carbon or ferrocyanide is predicted to be in the tank (Brevick et al. 1995).

REFERENCES

Babad, H., and K. S. Redus, 1994, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Babad, H., S. M. Blacker, and K. S. Redus, 1995, *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue*, WHC-SD-WM-DQO-006, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Borsheim, G. L., B. C. Simpson, 1991, *An Assessment of the Inventories of the Ferrocyanide Watch List Tanks*, WHC-SD-WM-ER-133, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-ER-351, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, fourth amendment, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Hanlon, B. L., 1995, *Waste Tank Summary Report for Month Ending May 31, 1995*, WHC-EP-0182-86, Westinghouse Hanford Company, Richland, Washington.

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

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 Process*, WHC-SD-WM-DQO-007, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Meacham, J. E., R. J. Cash, G. T. Dukelow, 1995a, *Quarterly Report on the Ferrocyanide Safety Program for the Period Ending December 31, 1994*, WHC-EP-0474-15, Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1995b, *216-Day Safety Screen Results and Final Report for Tank 241-T-104*, Auger Samples 95-AUG-008 and 95-AUG-009, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.

This page intentionally left blank.

CONTENTS

1.0 INTRODUCTION 1-1
1.1 PURPOSE 1-1
1.2 SCOPE 1-1

2.0 HISTORICAL TANK INFORMATION 2-1
2.1 TANK STATUS 2-1
2.2 TANK DESIGN AND BACKGROUND 2-2
2.3 PROCESS KNOWLEDGE 2-6
2.3.1 Waste Transfer History 2-6
2.3.2 Historical Estimation of Tank Contents 2-7
2.4 SURVEILLANCE DATA 2-8
2.4.1 Surface Level Readings 2-8
2.4.2 Internal Tank Temperatures 2-13
2.4.3 Tank 241-TY-104 Photographs 2-13

3.0 TANK SAMPLING OVERVIEW 3-1
3.1 DESCRIPTION OF AUGUST 1985 SAMPLING EVENT 3-1
3.1.1 Sample Handling (August 1985) 3-1
3.1.2 Sample Analysis (August 1985) 3-3
3.2 DESCRIPTION OF FEBRUARY 1995 SAMPLING EVENT 3-3
3.2.1 Sample Handling (February 1995) 3-4
3.2.2 Sample Analysis (February 1995) 3-4

4.0 ANALYTICAL RESULTS AND WASTE INVENTORY ESTIMATES 4-1
4.1 OVERVIEW 4-1
4.2 DATA PRESENTATION 4-2
4.2.1 Total Alpha 4-5
4.2.2 Total Organic Carbon 4-6
4.2.3 Percent Water Analyses 4-8
4.2.4 Thermodynamic Analyses 4-9

5.0 INTERPRETATION OF CHARACTERIZATION RESULTS 5-1
5.1 ASSESSMENT OF SAMPLING AND ANALYTICAL RESULTS 5-1
5.1.1 Field Observations 5-1
5.1.2 Quality Control Assessment 5-1
5.1.3 Data Consistency Checks 5-2
5.2 COMPARISON OF DATA SOURCES 5-6
5.2.1 Comparison of 1995 and 1985 Data 5-6
5.2.2 Comparison of 1985 Data to the Historical Tank Content Estimates 5-7
5.3 TANK WASTE INVENTORY PROFILE 5-7

CONTENTS (Continued)

5.4 COMPARISON OF ANALYTICAL DATA AND TRANSFER HISTORY INFORMATION 5-9
5.5 EVALUATION OF PROGRAM REQUIREMENTS 5-10
5.5.1 Safety Evaluation 5-10
5.5.2 Operational Evaluations 5-13
5.5.3 Process Development Evaluation 5-13

6.0 CONCLUSIONS AND RECOMMENDATIONS 6-1

7.0 REFERENCES 7-1

APPENDIXES

A 1985 AQUEOUS LIQUID SAMPLE DATA A-1

B ANALYTICAL PROCEDURES FOR 1985 CORE SAMPLES AND 1995 AUGER SAMPLES B-1

C PHOTOGRAPHS OF EXTRUDED AUGER SAMPLES (FEBRUARY 1995) C-1

LIST OF FIGURES

2-1 Riser Configuration of Tank 241-TY-104 2-3

2-2 Cross-section View of Tank 241-TY-104 2-5

2-3 Tank Layer Model 2-9

2-4 Tank Level History 2-12

2-5 Tank 241-TY-104 Weekly High Temperature Plot 2-14

2-6 Tank 241-TY-104 Waste Surface Photographs 2-15

LIST OF TABLES

2-1 Summary Tank Contents Status 2-1

2-2 Tank 241-TY-104 Risers 2-4

2-3 Tank 241-TY-104 Major Transfers 2-6

2-4 Synopsis of Major Waste Transferred 2-7

2-5 Tank Inventory Estimate 2-10

3-1 Tank 241-TY-104 1985 Sample Data 3-2

3-2 Tank 241-TY-104 1985 Specimen Preparation 3-3

3-3 Tank 241-TY-104 1995 Sample Data 3-5

4-1 Analytical Data Presentation Tables for Tank 241-TY-104 4-1

4-2 1985 Solid Sample Data 4-3

4-3 Tank 241-TY-104 Analytical Data: Total Alpha 4-5

4-4 Tank 241-TY-104 Analytical Data results for Total Organic Carbon 4-7

4-5 Thermogravimetric Results for Tank 241-TY-104 4-8

4-6 Differential Scanning Calorimetry Results for Tank 241-TY-104 4-9

5-1 Comparison of Total Beta Activity with the Total of the Individual Activities for 1985 Results. 5-3

5-2 Comparison of Total Alpha Activity with the Total of the Individual Activities for 1985 Results 5-3

5-3 Cation Mass and Charge Data for 1985 Results 5-4

5-4 Anion Mass and Charge Data for 1985 Results 5-5

5-5 Mass Balance Totals for 1985 Results 5-5

5-6 Comparison of 1985 Core Sampling Data with the Historical Tank Content Estimate. 5-8

LIST OF TABLES (Continued)

5-7 Comparison of Analytical Results with Decision Criteria of Safety Screening and Organic Data Quality Objectives 5-11

5-8 Tank 241-TY-104 Projected Heat Load 5-13

5-9 Percent Water Solubility for Tank 241-TY-104 Analytes for 1985 Results 5-15

LIST OF TERMS

1CFeCN	ferrocyanide scavenged first cycle waste
ANOVA	analysis of variance
DQO	data quality objective
DSC	differential scanning calorimetry
FIC	Food Instrument Corporation
HTCE	Historical Tank Content Estimate
LFL	lower flammability limit
RSD	relative standard deviation
RPD	relative percent difference
TBP	tributyl phosphate
TCP	tank characterization plan
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TOC	total organic carbon
UR	uranium recovery

1.0 INTRODUCTION

This report presents an overview of single-shell tank 241-TY-104 (hereafter, tank 241-TY-104) 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. Results of the two most recent sampling events, auger sampling in 1995 and core sampling in 1985, are presented in this document. The tank is categorized as an assumed leaker, and is included on both the Ferrocyanide and Organic Watch Lists.

The tank was removed from active service in 1974 and presently contains sludge and supernatant left behind by the uranium recovery (UR) process. The concentration and inventory estimates reported in this document reflect the current composition of the waste based on the available data. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-08 (Ecology et al. 1994) and Ferrocyanide Tank Safety Program Milestone T2B-95-123 (Jordan 1994).

1.1 PURPOSE

The primary purpose of this report is to summarize the information about the use and contents of tank 241-TY-104. Where possible, this information will be used to assess issues associated with safety, operations, and process development activities. This report also provides a reference point for more detailed information about tank 241-TY-104.

1.2 SCOPE

The six core samples obtained in 1985 were acquired to provide waste characterization in support of the proposed dome-fill tests on the 241-TY Tank Farm. The dome-fill tests were based on a proposal to fill the SSTs with suitable material to minimize the effects of eventual dome collapse (Weiss 1986). The samples were analyzed for metals, anions, and radionuclides. The common safety screening analyses for percent water and differential scanning calorimetry were not performed, and other than total inorganic and organic carbon, no specific organic analyses were conducted.

The two auger samples taken in 1995 were obtained in accordance with the *Tank Safety Screening Data Quality Objective* (Babad and Redus 1994). Since tank 241-TY-104 is on the Organic and Ferrocyanide Tank Watch Lists, the two documents, *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue* (Babad et al. 1994) and *Data Requirements for the Ferrocyanide Safety Issue Developed Through the Data Quality Objectives Process* (Meacham et al. 1994) also governed the sampling event. Sampling and analysis activities are focused on either verification of the Watch List tank status or identification of any unknown safety issues associated with the tank. The Ferrocyanide

Safety Program has created a characterization priority list of tanks that bound ferrocyanide degradation (aging) (Meacham et al. 1995b). Since tank 241-TY-104 is not included on the priority list, not all of the analyses required by the Ferrocyanide Data Quality Objective (DQO) were performed. Sample material was archived so that analyses could be run in the future if needed by the Ferrocyanide Safety Program.

Terms such as waste types, waste generating processes, and such, generally are not defined in this document; detailed explanations of these and many other tank farm or Hanford Site terms can be found in WHC-SD-WM-TI-648, *Tank Characterization Reference Guide* (De Lorenzo et al. 1994).

2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-TY-104 based on historical information. The first part of the section details the current condition of the tank, followed by discussions on the tank's background, transfer history, and process sources that contributed to the tank waste, including an estimate of the current contents based on the process history. Events that may be related to tank safety issues such as potentially hazardous tank contents (ferrocyanide or organic compounds) or off-normal operating temperatures that could cause tank damage or chemical reactions are discussed. The second part of this section details any surveillance data available for the tank. Solid and liquid level data are used to determine tank integrity (leaks) and to provide clues to internal activity in the solid/crust layers of the tank (i.e., slurry growth from gas evolution with subsequent burping and collapse, or shrinkage from consolidation or drying). Drywell activity monitoring is noted where anomalies may suggest leaking of nearby tanks. Temperature data are provided to evaluate the heat generating characteristics of the waste.

2.1 TANK STATUS

As of the May 1995 Waste Status Report (Hanlon 1995), tank 241-TY-104 contained 174,000 L (46,000 gal) of waste classified as non-complexed. Approximate volumes of the different waste phases are shown in Table 2-1 (Hanlon 1995).

Table 2-1. Summary Tank Contents Status.

Waste form	kL (kg)
Total waste	174 (46)
Sludge	163 (43)
Salt cake	0 (0)
Supernatant	11.4 (3)
Drainable interstitial liquid	45.6 (12)
Drainable liquid remaining	57 (15)
Pumpable liquid remaining	0 (0)

The tank is on the Ferrocyanide and Organics Tank Watch Lists. Presently, the waste is classified non-complexed, principally composed of ferrocyanide scavenged first cycle (1C) waste and UR waste. None of the drywells surrounding tank 241-TY-104 have indicated tank leakage.

2.2 TANK DESIGN AND BACKGROUND

The TY Tank Farm was constructed between 1951 and 1952 in the 200-West Area. The TY Tank Farm contains six Type II 100 series tanks. These tanks are 2,870,000 L (758,000 gal), 22.86 m (75 ft) in diameter with a 7-m (23 ft) operating depth. Tank 241-TY-104 first went into operation in the third quarter of 1953. Built as one of the second generation tank farms, the TY Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F). Tank 241-TY-104 is second in the two tank cascade of tank 241-TY-103 and 104. A 76 mm (3 in.) diameter cascade overflow line connects the two tanks. The bottom center elevation of 241-TY-103 is 190.3 m (624.3 ft) cascading to Tank 241-TY-104 with a bottom elevation of 190 m (623.3 ft) above mean sea level. The cascade overflow height is approximately 7.19 m (283 in.) from the dished tank bottom and 0.6 m (2 ft) below the top of the steel liner.

The TY Tank Farm tanks have dished bottoms with a 1.2 m (4 ft) radius knuckle. Similar to all other single-shell tank farms, they are designed with a primary carbon steel liner (ASTM A283 Grade C) and a concrete dome with various risers. The riser layout was modified from the first generation for better access to the tank. The tanks are set on a reinforced concrete foundation. A three-ply cotton fabric waterproofing was applied over the foundation and steel tank. Four coats of primer paint were sprayed on all exposed interior tank surfaces. Tank ceiling domes were covered with three applications of magnesium zincfluosilicate wash. Lead flashing was used to protect the joint where the steel liner met the concrete dome. Asbestos gaskets were used to seal the manholes in the tank dome. The tanks were waterproofed on the sides and top with tar and gunnite. Each tank was covered with approximately 2.43 m (8 ft) of overburden. (See Figure 2-1.)

The surface level is monitored through Riser 1 with a Food Instrument Corporation level monitor. Tank 241-TY-104 has 12 risers ranging in size from 100 mm (4 in.) diameter to 1.07 m (42 in.) diameter. Table 2-2 shows riser number, size and descriptions. A plan view that depicts the riser configuration is shown as Figure 2-1. This constitutes all installed equipment for 241-TY-104. Risers 3 and 15 which are 100 mm (4 in.) in diameter and Riser 5 which is 300 mm (12 in.) diameter are available for use. A tank cross-section showing the approximate waste level along with a schematic of the tank equipment is found in Figure 2-2.

Tank 241-TY-104 is out of service as are all single-shell tanks. This tank is categorized as an assumed leaker and has been interim stabilized with intrusion prevention completed. The tank is passively ventilated.

Figure 2-1. Riser Configuration of Tank 241-TY-104.

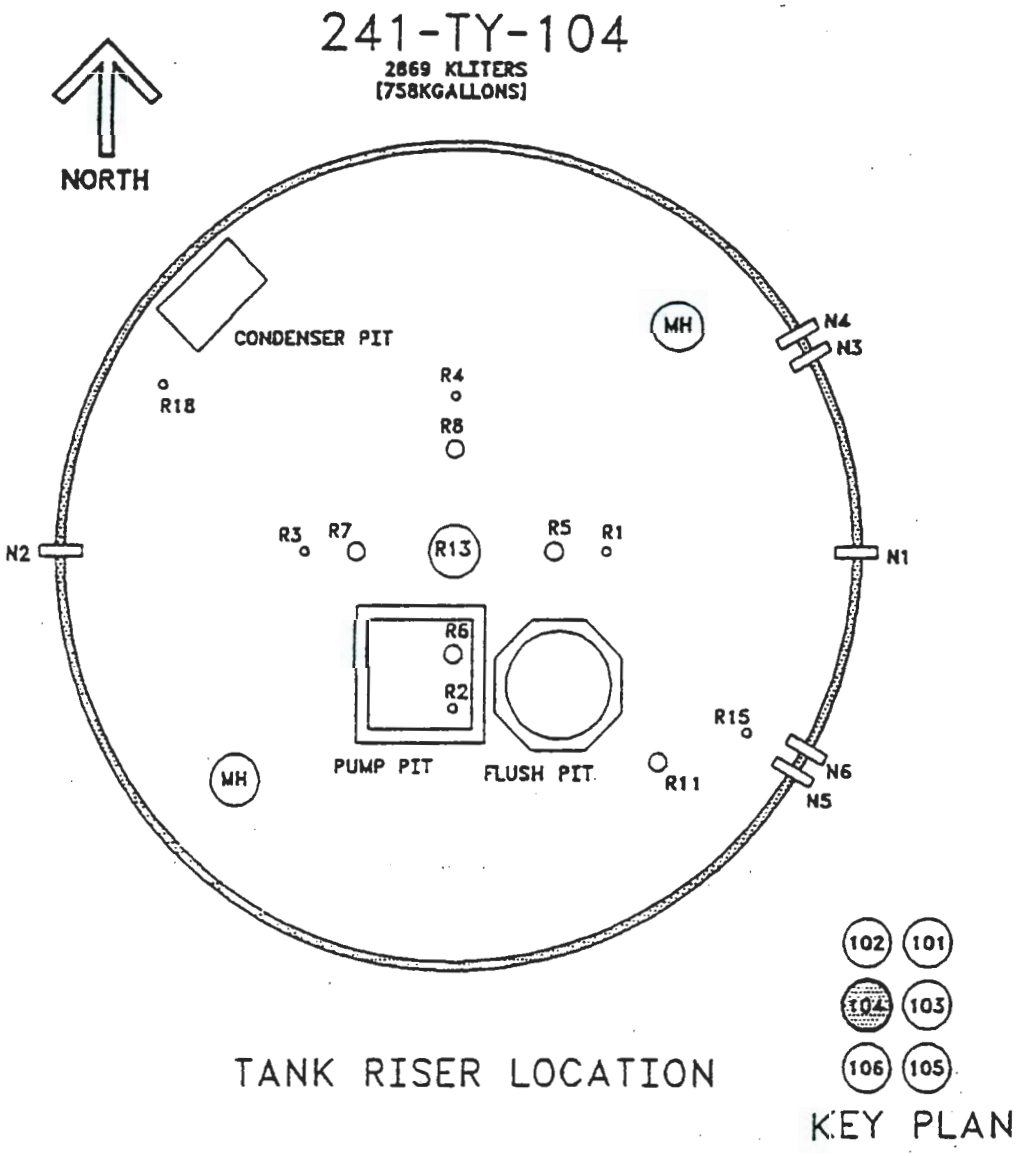
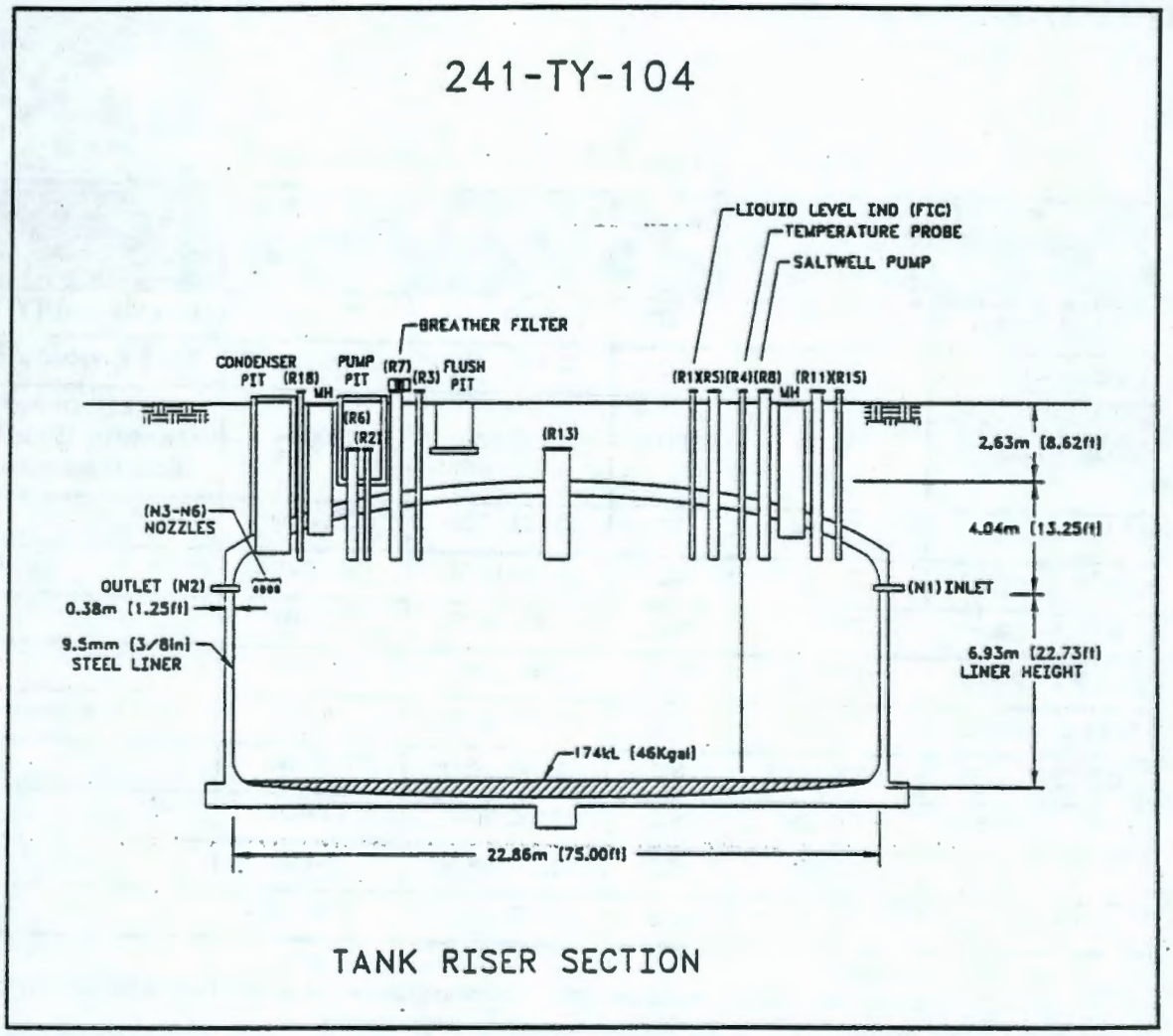


Table 2-2. Tank 241-TY-104 Risers.

No.	Diameter (inches)	Description and comments
R1	4	FIC
R2	4	WC
R3	4	Temperature vapor probe
R4	4	Temperature probe
R5	12	Flange/B - 222 Obsv port, BM
R6	12	Pump WC
R7	12	Breather filter
R8	12	Saltwell screen and pump, BM
R11	12	Air inlet stack with blind flange
R13	42	BG
R15	4	Flange
R18	4	WC; sampled in 1995
N1	3	Cascade inlet from Tank 241-TY-103
N2	3	Outlet to crib
N3	3	Spare
N4	3	Spare
N5	3	Spare
N6	3	Spare

BG = below grade.
BM = benchmark.
FIC = Food Instrument Corporation gauge.
WC = weather covered.

Figure 2-2. Cross-section View of Tank 241-TY-104.



2.3 PROCESS KNOWLEDGE

These sections present the transfer history of tank 241-TY-104 and describe the process wastes transferred. Section 2.3.1 and Table 2-3 present some major transfers that involved tank 241-TY-104 along with a narrative describing the transfers. This information was obtained from the *Waste Status and Transaction Record Summary for the Northwest Quadrant* (WSTRS) (Agnew et al. 1995a).

Table 2-3. Tank 241-TY-104 Major Transfers.

Year:Qtr	Transaction source	Waste type	Transaction amount kL (kgal)	Destination	Comments
1953:3 - 1955:1	TY-103	TBP	5,326 (1,407)	TY-104	Cascade from TY-103
1953:4 - 1953:4	TY-104	SU	-2,446 (-646)	TX-118	242-T Evaporator feed
1955:1 - 1955:1	TY-103	1CFeCN	3,220 (850)	TY-104	700 kgal through a transfer, 150 kgal through the cascade
1955:1 - 1955:1	TY-104	SU	-2,684 (-709)	TX-109	
1955:3 - 1955:3	TY-104	SU	-2,404 (-635)	Crib T-026	
1959:3 - 1961:3	TX-118	SU	2,328 (615)	TY-104	
1959:3 - 1959:3	TY-106	SU	261 (69)	TY-104	
1966:3 - 1970:2	TY-104	SU	-5,342 (-1,411)	TX-118	242-T Evaporator feed
1967:2 - 1967:4	TX-115	SU	2,491 (658)	TY-104	
1970:1 - 1970:4	TY-103	SU	3,312 (875)	TY-104	
1974:1 - 1974:1	TY-104	SU	-2,567 (-678)	S-110	
1974:3 - 1974:4	TY-104	SU	-11 (-3)	TY-102	

Qtr = quarter.
SU = Supernatant (liquid considered free of contamination to the extent it could be pumped to a crib); may have also included decontamination wastes.
TBP = Tributyl phosphate waste from solvent based uranium recovery operation in the 1950's (renamed to uranium recovery [UR] waste).
1CFeCN = First cycle waste scavenged with ferrocyanide.

2.3.1 Waste Transfer History

Waste was initially added to tank 241-TY-104 in the third quarter of 1953 with the cascade of tributyl phosphate (TBP) waste from tank 241-TY-103. Tank 241-TY-104 intermittently received TBP waste from tank 241-TY-103, by cascade, until the second

quarter of 1954. In the first quarter of 1955, Tank 241-TY-103 began receiving ferrocyanide scavenged first cycle waste (1CFeCN), which was sent to Tank 241-TY-104 via the cascade and through the pump pit risers.

Supernatant was pumped from tank 241-TY-104 to tanks 241-TX-118, 241-TX-109, and crib T-026 during the fourth quarter of 1954, the first quarter of 1955, and the third quarter of 1955, respectively. Tank 241-TY-104 received supernatant from tank 241-TX-118 intermittently from the third quarter of 1959 to the third quarter of 1961. Also, during the third quarter of 1959, tank 241-TY-104 received supernatant from tank 241-TY-106. Tanks 241-TX-115 and 241-TY-103 were also active in sending supernatant to tank 241-TY-104 from the second quarter of 1966 until the fourth quarter of 1967 and from the first quarter of 1970 until the fourth quarter of 1970, respectively. The last major transfer of supernatant from tank 241-TY-104 occurred during the first quarter of 1974 to tank 241-S-110.

Tank 241-TY-104 was removed from service in 1974. Tank 241-TY-104 is categorized as an assumed leaker (with a leak of approximately 5.3 kL [1.4 kgal] in 1981) (Hanlon 1995).

A synopsis of the major waste transferred through 241-TY-104 is as follows in Table 2-4. From Table 2-4 it appears that 1,484 kL (392 kgal) of waste remain in the tank instead of the 174 kL (46 kgal) reported in Hanlon (1995). The discrepancy is caused by the lack of a complete transfer history and unknown removals of waste.

Table 2-4. Synopsis of Major Waste Transferred.

Transfer type	Volume kL (kgal)
Addition of TBP (also known as UR)	5,326 (1,407)
Addition of 1CFeCN	3,220 (850)
Addition of SU	8,392 (2,217)
Transfer out of SU	15,454 (4,082)

SU = supernatant.
TBP = tributyl phosphate.
UR = uranium recovery.
1CFeCN = ferrocyanide scavenged first cycle waste.

2.3.2 Historical Estimation of Tank Contents

This section contains an estimate of the contents for Tank 241-TY-104 based on historical transfer data. The historical data used for the estimate is WSTRS (Agnew et al. 1995a), the Hanford Defined Waste (HDW) list (Agnew 1995), and the Tank Layer Model

(TLM) (Agnew et al. 1995b). WSTRS is a compilation of available 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 of the transfer data and the modeling results derived from it. 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 that requires further evaluation using analytical data. The estimate is presented in the Historical Tank Content Estimate (Brevick et al. 1995).

Based on the Tank Layer Model (Agnew et al. 1995b), tank 241-TY-104 contains 163 kL (43 kgal) of UR (also known as TBP) type waste and 11 kL (3 kgal) of supernatant. Figure 2-3 shows a graphical representation of the estimated waste type and volumes for the tank layers. The bottom layer has been determined to be waste type UR, while the top layer is supernatant. The UR waste should contain large amounts of sodium, sulfate, nitrate, iron, uranium, hydroxide and water. Also present should be phosphate, ^{137}Cs, and ^{90}Sr. These radionuclides (of which strontium has the higher concentration) will produce a modest activity. Table 2-5 shows an estimate of the expected waste constituents and their concentrations.

2.4 SURVEILLANCE DATA

Tank 241-TY-104 surveillance consists of surface level measurements, temperature monitoring inside the tank (waste and vapor space from two instrument trees, including the temperature vapor probe installed in Riser #3), and leak detection well (drywell) monitoring for radioactivity outside the tank. Surveillance data are significant because they provide the basis for determining tank integrity.

Liquid level measurements are used to determine the existence of a major leak from the tank. Solid surface level measurements provide indications of physical changes and consistency of the solid layers of the tank. Drywells located around the perimeter of the tank are used to detect increased radioactivity from a tank leak to the soil.

2.4.1 Surface Level Readings

A Food Instrument Corporation (FIC) gauge is used to measure the surface level of tank 241-TY-104. The FIC gauge is installed in Riser 1. Manual readings are required daily if the FIC gauge fails. The readings taken between January 1, 1991 and October 6, 1994 indicate a steady waste level with the readings ranging between 57 cm (22.5 in.) to 60 cm (23.8 in.). On June 21, 1995, the surface level measured 59.9 cm (23.6 in.). A graphical representation of the surface level history is provided in Figure 2-4.

Figure 2-3. Tank Layer Model.

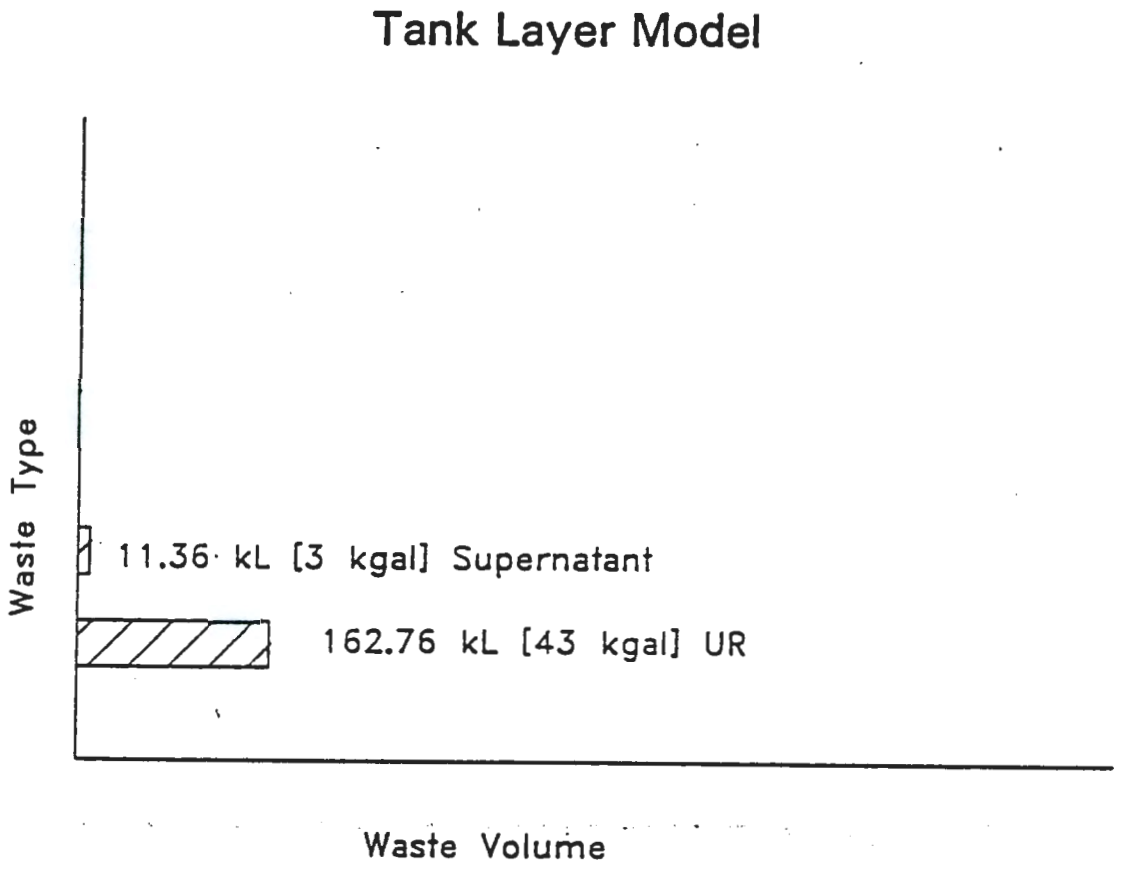


Table 2-5. Tank Inventory Estimate (2 sheets).

Single-Shell Tank 241-TY-104			
Solids composite inventory estimate*			
Physical properties			
Total solid waste	2.31 E+05 kg (43 kgal)		
Heat load	6.09 E-03 kW (21 Btu/hr)		
Bulk density	1.42 (g/mL)		
Void fraction	0.711		
Water wt%	55.5		
TOC wt% C (wet)	0		
Chemical constituents	M	ppm	kg
Na^{+}	4.62	7.49 E+04	1.73 E+04
Al^{+3}	0	0	0
Fe^{+3} (total Fe)	2.43	9.56 E+04	2.21 E+04
Cr^{+3}	5.74 E-03	210	48.5
Bi^{+3}	0	0	0
La^{+3}	0	0	0
Ce^{+3}	0	0	0
Zr (as $ZrO(OH)_2$)	0	0	0
Pb^{+2}	0	0	0
Ni^{+2}	8.03 E-02	3.32 E+03	768
Sr^{+2}	0	0	0
Mn^{+4}	0	0	0
Ca^{+2}	0.172	4.85 E+03	1.12 E+03
K^{+}	0	0	0
OH^{-}	8.30	9.94 E+04	2.30 E+04
NO_3^{-}	2.06	9.02 E+04	2.08 E+04
NO_2^{-}	0	0	0
CO_3^{-2}	0.302	1.28 E+04	2.95 E+03
PO_4^{-3}	9.32 E-02	6.24 E+03	1.44 E+03

Table 2-5. Tank Inventory Estimate (2 sheets).

Single-Shell Tank 241-TY-104			
Solids composite inventory estimate*			
Chemical constituents	(M)	(ppm)	(kg)
SO_4^{-2}	0.977	6.61 E+04	1.53 E+04
Si (as SiO_3^{-2})	0	0	0
F^-	0	0	0
Cl^-	7.47 E-02	1.86 E+03	431
$C_6H_5O_7^{-3}$	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
CCl4	0	0	0
hexone	0	0	0
$Fe(CN)_6^{-4}$	0	0	0
Radiological constituents	(M)	(ppm)	(kg)
Plutonium		2.32 E-03 (μCi/g)	8.92 E-03 (kg)
Uranium	0.140 (M)	2.34 E+04 (μg/g)	5.41 E+03 (kg)
^{137}Cs	9.07 E-04 (Ci/L)	0.639 (μCi/g)	148 (Ci)
^{90}Sr	4.93 E-03 (Ci/L)	3.47 (μCi/g)	802 (Ci)

*Composite inventory excludes supernatant, diatomaceous earth, and cement. Unknowns in tank inventory are assigned by Tank Layer Model.

M = molar.
ppm = parts per million.
TOC = total organic carbon.
1 Ci = 3.7 E+10 Bq.

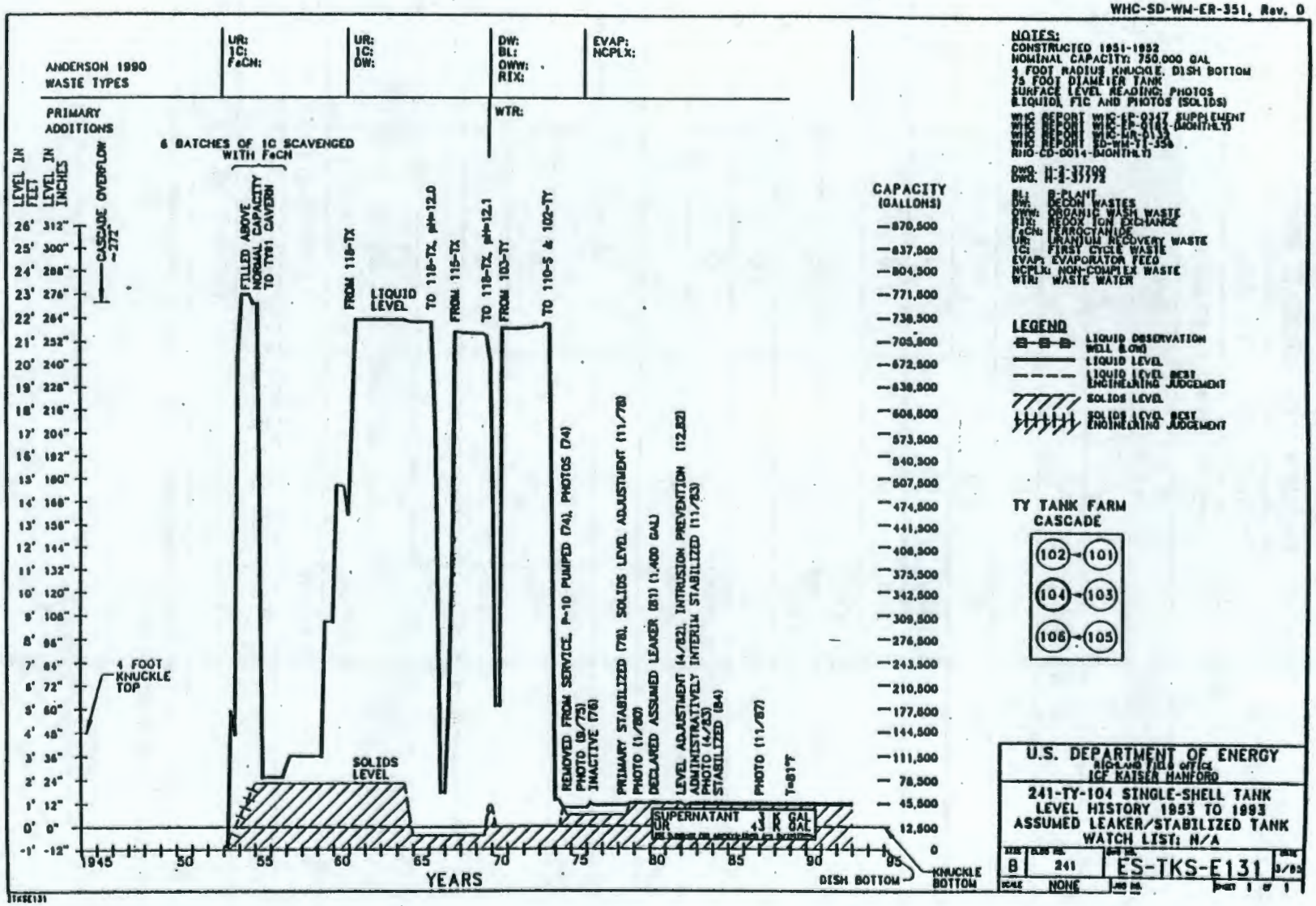


Figure 2-4. Tank Level History.

Zip cord readings performed prior to February 1995 auger sampling show the waste surface level at 30.5 cm (12 in.). The discrepancy between readings may be attributed to the FIC probe contacting a pool of liquid waste under Riser 1 or possibly an uneven (non-level) waste surface.

The tank was removed from service in 1974 and most of the liquid waste was pumped out. The tank was primarily stabilized in 1978 and a solids level adjustment was performed late in 1978. Another level adjustment and an intrusion prevention were performed in 1982. The tank was interim stabilized in 1983.

2.4.2 Internal Tank Temperatures

There are 14 thermocouples on a single thermocouple tree in tank 241-TY-104, Riser 4. Elevations are available for all probes on the tree. Probes are located every 61 cm (24 in.) except the top two, which are separated by 122 cm (48 in.) (Tran 1993). Only the first probe is located in the waste. Additionally, a temperature vapor probe has just recently been installed in Riser 3.

The mean temperature of the first electronically available data set in September 1970 for thermocouples 1 through 7 is 17 °C (63 °F). From January 1976 to January 1994, the average temperature was 18 °F (65 °F) with a minimum of 12 °C (53 °F) and a maximum of 34 °C (94 °F). The thermocouple plots can be found in the HTCE for tank 241-TY-104. A graphical representation of the weekly high temperature is found in Figure 2-5.

2.4.3 Tank 241-TY-104 Photographs

Figure 2-6 contains photographs of the surface of the waste in tank 241-TY-104. The surface of the waste may be biased towards the blue tones in the photograph giving it a lavender appearance. The photographs are very hazy making the interpretation of the waste surface characteristics very difficult. It appears there may be iron oxide in solution in the center of the tank. A temperature probe, a FIC level probe, and some manholes, nozzles and risers are visible. The photographs were taken in 1987. There has been limited activity in the tank since 1987 (1995 auger sampling and temperature vapor probe installation) and the surface level of the tank waste has remained consistent. Therefore, the photographs should reasonably represent the existing tank interior. The tank contains about 174 kL (46,000 gal) of waste which is equivalent to about 0.6 m (2 ft) of depth.

Figure 2-5. Tank 241-TY-104 Weekly High Temperature Plot.

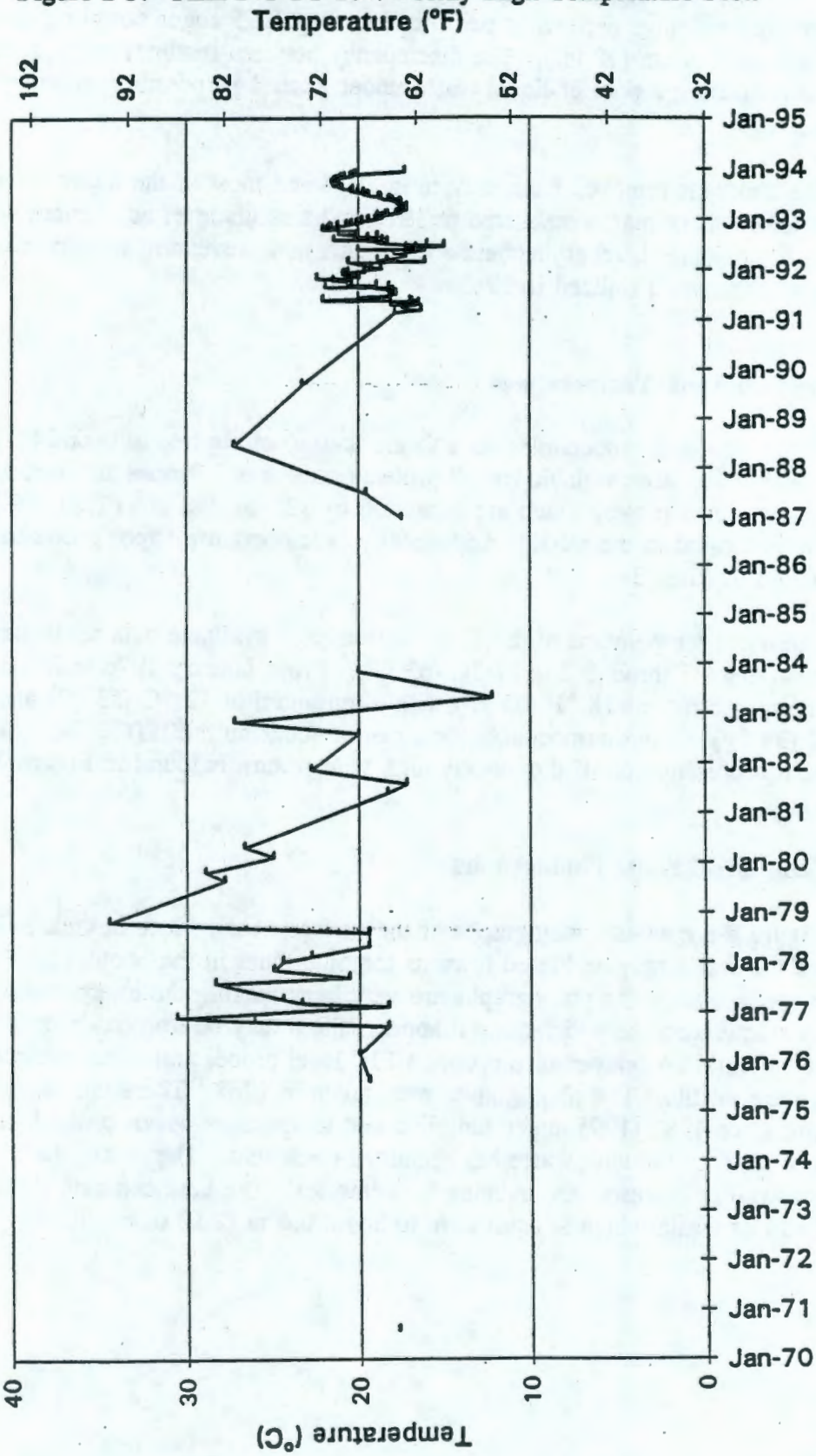
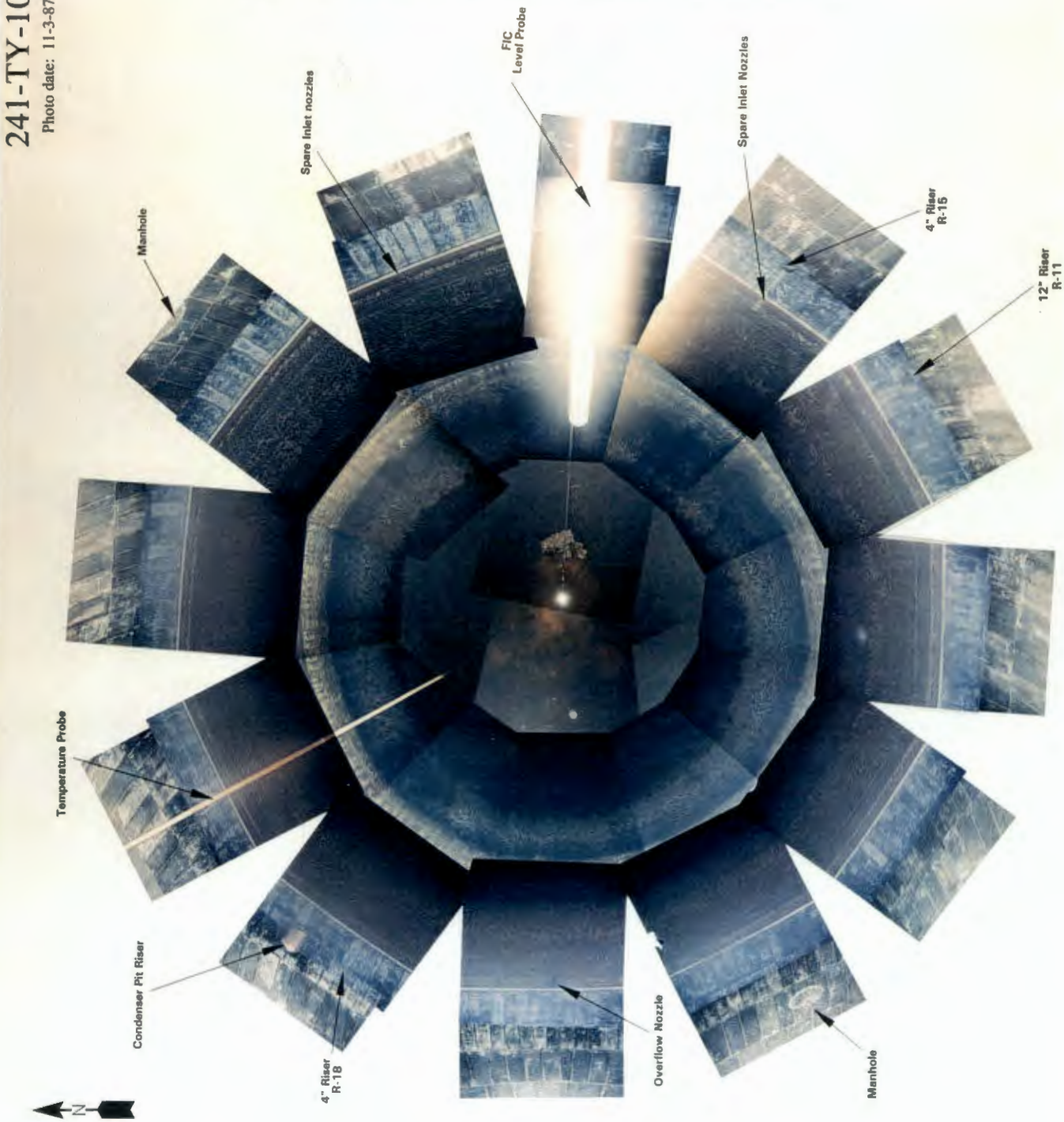


Figure 2-6. Tank 241-TY-104 Waste Surface Photographs.



This page intentionally left blank.

3.0 TANK SAMPLING OVERVIEW

This section describes two sampling and analysis events associated with tank 241-TY-104. The first event involves core samples retrieved in August 1985 for characterization analysis. The more recent event concerns two auger samples retrieved in February 1995 for analysis following the requirements in *Tank Safety Screening Data Quality Objective* (Babad and Redus 1994), *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objective Process* (Meacham et al. 1994), *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue* (Babad et al. 1994), and other requirements described in the *Tank 241-TY-104 Tank Characterization Plan* (Schreiber 1995).

3.1 DESCRIPTION OF AUGUST 1985 SAMPLING EVENT

Using a combination of push and rotary modes, six cores were taken through Risers 3, 5, and 15 in August 1985 to gather information and data for characterization of the waste contained in tank 241-TY-104 (Weiss and Mauss 1987). Recovery data, drill string dose rates, and sample descriptions are provided in Table 3-1. Percent recovery in Table 3-1 is calculated based on the volume (length) of expected waste versus the volume (length) of waste actually recovered. The sample identification was the breakdown number assigned to each segment. No separable organic layering was noted within the liquids collected, but an organic layer is described in core 3, segment C-2 and in core 4 segment D-1.

3.1.1 Sample Handling (August 1985)

The core segments were extruded and sub-sampled at the Westinghouse Hanford Company 222-S Laboratory. The prepared specimens and their matrices are presented in Table 3-2. Composite identification numbers shown in Table 3-2 are those assigned by the laboratory for each specimen prepared for analysis. No analytical preparation was required for the drainable liquid composites except filtering.

Those composites (232S0000, 241S0000, 251S0000, and 261S0000) that had sufficient amounts of solid material for analysis were washed with water, centrifuged, and the water was analyzed for a set of water soluble analytes. The left over sludge was then treated with a 5 molar hydrochloric acid solution, centrifuged, and the leachate analyzed for chemical and radiochemical constituents. Any material not dissolved by the acid was combined with a HCl-HNO_3-HF solution at elevated temperatures in a pressure reactor before the remaining analytes were identified. For samples with large amounts of acid insoluble solids, only a portion of the material was used for the pressure dissolution (0.5 load limit of the reactor).

Table 3-1. Tank 241-TY-104 1985 Sample Data.

Core	Seg	Riser	Percent recovery	Drill string dose rate (mR/hr)	Sample ID	Sample description
1	A-1	R-5	0	35	211	Approximately 25 mL of clear liquid. Insufficient solids recovered for analysis.
1	A-2	R-5	0	21	212	Approximately 50 mL of liquid. Insufficient solids recovered for analysis.
2	B-1	R-5	0	40	221	Approximately 50 mL liquid. Insufficient solids recovered for analysis.
2	B-2	R-5	0	NR	222	Equipment problems. No attempt made to recover sample.
3	C-1	R-5	0	<1	231	Approximately 50 mL clear liquid. Insufficient solids recovered for analysis.
3	C-2	R-5	63	150	232	154 mL of liquid and solids: 11 mL of organic, 98.5 mL aqueous, 44.5 mL solids. Solids dark brown, very chunky, with several pieces octahedron shaped translucent crystals. Organic layer colorless. Aqueous clear yellow. Hard dark rock chunk also found.
4	D-1	R-5	78	170	241	184 mL liquid and solids: 16.5 mL organic, 147 mL aqueous, 20.5 mL solids. Very similar to #232. Solids drier than #232 with large and small translucent crystals. Several dark rock chunks also seen.
5	A-1	R-3	51	350	251	183 g of sample much firmer than previous two. Dark brown solids. Several large translucent crystals.
6	A-1	R-15	100	350	261	208 g of sample like soft butter. Dark brown with translucent octahedron crystals.

NR = not reported.

Table 3-2. Tank 241-TY-104 1985 Specimen Preparation.

Composite ID	Composition	Matrix
211D0000	Combined liquids from samples 211, 212, and 221	Aqueous
232D0000	Aqueous portion of sample 232	Aqueous
232S0000	Solid portion of sample 232	Solid
241D0000	Aqueous portion of sample 241	Aqueous
241S0000	Solid portion of sample 241	Solid
251S0000	Blended solids of sample 251	Solid
261S0000	Blended solids of sample 261	Solid

3.1.2 Sample Analysis (August 1985)

The specimens prepared from the tank 241-TY-104 samples were analyzed for chemical constituents, radiochemical constituents, and physical properties at the Westinghouse Hanford Company 222-S Laboratory. Results of these analyses are reported in *Data Transmittal Package for 241-TY-104 Waste Tank Characterization* (Weiss and Mauss 1987). No quality control information for these analyses is contained in the referenced document.

No transfers to or from tank 241-TY-104 have occurred since the 1985 sampling event (Brevick et al. 1994), so the results of these analyses should provide relevant information on the current composition of the waste. The analytical summaries for the liquid composite specimens are presented in Appendix A of this document; those for the solids samples are presented in Table 4-2. Analytical methods and procedure numbers are given in Table B-2 of Appendix B.

3.2 DESCRIPTION OF FEBRUARY 1995 SAMPLING EVENT

Two samples were obtained from tank 241-TY-104 using 20-in. augers. The first auger sample (#95-AUG-008) was retrieved from Riser 18 on February 23 and the second sample (#95-AUG-009) was retrieved from Riser 15 on February 24, 1995. The total amount of solid material recovered for the first sample was about 90.6 g with most of the material covering the auger from flutes #8 through #19. About 277 g of solid material was recovered from flutes #8 through #19 for the second sampling.

For both samplings, auger flutes #1 through #7 were clean, so that the sample material covered only the bottom 12 in. of the auger. Actual recovery was 3 in. less than expected recovery (15 in.) according to the TCP (Schreiber 1995). No crust material was

observed and no drainable liquid was recovered from the augers. The drill string dose rates for Risers 18 and 15 were 200 and 250 mR/hr respectively. No problems related to the sample event were noted.

3.2.1 Sample Handling (February 1995)

The two samples were received at the Westinghouse Hanford Company 222-S Laboratory on February 28, 1995, and extruded March 2 and 3, 1995. Color photographs of the extruded auger samples are included in Appendix C.

The picture of auger sample 95-AUG-008 (Figure C-1) shows a thin, very moist, dark-brown material on the flutes of the auger and several puddles of material in the tray below the auger. Conversely, the picture of auger sample 95-AUG-009 (Figure C-2) shows a thick, moist, dark-brown material between the flutes of the auger. A few drips of waste can be seen in the tray below the auger containing sample 95-AUG-009. Neither auger sample contained any drainable liquid or crust material. Subsampling information is provided for both samples in Table 3-3.

Sample #95-AUG-008 was originally separated as material that had fallen into the tray and material that remained on flutes #8 through #19. Per instructions from the Ferrocyanide Safety Program, these materials were held for over a week to determine if a sufficient amount had been collected for the needs of the program or if another sample collection was necessary. Upon notification to proceed with the work, the separated subsamples were combined and designated as tank waste representing quarter segment D. All analyses were performed and sample archives were collected from this quarter segment of the auger sample.

Material from flutes #14 through #19 was taken to represent quarter segment D and material from flutes #8 through #14 was taken to represent quarter segment C for sample #95-AUG-009. Energetics by differential scanning calorimetry (DSC) and percent water by thermogravimetric analyses (TGA) were determined on each quarter segment. Total alpha activity and TOC analyses were completed on a composite of these two quarter segments (half segment).

3.2.2 Sample Analysis (February 1995)

Following the requirements of the tank characterization plan (TCP) (Schreiber 1995), energetics by DSC, percent water by TGA, TOC by persulfate/coulometry, and total alpha analyses were completed on the samples. Total inorganic carbon (TIC) was reported for two samples as a by-product of the TOC analysis. No results exceeded the applicable DQO notification limits. Analytical methods and procedure numbers are given in Table B-1 of Appendix B.

Table 3-3. Tank 241-TY-104 1995 Sample Data.

Sample ID	Core ID	Seg. portion	Riser	Analyses
S95T000316	95-AUG-008	D (Bottom quarter)	18	TGA, DSC, TOC and TIC by persulfate
S95T000318	95-AUG-008	D (Bottom quarter)	18	Total alpha
S95T000737	95-AUG-008	D (Bottom quarter)	18	TOC by furnace oxidation
S95T000240	95-AUG-009	C (Third quarter)	15	TGA, DSC
S95T000235	95-AUG-009	D (Bottom quarter)	15	TGA, DSC
S95T000236	95-AUG-009	D&C (Lower half)	15	TOC and TIC by persulfate
S95T000243	95-AUG-009	D&C (Lower half)	15	Total alpha
S95T000738	95-AUG-009	D&C (Lower half)	15	TOC by furnace oxidation

DSC = differential scanning calorimetry.
TGA = thermogravimetric analysis.
TIC = total inorganic carbon.
TOC = total organic carbon.

A deviation from the TCP requirement that total alpha and TOC analysis be performed on half segments occurred because it was determined that all of the material from sample #95-AUG-008 represented only a quarter segment.

The reported total alpha results were taken from the rerun batch because spike recoveries for the original batch exceeded accuracy control limits. The total alpha duplicate analyses for samples S95T000243 and S95T000318 did not meet the specified precision criterion of ± 10 percent relative percent difference. Both samples also exceeded the accuracy control limits on the rerun batch.

The TOC by hot persulfate duplicate analysis results for samples S95T000236 and S95T000316 exceeded the precision acceptance criteria. TOC blank values were greater than the detection limit, but were 46 times less than the mean concentration of the samples, indicating that contamination was not significant.

The TOC results by furnace oxidation are approximately 7 times greater than the TOC values by hot persulfate. This disparity can be attributed to the water digestion preparation of the sample that the laboratory must use since furnace oxidation analysis of solid samples cannot be performed at the 222-S Laboratory. Because of the difficulty in extracting TOC from solids by water digestion, a large dilution of the specimen is required. The furnace oxidation results for samples S95T000737 and S95T000738 were just over the detection limit, and at this concentration the quantitative accuracy is subject to error. The

large quantitative error, when multiplied by the large digestion preparation dilution factor, can produce large errors in the sample results. The TOC by furnace oxidation duplicate sample analysis for S95T000738 exceeded the specified precision criterion. Further discussion of quality control procedures can be found in Section 5.1.2.

No other problems were noted for the analysis of the two auger samples.

4.0 ANALYTICAL RESULTS AND WASTE INVENTORY ESTIMATES

4.1 OVERVIEW

The purpose of this section is to summarize the analytical results from the sampling events described in Section 3.0 and to provide concentration and inventory estimates for measured analytes. The data on which the estimates are based were obtained from the February 1995 sampling event (Miller 1995a; Miller 1995b) and the August 1985 sampling event (Weiss and Mauss 1987). Material has not been transferred to or pumped from the tank since 1974; therefore, the data obtained in August 1985 are considered to be useful for comparative purposes. The information obtained from this sampling event is the best available data because a more recent analysis of the chemical and radiochemical constituents has not been performed. The summary tables and the appropriate appendices where the data can be found in this document are identified in Table 4-1.

Table 4-1. Analytical Data Presentation Tables for Tank 241-TY-104.

Analysis	Tabulated result location
1985 Solid sample data (1985)	Table 4-2
1985 Drainable aqueous liquid data (1985)	Table A-1
Total alpha (February 1995)	Table 4-3
Total organic carbon (February 1995)	Table 4-4
Thermogravimetric analysis (February 1995)	Table 4-5
Differential scanning calorimetry (February 1995)	Table 4-6

The chemical and radiological composition and projected inventory for the waste in tank 241-TY-104 is derived from a 1985 sampling event which was described in Section 3.0. The 1985 sampling event was performed before DQO were developed and implemented; the resulting data do not fully comply with the recent requirements for a safety screening listed in *Tank Safety Screening Data Quality Objective* (Babad and Redus 1994).

The February 1995 sampling and analysis event was performed for evaluation of the safety screening criteria defined in Babad and Redus (1994). The DQO stipulates that weight percent water by TGA, DSC for evaluation of fuel content and thermal output, total alpha analyses for criticality evaluation, headspace gas composition (as a percent of the lower flammability limit [LFL]) are required for tank 241-TY-104.

Before waste sampling occurred in February 1995, the headspace flammability, as measured by combustible gas meter, was found to be less than 1% of the LFL (Meacham 1995a). Detailed results of this headspace gas sampling are contained in *Tank 241-TY-104 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-463, Rev. 0, (Huckaby 1995) and are not reproduced here.

Because tank 241-TY-104 is on both the Ferrocyanide and Organic Watch Lists, the Ferrocyanide DQO (*Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objective Process* [Meacham et al. 1994]) and the Organic DQO (*Data Quality Objectives to Support Resolution of the Organic Fuel Rich Tank Safety Issue* [Babad et al. 1994]) are also applicable to the February 1995 sampling and analysis. All primary analyses required by the Ferrocyanide DQO were not performed, since tank 241-TY-104 is not on the Ferrocyanide Safety Program's priority list. Sample material from the augers was archived for future analysis when needed by the Ferrocyanide Safety Program. The only additional analysis mandated by the Organic DQO which was not already required by the Safety Screening DQO was the evaluation of TOC by the hot persulfate method. Based on the results from this analysis, a secondary TOC analysis by furnace oxidation was also performed.

All of the various DQO sampling and analysis criteria and requirements for the 1995 sampling event are summarized in *Tank 241-TY-104 Tank Characterization Plan* (Schreiber 1995). Results from analyses performed on the 1995 augers are contained in *45-Day Safety Screen Results for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009* (Miller 1995a) and *216-Day Safety Screen Results and Final Report for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009* (Miller 1995b) and are discussed in the following sections.

4.2 DATA PRESENTATION

The chemical composition of the sludge in Tank 241-TY-104 is reported in Table 4-2. The values were derived from the 1985 sampling and analysis events (Weiss 1986). The solid composite analyte concentration (as listed in columns 2 through 5 of Table 4-2) for each sample was calculated by adding the results from each of three digestions: water, acid, and fusion. The results are additive because each successive digestion step was performed on the residue from the previous step. A simple average of the results from all composite samples was then used to calculate a tank concentration estimate. The relative standard deviations (RSD) were calculated by treating each of the four sample results equally. The projected inventory calculations associated with the sludge in the tank were calculated conservatively, attributing the total waste volume of 174 kL (46 kgal) to sludge since the liquid concentrations (Table A-1) are very small compared to the sludge. All pumpable liquid has been removed from this tank. From calculations performed in the *Single-Shell Tank Stabilization Record* (Swaney 1994), only 7 percent (3 kgal) of the total waste remaining in

Table 4-2. 1985 Solid Sample Data.* (2 sheets)

Analyte	232S	241S	251S	261S	Average	RSD	Projected inventory
Metals	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(%)	(kg)
Aluminum	10,000	9,330	8,770	8,210	9,080	8.44	2,670
Barium	321	505	615	330	443	32.2	130
Bismuth	9,160	16,800	25,700	19,400	17,800	38.5	5,230
Cadmium	12.3	22.6	23.0	6.74	16.2	49.5	4.76
Chromium	928	1,900	1,480	1,350	1,410	28.3	415
Iron	22,500	58,800	25,800	23,200	32,600	53.9	9,580
Lead	433	593	651	625	576	17.0	169
Manganese	2,690	2,360	1,370	487	1,730	57.9	509
Nickel	850	1,750	1,630	1,730	1,490	28.9	438
Phosphorus	38,900	29,700	8,310	27,900	26,200	49.1	7,700
Silicon	2,580	9,480	9,630	10,700	8,100	45.9	2,380
Silver	9.46	13.0	23.6	2.41	12.1	72.9	3.56
Sodium	137,000	119,000	84,200	112,000	113,000	19.4	33,200
Uranium	12,300	21,300	15,700	28,600	19,500	36.6	5,730
Zirconium	139	182	212	190	181	16.9	53.2
Anions	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(μg/g)	(%)	(kg)
Carbonate	14,600	16,400	23,900	19,900	18,700	22.0	5,500
Chloride	<848	463	809	672	698	24.9	205
Fluoride	10,200	5,540	1,060	4,610	5,350	70.3	1,570
Hydroxide	1,580	1,240	778	1,560	1,290	29.1	379
Nitrate	35,000	35,900	62,300	53,200	46,600	28.8	13,700
Nitrite	9,300	9,770	16,900	12,900	12,200	28.7	3,590
Sulfate	<8,200	<3,890	4,830	<3,980	5,230	38.8	1,540
Total carbon	(μg C/g)	(μg C/g)	(μg C/g)	(μg C/g)	(μg C/g)	(%)	(kg)
Total organic carbon	2,100	2,780	1,950	907	1,930	40.0	567

Table 4-2. 1985 Solid Sample Data.* (2 sheets)

Analyte	232S	241S	251S	261S	Average	RSD	Projected inventory
Radionuclides	(μCi/g)	(μCi/g)	(μCi/g)	(μCi/g)	(μCi/g)	(%)	(Ci)
^{241}Am	0.0222	0.0317	0.0429	0.0369	0.0334	26.2	9.82
^{14}C	0.00327	0.00479	0.00249	0.00216	0.00318	36.9	0.935
^{137}Cs	15.1	26.1	93.3	47.0	45.4	76.2	13,300
^{60}Co	0.0155	0.0261	0.0432	0.00572	0.0226	70.9	6.64
^{129}I	<0.0470	<0.0470	<0.0900	<0.590	<0.194	137	<57.0
$^{239/240}$Pu	0.136	0.193	0.190	0.202	0.180	16.6	52.9
^{90}Sr	29.5	215	45.8	236	132	82.8	38,800
^{99}Tc	0.0235	0.0306	0.0345	0.0344	0.0308	16.8	9.06
Total alpha	0.577	0.282	0.198	0.218	0.319	55.2	93.8
Total beta	907	500	661	842	728	25.3	214,000
Total gamma	19.0	27.1	95.4	47.1	47.2	72.7	13,900
Physical						(%)	
pH	12.0	11.9	11.7	12.0	11.9	1.19	–
Density (g/mL)	1.85	1.77	1.66	1.48	1.69	9.48	–

*Weiss, R. L., 1986, *TY Tank Farm Waste Characterization Data*, RHO-WM-TI-1P, Rockwell Hanford Operations, Richland, Washington.

RSD = relative standard deviation (standard deviation/mean) of the data.

1 Ci = 3.7 E+10 Bq.

the tank is supernatant. The average density of the sludge was determined to be 1.69 g/mL, so the volume of sludge can be converted from liters to kilograms by the following equation:

Volume of sludge (L) x determined sludge density

$= (174{,}000\ L)(1000\ mL/L)(1.69\ g/mL)(1.0 \times 10^{-3}\ kg/g)$

$= 294{,}000\ kg.$

4.2.1 Total Alpha

4.2.1.1 Total Alpha Activity in 1985 Core Samples. Although the DQO process was not in place when the 1985 samples were obtained, it is briefly discussed in this section for consistency and corroboration. As can be seen in Table 4-2, the highest total alpha activity was 0.577 μCi/g, which is well below the notification limit specified in Babad and Redus (1994). Total alpha analyses were performed in accordance with procedure number LA-508-103. All four composite samples used for the tank inventory estimates were analyzed for total alpha, and all three digestion methods (water, acid, and fusion) were used.

4.2.1.2 Total Alpha Activity in 1995 Safety Screening Samples. Total alpha samples were prepared by fusion using procedure LA-549-141, Rev. C-2. The total alpha measurements were performed on the lower half segment from Riser 15 and the quarter segment from Riser 18 following procedure LA-508-101, Rev. D-2. Even though the TCP requires that a full half segment be used in the total alpha evaluation, only a quarter segment was obtained from Riser 18 and this quarter segment was utilized for the measurement. The results of the total alpha analysis are presented in Table 4-3.

Table 4-3. Tank 241-TY-104 Analytical Data: Total Alpha.*

Analyte	Sample number	Sample location (Riser:segment)	Sample result (μCi/g)	Duplicate result (μCi/g)	Mean (μCi/g)
Total alpha	S95T000318	18:lower ¼	0.137	0.184	0.145
	S95T000243	15:lower ½	0.143	0.117	

*Miller, G. L., 1995a, *45-Day Safety Screen Results for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009*, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.
1 Ci = 3.7 E+10 Bq.

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 the sampling event are contained in Section 3.0. The third column describes the sample location of the individual sample. The first number lists the riser number, which is followed by a colon, and then the portion on the auger from which the sample was derived. The fourth column, labeled Sample Result, is the specific concentration of the analyte determined at the different sampling points. The number listed is an average between the primary sample and its duplicate sample. The column labeled Mean is a simple mean of all the results for the analyte.

4.2.2 Total Organic Carbon

4.2.2.1 Total Organic Carbon In 1985 Core Samples. Total organic carbon analyses were performed on the 1985 core samples using procedure LA-344-101. As discussed above in Section 4.2.1, the DQO process was not in place when the 1985 samples were analyzed. The DQO sample results are discussed in comparison with the DQO requirements for purposes of comparison and corroboration. As can be seen in Table 4-2, the highest sample results were well within the 30,000 μg C/g limit listed in Babad and Redus (1994).

4.2.2.2 Total Organic Carbon In 1995 Safety Screening Samples. TOC determination was performed by the hot persulfate method (LA-342-100) as a primary analysis, and by the furnace oxidation method (LA-344-105) as a secondary analysis. The hot persulfate procedure included the TOC analysis requested by the tank characterization plan and TIC data as a by-product of the TOC analysis. As with the total alpha analysis, the Riser 18 segment (S95T000316) was performed on the quarter segment. TOC sample values by the hot persulfate method were more than 30-fold less than the DQO notification limit of 30,000 μg C/g (Miller 1995b). Quality control information can be found in Section 5.1.2.

Total organic carbon was analyzed by the furnace oxidation procedure because the energy equivalent values of TOC by the hot persulfate procedure were less than 75 percent of the DSC values. Water digested samples were derived from the two risers using "Water Leach of Solids with Residual Solids Collection" procedure LA-504-101, Rev. C-0. These aliquots displayed TOC values ranging from 5,510 to 6,940 μg/g, which is 5-fold less than the notification limit. However, the TOC values by furnace oxidation procedure were approximately seven times greater than the TOC values by the hot persulfate method. This contrast in results between the two analytical methods is caused by the water digestion of the samples. Currently, the 222-S Laboratory is not able to perform TOC analysis by the furnace oxidation method on a solid sample. To accommodate this procedure, solid samples must first be prepared using a water digestion, as specified in the tank characterization plan. This digestion is inefficient at extracting TOC from the solids, and therefore, requires a large dilution of the sample. This method of digestion results in calculations of the final sample TOC concentration using a large sample dilution factor (Miller 1995b).

The furnace oxidation method TOC values for Tank 241-TY-104 were only slightly greater than the analytical instrument's calibrated detection limit, at which concentration the accuracy of quantitation is subject to significant error. Such a large quantitation error, multiplied by the large digestion dilution factor, caused large errors in the final sample TOC results. Consequently, TOC analysis results by the two different procedures are unlikely to be comparable.

The TOC and TIC results are listed in Table 4-4. 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 the sampling event are contained in Section 3.0. The third column describes the sample location of the individual sample. The first number lists the riser number, which is followed by a colon, and then the portion of the auger from which the sample was derived. The fourth column, labeled Sample Result, is the specific concentration of the analyte determined at the different sampling points. The number listed is an average between the primary sample and its duplicate sample. The column labeled Mean is a simple mean of all the results for the analyte.

Table 4-4. Tank 241-TY-104 Analytical Data Results for Total Organic Carbon.[a]

Analyte	Sample No.	Sample location (Riser:segment)	Sample result[b] (µg C/g)	Duplicate result[b] (µg C/g)	Mean (µg C/g)
TOC					
TOC by hot persulfate	S95T000316	18:lower ¼	774	895	867
	S95T000236	15:lower ½	826	971	
TOC by furnace oxidation	S95T000737	18:lower ¼	6,520	6,520	6,373
	S95T000738	15:lower ½	5,510	6,940	
Analyte	Sample No.	Sample location (Riser:segment)	Sample result[b] (µg/g)	Duplicate result[b] (µg/g)	Mean (µg/g)
TIC					
TIC by hot persulfate	S95T000236	18:lower ¼	5,480	6,460	6,035
		15:lower ½	5,870	6,330	

[a]Miller, G. L., 1995a, *45-Day Safety Screen Results for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009*, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.

[b]Wet basis.

4.2.3 Percent Water Analyses

Percent water analyses were not performed on the 1985 core samples.

Thermodynamic analyses of the waste are the only physical requirements identified in the safety screening DQO. The TGA provides as an estimate of the weight percent water, and is also utilized to interpret and define the DSC results. Results for the TGA analyses are summarized in the following section.

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

Weight percent water by TGA was performed under a nitrogen atmosphere using procedure LA-560-112, Rev. A-2. The results for the three samples and their respective duplicates ranged in value from 49.75 to 55.23 percent water by weight. Consequently, none of the samples were below the DQO notification limit of 17 percent water. The results of the TGA analyses are provided in Table 4-5.

Table 4-5. Thermogravimetric Results for Tank 241-TY-104.*

Sample number	Sample location (Riser:segment)	Run	Temperature range (°C)	Sample result (wt% loss)	Mean (wt% loss)
S95T000316	18:lower ¼	1	amb to 139	53.23	51.6
		2	amb to 148	49.95	
S95T000240	15:3rd ¼ D	1	amb to 159	51.42	51.6
		2	amb to 157	51.67	
S95T000235	15:bottom ¼	1	amb to 142	55.23	52.5
		2	amb to 144	49.75	
Tank 241-TY-104 wt% water loss					51.8

*Miller, G. L., 1995a, *45-Day Safety Screen Results for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009*, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.
amb = ambient.

The recorded weight losses are relative to the original weight of the sample. The TGA associated with the samples obtained from Tank 241-TY-104 displayed only one broad transition ranging from ambient temperature to approximately 160 °C. The loss of sample

weight within this temperature range is attributed to the evaporation of free water and the dissociation of covalently bonded water molecules.

4.2.4 Thermodynamic Analyses

DSC analyses were not performed on the 1985 core samples.

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 (releasing, as opposed to absorbing heat) event on a DSC is determined graphically.

Analyses for DSC were performed under a nitrogen atmosphere using procedure LA-514-113, Rev. B-1. No exothermic reactions were observed in any of the three samples or their respective duplicates on a wet weight basis. Like the TGA analysis, the DSC analyses were performed in duplicate (run 1 and run 2).

The DSC results for Tank 241-TY-104 are given in Table 4-6. The temperature range, temperature at maximum enthalpy change, and the magnitude of the enthalpy change in J/g are provided for each transition. The first transition represents the endothermic reaction for the evaporation of free and interstitial water. The second endothermic transition probably represents the energy (heat) required to remove the bound water from hydrated compounds or to melt salts such as sodium nitrate.

Table 4-6. Differential Scanning Calorimetry Results for Tank 241-TY-104.*

Sample number	Sample location (Riser:flutes)	Run	Sample weight (mg)	Transition 1 range amb to 200 °C		Transition 2 range 220 °C to 305 °C	
				Onset temp. °C	ΔH J/g	Onset temp. °C	ΔH J/g
S95T000235	15:14-19	1	29.3	107.3	997.9	271.2	19.4
		2	36.4	107.3	796.1	265.1	13.0
S95T000240	15:8-13	1	31.6	113.3	834.7	--	--
		2	32.2	111.3	977.4	--	--
S95T000316	18:8-19	1	29.9	107.3	819.0	273.0	40.7
		2	30.6	109.3	870.8	273.1	40.1

*Miller, G. L., 1995a, *45-Day Safety Screen Results for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009*, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.

ΔH > 0 indicates an endotherm.

This page intentionally left blank.

5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

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 and to identify any limitations in the use of the data.

5.1.1 Field Observations

Recoveries for the 1985 core sampling effort were less than expected (Weiss and Mauss 1987). Specifically, the sample from Riser 5 was affected by the presence of a hole in the waste caused by a previously installed salt well screen. Excess liquid will accumulate in the hole, possibly resulting in high recoveries of liquid in the samples. For this reason, tank waste inventory estimates based on Riser 5 samples should be considered suspect (Weiss 1986). A physical description of the waste samples is presented in Table 3-1.

5.1.2 Quality Control Assessment

No quality control information was available for the 1985 data. The appropriate blanks, duplicates, spikes, and standards for quality control measures were performed on the 1995 auger sampling analyses. The tank characterization plan (Schreiber 1995) established a criteria of ± 10 percent for 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. All of the standards conducted on percent water, DSC, TIC and TOC were in the acceptable range (Miller 1995a&b). However, the only standard run for total alpha was slightly below the criterion (89.6), indicating that the analytical results for total alpha may be biased slightly low. Only one spike each was conducted on TIC and both TOC methods, and all were within the criterion. Both of the spikes conducted on total alpha were below the criterion (78.3 and 79.6), again indicating that the analytical results may be biased low. These were the rerun results, as the spikes from the first run were also outside the limits. Spikes are not applicable to the DSC and TGA methods.

Evaluation of blanks is only applicable to the total alpha, TIC, and both TOC analyses. Both blanks were below the detection limit for total alpha and TOC by furnace oxidation, indicating that contamination was not a problem for these analytes. For TOC by the hot persulfate method and TIC, both blank values were greater than the detection limit. However, they were 46 fold (TOC) and over 600 fold (TIC) less than the mean concentration of the samples, indicating the relative insignificance of contamination. The precision requirements are calculated by the relative percent difference (RPD) between primary and

duplicate samples (Miller 1995a&b). No RPDs were calculated for DSC because no exothermic reactions were detected, and all RPDs for TGA met the criteria. Both RPDs for total alpha (20.0, 29.3) and TOC by the hot persulfate method (16.1, 14.5) exceeded the criterion, as well as one of two for TIC (16.4) and TOC by furnace oxidation (23.0). However, these violations are not extreme because the results were well below the safety limit concern, as mentioned in Section 4.

In summary, the total alpha results may be biased because the low standard and spike recoveries, as well as high RPD results. The quality control information for the remainder of the analytes indicated that the analytical results should be reasonably good.

5.1.3 Data Consistency Checks

5.1.3.1 Comparison of Total Alpha and Total Beta with the Sum of Individual Isotopes. This evaluation can be used to ascertain the performance of the radiochemical separation methods or as an indicator of the presence of other isotopes in significant quantities. With regard to the results from the 1985 core samples, a comparison was made between the gross beta activity and the sum of the individual beta emitters. The values compared are the averages of the individual activities, and the average total beta activity (See Table 4-2). The average activities of the individual beta emitters were summed according to the following equation:

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

The factor of 2 in the equation accounts for the ^{90}Y daughter product. The ^{90}Sr and ^{137}Cs analytical values were multiplied by correction factors prior to the comparison with gross beta. The reason for this is that in converting from counts per minute to disintegrations per minute, a counter efficiency factor is used. This factor is determined by calibrating the counter with a ^{60}Co source of known activity. Since the counting efficiency for beta particles emitted by ^{60}Co is different from those emitted by ^{90}Sr and ^{137}Cs, the coefficients of 1.42 and 1.51 are needed to correct for this error.

A comparison was also made between the gross alpha activity and the sum of the individual alpha emitters. As was the case with the total beta comparison, the values compared are averages taken from Table 4-2. The activities of the individual alpha emitters were summed as follows:

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

The comparisons are made in Tables 5-1 and 5-2. Both tables are based on results given in Weiss and Mauss (1987). The relative percent difference between the sum of beta emissions and the total beta result is 49 percent. Similarly, the relative percent difference for the alpha activity comparison is 40 percent. Given the differences in sample recovery among the four cores used for characterization and variations in the waste form, the large relative percent differences (RPDs) are expected.

Table 5-1. Comparison of Total Beta Activity with the Total of the Individual Activities for 1985 Results.

Analyte	Half-life	Beta activity (μCi/g)
^{90}Sr	28.6 y	132
^{137}Cs	30.17 y	45.4
Sum of beta emitters (a)	--	443
Total beta result (b)	--	728
Relative percent difference*	--	49%

*Relative percent difference = the absolute difference of (a) and (b), divided by the average of (a) and (b).

1 Ci = 3.7 E+10 Bq.

Table 5-2. Comparison of Total Alpha Activity with the Total of the Individual Activities for 1985 Results.

Analyte	Half-life	Alpha activity
^{241}Am	458 y	0.0334
$^{239/240}Pu$	24,400 y	0.180
Sum of alpha emitters (a)	--	0.213
Total alpha (b)	--	0.319
Relative percent difference*	--	40%

*Relative percent difference = the absolute difference of (a) and (b), divided by the average of (a) and (b).

1 Ci = 3.7 E+10 Bq.

As a further check, RPDs were calculated for the sum of the alpha emitters and total alpha activity on an individual core basis. The resulting RPDs were 114% for sample 232S, 22.5% for sample 241S, 16.2% for sample 251S, and 8.3% for sample 261S. These results revealed that only sample 232S had an unreasonable RPD between the total alpha value and the sum of the individual alpha emitters, skewing the tank comparison.

A similar core comparison was performed for total beta. The resulting RPDs for the total beta activity and the sum of the individual beta emitters were 132% for sample 232S, 26.8% for sample 241S, 83.7% for sample 251S, and 12.8% for sample 261S. Two samples contained large RPDs, while the other two had close agreement. Sample 232S exhibited the largest RPDs for both the total alpha and total beta comparisons.

5.1.3.2 Mass and Charge Balance. The objective in performing a mass and charge balance is to determine if the measurements are self-consistent. In calculating the balances, only the sludge data from 1985 were considered, and only analytes listed in Table 4-2 which were detected at a concentration of 5,000 μg/g (0.5% of the total mass) or greater were considered.

Aluminum, bismuth, iron, silicon, and uranium were assumed to be present as insoluble species, and the concentration of the assumed species was calculated stoichiometrically (Table 5-3). Since precipitates are neutral species, all positive charge was attributed to the sodium cation. The anionic analytes listed in Table 5-4 were assumed to be present as sodium salts and were expected to balance the positive charge exhibited by the cations. The concentrations of the assumed species in Table 5-3, the anionic species in Table 5-4, and the percent water were ultimately used to calculate the mass balance.

Table 5-3. Cation Mass and Charge Data for 1985 Results.

Analyte	Concentration (μg/g)	Assumed species	Concentration of assumed species (μg/g)	RSD (%)	Charge (μmol/g)
Aluminum	9,080	$Al(OH)_3$	26,200	8.4	0
Bismuth	17,800	$Bi(OH)_3$	22,100	38.5	0
Iron	32,600	FeO(OH)	51,900	53.9	0
Silicon	8,100	SiO_2	17,400	45.9	0
Sodium	113,000	Na^+	113,000	19.4	4,910
Uranium	19,500	U_3O_8	23,000	36.6	0
Totals			~254,000	N/A	4,910

Table 5-4. Anion Mass and Charge Data for 1985 Results.

Analyte	Concentration (μg/g)	RSD (%)	Charge (μmol/g)
Carbonate	18,700	22.0	623
Fluoride	5,350	70.3	282
Nitrate	46,600	28.8	752
Nitrite	12,200	28.7	265
Phosphate	80,300	49.1	2,540
Sulfate	5,230	38.8	54.5
Totals	~169,000	N/A	~4,520

RSD = relative standard deviation.

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

$$\begin{aligned}\text{Mass balance} &= \%\ \text{Water} + 0.0001 \times \{\text{Total Analyte Concentration}\} \\ &= \%\ \text{Water} + 0.0001 \times \{Bi(OH)_3 + FeO(OH) + Na^+ + U_3O_8 + \\ &\qquad CO_3^{-2} + NO_3^- + NO_2^- + PO_4^{-3}\}\end{aligned}$$

The total analyte concentrations calculated from the above equation was 423,000 μg/g. The mean weight percent water obtained from the 1995 thermogravimetric analysis reported in Table 4-5 (51.8 percent). The mass balance resulting from adding the percent water to the total analyte concentration is 94.1 percent (Table 5-5).

Table 5-5. Mass Balance Totals for 1985 Results.

	Concentrations (μg/g)
Total from Table 5-3 (from 1985 data)	254,000
Total from Table 5-4 (from 1985 data)	169,000
Water (from 1995 data)	518,000
Grand total	941,000

RSD = relative standard deviation.

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

Total cations (microequivalents) = $Na^+/23.0$ = 4,910 microequivalents

Total anions (microequivalents) = $CO_3^{-2}/60.0 + F^-/19.0 + NO_3^-/62.0 + NO_2^-/46.0 + PO_4^{-3}/95.0 + SO_4^{-2}/96.0$ = 4,520 microequivalents

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 1.09.

The above calculations yield reasonable mass and charge balance values (close to 1.00 for charge balance and 100 percent for mass balance), giving a strong indication that the analytical results are fairly self-consistent and therefore reliable.

5.2 COMPARISON OF DATA SOURCES

5.2.1 Comparison of 1995 and 1985 Data

Total alpha is the sole analyte which is common to both the 1985 and the 1995 data sets. Since the tank contents did not change appreciably in the interim, either by transfers or by radioactive decay, a valid comparison can be made. The average total alpha activity from the 1985 sampling effort was 0.319 microcuries per gram (μCi/g). The average total alpha activity from the 1995 sampling effort was 0.145 μCi/g. A relative percent difference between the two values is 75 percent. As in the case of the comparison in Section 5.1.3.1 between the total alpha activity and that of the sum of the individual alpha emitters, the difference could have been caused by inconsistencies in the size of the samples.

Sample heterogeneity may also be the cause of the differences between the 1985 and 1995 data. Samples were not taken from Riser 5 in the 1995 sampling event as they were in the 1985 sampling event. Recalculating the 1985 total alpha mean (from Table 4-2) excluding the two samples from Riser 5 (leaving only samples 251S and 261S) gives 0.208 μCi/g, much closer to the 1995 result. When comparing just the total alpha data from samples taken from the riser common to both sampling events (Riser 15), the results are more consistent. Sample 261S from 1985 measured 0.218 μCi/g and the 1995 sample S95T000243 registered 0.130 μCi/g, for a relative percent difference of 51%.

5.2.2 Comparison of 1985 Data to the Historical Tank Content Estimates

Analytes common to both the Historical Tank Contents Estimate (Brevick et al. 1995) and the 1985 core sampling data are compared in Table 5-6. As can be seen in Table 5-6, the agreement is poor. Only four analytes out of fifteen had relative percent differences of less than 50 percent. However, those four analytes comprise nearly two-thirds of the waste matrix.

Several analytes that contribute relatively minor amounts to the waste matrix do not compare well, including chromium, nickel, and chloride. However, the large differences observed between predicted and observed values do not change the interpretation of the data. Even the seven-fold difference in chromium is not of concern because it remains less than 0.01% of the waste. Radionuclides were consistently underpredicted. Although present in small quantities on a mass basis, they can have substantial impact on the properties and treatment of the waste.

Analytes that contributed substantially to the matrix and did not compare well with predicted values are of more concern. These analytes include iron, hydroxide, and sulfate. the model appears in this case to overpredict them substantially. The hydroxide comparison is not valid, since the analytical values only measure soluble hydroxide and the model value is for total (soluble and insoluble) hydroxide.

5.3 TANK WASTE INVENTORY PROFILE

The only available measure of tank waste variability for the 1985 sampling event were the RSD calculated and included in Table 4-2. The larger the RSDs, the more variable the waste was between sampling locations for a particular analyte. A more complete statistical analysis was not possible for that data set since no duplicate samples were analyzed.

Based on the analyses from the 1995 sampling, it was possible to conduct simple statistical tests for the percent water, total alpha, TIC, and TOC analyses to determine if there were any differences in analyte concentrations between the two risers (horizontal trend). For the TOC analysis, only the results for the furnace oxidation method were used.

There were several possible limitations in evaluating the comparisons between sampling locations. The depth of waste in the tank was too small to warrant any effort at examining vertical trends, and there were very few analytes available to test. The sample recovery from Riser 18 was also quite poor (Miller 1995b). Finally, Riser 15 was much closer to the tank inlet than Riser 18, raising the possibility that this could have influenced the disposition of waste in the tank.

Table 5-6. Comparison of 1985 Core Sampling Data with the Historical Tank Content Estimate.

Analyte	Average concentration from 1985 sampling effort	Historical tank contents estimate[a]	Relative percent difference[b]
Metals	(μg/g)	(μg/g)	(%)
Chromium	1,410	210	148
Iron	32,600	95,600	98.3
Nickel	1,490	3,320	76.1
Sodium	113,000	74,900	40.1
Uranium	19,500	23,400	18.2
Anions	(μg/g)	(μg/g)	(%)
Chloride	698	1,860	90.9
Hydroxide	1,290	99,400	195
Nitrate	46,600	90,200	63.4
Sulfate	5,230	66,100	171
Carbonate	18,700	12,800	37.5
Radionuclides	(μCi/g)	(μCi/g)	(%)
^{137}Cs	45.4	0.639	194
^{90}Sr	132	3.47	190
$^{239/240}Pu$	0.180	0.00232	195
Density (g/mL)	1.69	1.42	17.4
Percent water	51.8	55.5	7.00

[a]Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995 *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area*, WHC-SD-WM-ER-351, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[b]Relative Percent Difference = the absolute difference of a and b, divided by the average of a and b.

1 Ci = 3.7 E+10 Bq.

The statistical procedure used to determine differences between the two risers is known as the analysis of variance (ANOVA). 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 from each other.

Only one pair of analytical results were available for total alpha, TIC, and TOC analyses. For percent water, the two pairs of results from Riser 15 were treated equally and compared to the single pair of results from Riser 18. The results of the ANOVA tests for percent water (p-value = 0.841), total alpha (p-value = 0.374), TIC (p-value = 0.833), and TOC (p-value = 0.751) indicated that there were no significant differences in analyte concentrations between the two risers for any of the four analytes. Therefore, based on the results of these four analytes alone, the contents of tank 241-TY-104 appear to be horizontally homogeneous.

The visual observations from the 1985 sampling event were not unlike the descriptions for the 1995 samples. There was some supernatant from one of the risers in the 1985 event, and the solids were dark brown and mostly firm but with some variation in moisture between risers. The visual observations for moisture in the extruded segments from the 1995 sampling event did not elaborate much beyond mention that no drainable liquid was recovered. The only specific statement was that the sample from Riser 18 was thin, moist, and dark brown, while the sample from Riser 15 was thick, moist, and dark brown. Any difference between the two risers based on the thin versus thick descriptions was not substantiated by the statistical analysis, which showed no significant difference in percent water between the two risers. Thus, there is no reason to distinguish between the waste sampled from the two risers based on appearance or analytical results.

5.4 COMPARISON OF ANALYTICAL DATA AND TRANSFER HISTORY INFORMATION

According to the Tank Layer Model (Agnew et al. 1995b), two waste types remain in the tank, (UR, also known as TBP) waste cascaded from tank 241-TY-103 and through the pump pit risers, and supernatant from other tanks in the TX and TY Tank Farms. The 1CFeCN waste supernatant was considered suitable for pumping to a crib, and what small amount remains contributes little to the present day radioactivity. The UR sludge, according to *Hanford Defined Wastes: Chemical and Radionuclide Compositions* (Agnew 1995), had relatively high concentrations of water, cesium, strontium, uranium, sodium, iron, uranium, hydroxide, nitrate, carbonate, and sulfate. The 1985 core data agree moderately with the values given in Agnew (1995) for sodium, water, and uranium. Values for nitrate, hydroxide, iron, sulfate, carbonate, uranium, ^{90}Sr and cesium exhibit poor agreement. Interestingly, based on Agnew (1995), no organic carbon or ferrocyanide is predicted to be in the UR waste. However, both Hanlon (1995) and Borsheim (1991) indicated that this tank received 12,000 g moles of ferrocyanide sludge in the 1950's.

Given the process history and the 1985 data, it is likely that ferrocyanide scavenged first cycle (1CFeCN) waste exists in the tank. A mixture of UR waste and 1CFeCN waste would agree well with the observed data. Analytes present in the waste that were not predicted by the Tank Layer Model (Agnew 1995) such as bismuth, aluminum, and nickel are indicative of 1CFeCN waste.

5.5 EVALUATION OF PROGRAM REQUIREMENTS

Only one of the two sampling events being used to characterize the waste in Tank 241-TY-104 was specifically governed by DQOs. The 1995 auger samples were obtained for a data assessment according to *Tank Safety Screening Data Quality Objective* (Babad and Redus 1994), *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue* (Babad et al. 1994), and *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objectives Process* (Meacham et al. 1994). All tanks are being screened for unidentified safety issues as mandated by the Safety Screening DQO. Tank 241-TY-104 is included on both the Ferrocyanide and Organic Watch Lists; the Ferrocyanide and Organic DQOs describe the sampling and analytical requirements for tanks on each of these Watch Lists.

The Ferrocyanide Safety Program has reassessed its need to sample all Ferrocyanide Watch List tanks and has created a priority list of tanks that bound aging (Meacham et al. 1995). Tank 241-TY-104 was not included on this list, so the nickel and total cyanide analyses required by the Ferrocyanide DQO were not performed on the 1995 auger samples. Sample material was archived in case the Ferrocyanide Safety Program needed analyses run later. Since none of the results from the primary analyses exceeded any decision criteria (see discussion below), none of the secondary analyses were required.

The 1985 core samples were acquired before the existence of DQOs. However, for informational purposes, comparisons have been made where applicable between the results from this sampling event and the requirements of the Safety Screening and Organic DQOs.

5.5.1 Safety Evaluation

The set of primary analyses required by the Safety Screening and Organic DQOs were similar. Both DQOs dictated that DSC be performed to evaluate fuel content, and thermogravimetry done to determine the weight percent water. The Safety Screening DQO also required analysis of total alpha activity, while a determination of the TOC content using the hot persulfate method was needed according to the Organic DQO. For each of the required analyses, a notification threshold is established by the respective DQO which, if exceeded, may warrant further investigation to assure the safety of the tank. When the analyses required by both the Safety Screening and Organic DQOs had conflicting notification limits, the more stringent restriction was used. The notification thresholds of both DQOs have been compared with the analytical results from the 1995 auger samples in Table 5-7.

Table 5-7. Comparison of Analytical Results with Decision Criteria of Safety Screening and Organic Data Quality Objectives.[a,b]

Applicable DQO	Primary decision variable	Decision criteria threshold	Analytical values
Safety screening; organic and ferrocyanide	Total fuel content	481 J/g (115 cal/g)	No exothermic reactions observed
Safety screening; organic	Percent moisture	17 wt%	51.8 percent
Safety screening	Total alpha	36.4 μCi/g (1 g/L)[c]	0.145 μCi/g
Safety screening	Flammable gas	≤25% LFL	<1% LFL
Organic	Total organic carbon[d]	30,000 μg C/g	867 μg C/g

[a]Babad, H., and K. S. Redus, 1994, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[b]Babad, H., S. M. Blacker, and K. S. Redus, 1994, *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue*, WHC-SD-WM-DQO-006, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[c]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. Using the tank waste density of 1.69 and the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criterion may be converted to 36.4 μCi/g as shown:

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

[d]Analyzed using the hot persulfate method.

1 Ci = 3.7 E+10 Bq.

As can be seen, none of the thresholds for the primary analyses were exceeded. The absence of energetics and the high nickel concentrations (see Table 4-2) indicate that the ferrocyanide has aged. The Organic DQO also requires a visual inspection of any recovered liquid for a possible organic layer. No liquid was recovered from either auger, so no organic layer observations were possible. It should be noted that observations from the 1985 core samples showed that two of the six cores contained a small amount of a separable organic phase (Weiss and Mauss 1987). However, because the 1985 sampling and analysis events occurred prior to the establishment of the organic DQO, organic analyses were not performed at that time. The small amount of separable organic phase material discovered during the 1985 sampling could have been due to the use of a liquid hydrocarbon as the hydrostatic head during core sampling.

Because the energy equivalent of the TOC values obtained by hot persulfate were <75 percent of the DSC value, a secondary analysis for TOC using the furnace oxidation method was performed. Results using this method were higher (6,370 μg C/g), but they were still much less than the 30,000 μg C/g notification limit specified in the Organic DQO (Babad et al. 1994).

The criteria identified in the Safety Screening and Organic DQOs can be compared to the results from the 1985 core samples for a rudimentary evaluation. A true safety screening and organic evaluation of these samples is not possible since the sampling was not done to DQO specifications and DSC and percent water determinations were not performed.

Although DSC analyses were not performed on the 1985 core samples, the waste fuel content can be investigated by reviewing TOC results. The TOC concentration of the sludge (1,930 μg C/g) and drainable liquid (2,110 μg C/g) is well below the 30,000 μg C/g notification limit (Babad et al. 1994). No cyanide analyses were performed during the 1985 analysis. The potential for criticality is assessed from either total alpha or plutonium analysis. The safety screening criteria is 1 g/L, or 36.4 μCi/g of $^{239/240}$Pu as derived previously. The 1985 sludge samples contained 0.180 μCi/g of $^{239/240}$Pu, far less than the threshold. The 1 g/L notification limit is equivalent to 61.5 μCi/mL of $^{239/240}$Pu, using the specific activity of $^{239/240}$Pu. The 1985 core sample data revealed that the drainable liquid contained only 0.00162 μCi/mL of $^{239/240}$Pu, more than satisfying the criticality requirement.

Another factor in assessing the safety of the tank is the heat generation and temperature of the waste. Heat is generated in the tanks primarily from radioactive decay. Temperature information for tank 241-TY-104 was given in Section 2.4.2. The amount of heat resulting from radioactivity in the tank is calculated in Table 5-8. The estimated total curies for each analyte is listed in column 2 (from Table 4-2), the RSD is given in column 3, and the number of watts is listed in column 4. Based on the information in this report, the projected heat load for the tank is 325 W (1,110 Btu/hr), which is approximately the energy emitted by three 100 W light bulbs. The heat load estimate is well below the 40,000 Btu/hr upper safety limit specified for single-shell tanks (Hanlon 1995). The temperature of the tank from January 1976 to January 1994 ranged between 12 °C and 34 °C (53-94 °F). Since an upper temperature limit is exhibited, it may be concluded that any heat generated from radioactive sources throughout the year is satisfactorily dissipated.

Information obtained from the document, *Estimation of Heat Load in Waste Tanks Using Average Vapor Space Temperatures* (Crowe 1993), shows tank 241-TY-104 as having an estimated heat load of 880 W (3,000 Btu/hr). This is approximately 2.7 times higher than the projected heat load calculated here. In any case, both heat load estimates are well below the upper safety limit specified for single-shell tanks.

Table 5-8. Tank 241-TY-104 Projected Heat Load.

Radionuclide	Ci	RSD	Watts
^{241}Am	9.82	26.2	0.322
^{137}Cs	13,300	76.2	62.8
^{60}Co	6.64	70.9	0.102
^{129}I	< 57.0	--	0.0267
$^{239/240}Pu$	52.9	16.6	1.61
^{90}Sr	38,800	82.8	260
^{99}Tc	9.06	16.8	4.54 E-03
Watts		64.4	325

RSD = relative standard deviation.
1 Ci = 3.7 E+10 Bq.

The flammability of the gas in the headspace of a tank is an additional safety screening consideration. Before waste sampling occurred in February 1995, the headspace flammability, as measured by combustible gas meter, was found to be less than 1% of the lower flammability limit (Meacham 1995a). Detailed results of this headspace gas sampling are contained in Huckaby (1995) and are not reproduced here.

5.5.2 Operational Evaluations

Tank 241-TY-104 has been removed from service and no longer receives waste. In addition, stabilization efforts have been completed to remove all pumpable liquid (Hanlon 1995). It is unlikely that further liquid will be removed. Consequently, a compatibility assessment for the tank liquid was not considered relevant.

5.5.3 Process Development Evaluation

The Pretreatment DQO, *Interim Data Quality Objectives for Waste Pretreatment and Vitrification* (Kupfer et al. 1994), lists a wide array of analyses that were requested to be run on tank samples. The Pretreatment Program has since decided that all of these analyses are not necessary. When the program has decided which analyses they need, they will then direct the laboratory to perform those evaluations. Therefore, the Pretreatment Program requested a 125 mL solid composite sample for process development and a 100 mL solid composite sample for archive.

The metal and anion analysis of the waste from the 1985 sampling is important for evaluating the disposal waste form (glass) formulations and identifying potential components that may affect the treatment and disposal process. Because the waste sludges may be blended, washed, and treated before disposal there are no specific criteria for the parameters measured. Extensive rheological analyses have yet to be conducted on the waste. The only information on rheology available from the 1985 sampling event indicates that the viscosity of the waste is >10,000 centipoise (Weiss and Mauss 1987). Once these evaluations are performed, the results will assist the retrieval and pretreatment programs in determining equipment needs.

The data from the metal and anion analyses reported on the water digested solids yields solubility information that may be useful in the retrieval of the tank waste. The solubility of metals, anions, and radionuclides was examined by comparing the water digested results with the total concentration results. This percent solubility determination is given in Table 5-9. Only those analytes that were detected in the leachate resulting from the water digestion for all four sludge samples were considered.

The data demonstrate that the anions (fluoride, nitrate, nitrite, and carbonate) were extremely soluble. Chromium, phosphorus, sodium, total organic carbon and ^{99}Tc were slightly less soluble. The results indicate that a large part of the chromium may be present as the soluble Cr(VI) species rather than the relatively insoluble Cr(III). More than two-thirds of the phosphorus in the tank will enter solution as the phosphate ion or one of its hydrogenated derivatives, depending on the pH. Silver and ^{137}Cs displayed limited solubility. The solubility of ^{137}Cs is expected to approach that of sodium, but the data indicate otherwise. The remaining metals and ^{90}Sr are relatively insoluble.

Table 5-9. Percent Water Solubility for Tank 241-TY-104 Analytes for 1985 Results.*

Analyte	Water digestion	Total analyte concentration	Percent soluble
Metals	(μg/g)	(μg/g)	(%)
Aluminum	415	9,080	4.6
Chromium	897	1,410	64
Iron	48.2	32,600	0.15
Nickel	16.7	1,490	1.1
Phosphorus	17,800	26,200	68
Silicon	163	8,100	2.0
Silver	2.79	12.1	23
Sodium	86,200	113,000	76
Uranium	37.8	19,500	0.19
Anions	(μg/g)	(μg/g)	(%)
Fluoride	5,350	5,350	100
Nitrate	44,700	46,600	96
Nitrite	12,200	12,200	100
Carbonate	18,700	18,700	100
Organic carbon	(μg C/g)	(μg C/g)	(%)
Total organic carbon	1,640	1,930	85
Radionuclides	(μCi/g)	(μCi/g)	(%)
^{137}Cs	16.5	45.4	36
^{90}Sr	0.0393	132	0.030
^{99}Tc	0.0240	0.0308	78

1 Ci = 3.7 E+10 Bq.

*Weiss, R. L., 1986, *TY Tank Farm Waste Characterization Data*, RHO-WM-TI-1P, Rockwell Hanford Operations, Richland, Washington.

This page intentionally left blank.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The sludge in tank 241-TY-104 was sampled and analyzed in 1985 and 1995. The 1985 core samples were evaluated for a broad spectrum of analytes which included metals, anions, radionuclides, density, and total organic carbon. Since transfers to or from the tank have not been made since 1974, the data are considered to adequately represent the composition of the sludge. The information obtained from the 1985 sampling event is the best available data and has not been confirmed by more recent sample analyses. These samples were taken before the existence of DQOs. Consequently, the sampling and analysis may not meet requirements of the currently applicable DQOs.

The 1995 auger sampling event was governed by *Tank Safety Screening Data Quality Objective* (Babad and Redus 1994), *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue Developed through the Data Quality Objectives Process* (Babad et al. 1994), and *Data Requirements for the Ferrocyanide Safety Issue Developed through the Data Quality Objectives Process* (Meacham et al. 1994). Since tank 241-TY-104 was not on the Ferrocyanide Safety Program's priority list, all primary analyses required by the Ferrocyanide DQO were not performed. Before waste sampling occurred in February 1995, the headspace flammability, as measured by combustible gas meter, was found to be less than 1% of the lower flammability limit (Meacham 1995a). Only analyses for fuel content (by differential scanning calorimetry), percent water (by thermogravimetric analysis), total organic carbon, and total alpha activity were done. None of the results exceeded notification limits of the applicable DQOs.

Tank 241-TY-104 is on the Organics Watch List. The Organic DQO established a 30,000 μCi/g threshold notification limit for TOC. TOC determinations from both the 1995 analysis and 1985 analysis show that TOC levels are far below this limit. Also, the absence of exothermic reactions demonstrates that excessive fuel (either total organic carbon or ferrocyanide) is not present. The presence of high nickel concentrations indicate the tank did receive ferrocyanide and that the ferrocyanide has subsequently aged. The thermogravimetric analysis showed that the sludge contained 51.8 percent water. Based on these results, it appears that the sludge poses no immediate safety concerns and the tank should be investigated for removal from the Organic Watch List. However, observations from the 1985 sampling event showed that a separate layer of organic was present in two of the six cores (possibly due to a liquid hydrocarbon being used as the hydrostatic head during core sampling). The 1995 auger sampling event only recovered solids. A water digestion of the 1995 auger samples is recommended to fully investigate the presence of soluble and insoluble organic species in the tank waste.

The waste was found to contain approximately 51.8 weight percent water based on the February 1995 auger samples and this compares well with the historical estimate in Table 2-5 of 55.5 weight percent water.

The sludge should primarily contain UR waste as expected from the tank layer model. Based on the transfer history, ferrocyanide scavenged first cycle waste may also be present. The only constituents found in levels close to their predicted amounts were sodium, water, and uranium. Only 1,110 Btu/hr (325 watts) are generated by the radionuclides in the tank using information in this report.

7.0 REFERENCES

Agnew, S. F., 1995, *Hanford Defined Wastes: Chemical and Radionuclide Compositions*, WHC-SD-WM-TI-629, Westinghouse Hanford Company, Richland, Washington.

Agnew, S. F., P. Baca, R. Corbin, T. Duran, and K. Jurgensen, 1995a, *Waste Status and Transaction Record Summary for the Northwest Quadrant*, WHC-SD-WM-TI-689, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Agnew, S. F., P. Baca, R. Corbin, T. Duran, and K. Jurgensen, 1995b, *Tank Layer Model (TLM) for Northeast, Southwest, and Northwest Quadrants*, LA-UR-94-4269, Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico.

Babad, H., and K. S. Redus, 1994, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Babad, H., S. M. Blacker, and K. S. Redus, 1994, *Data Quality Objective to Support Resolution of the Organic Fuel Rich Tank Safety Issue*, WHC-SD-WM-DQO-006, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Borsheim, G. L., and B. C. Simpson, 1991, *An Assessment of the Inventories of the Ferrocyanide Watch List Tanks*, WHC-SD-WM-ER-133, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995 *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area*, WHC-SD-WM-ER-351, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Crowe, R. D., M. Kummerer, and A. K. Postma, 1993, *Estimation of Heat Load in Waste Tanks Using Average Vapor Space Temperatures*, WHC-EP-0709, Westinghouse Hanford Company, Richland, Washington.

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

Ecology, EPA, and DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, fourth amendment, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Hanlon, B. L., 1995, *Waste Tank Summary Report for Month Ending May 31, 1995*, WHC-EP-0182-86, Westinghouse Hanford Company, Richland, Washington.

Huckaby, J. L., 1995, *Tank 241-TY-104 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-463, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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

Kupfer, M. J., J. M. Conner, R. A. Kirkbride, and D. R. Mobley, 1994, *Interim Data Quality Objectives for Waste Pretreatment and Vitrification*, WHC-SD-WM-DQO-011, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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 Objectives Process*, WHC-SD-WM-DQO-007, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Meacham, J. E., R. J. Cash, G. T. Dukelow, 1995a, *Quarterly Report on the Ferrocyanide Safety Program for the Period Ending December 31, 1994*, WHC-EP-0474-15, Westinghouse Hanford Company, Richland, Washington.

Meacham, J. E., R. J. Cash, B. A. Pulsipher, and G. Chen, 1995b, *Data Requirements for the Ferrocyanide Safety Issue Developed Through the Data Quality Objectives Process*, WHC-SD-WM-DQO-007, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1995a, *45-Day Safety Screen Results for Tank 241-TY-104, Auger Samples 95-AUG-008 and 95-AUG-009*, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1995b, *216-Day Safety Screen Results and Final Report for Tank 241-T-104, Auger Samples 95-AUG-008 and 95-AUG-009*, WHC-SD-WM-DP-101, Westinghouse Hanford Company, Richland, Washington.

Schreiber, R. D., 1995, *Tank 241-TY-104 Tank Characterization Plan*, WHC-SD-WM-TP-301, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Swaney, S. L., 1994, *Single-Shell Tank Stabilization Record*, WHC-SD-RE-178, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

Tran, T. T., 1993, *Thermocouple Status Single-Shell and Double-Shell Waste Tanks*, WHC-SD-WM-TI-533, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Weiss, R. L., and B. M. Mauss, 1987, *Data Transmittal Package for 241-TY-104 Waste Tank Characterization*, SD-RE-TI-182, Rockwell Hanford Operations, Richland, Washington.

Weiss, R. L., 1986, *TY Tank Farm Waste Characterization Data*, RHO-WM-TI-1P, Rockwell Hanford Operations, Richland, Washington.

This page intentionally left blank.

APPENDIX A

1985 AQUEOUS LIQUID SAMPLE DATA

This page intentionally left blank.

Table A-1. 1985 Aqueous Liquid Sample Data for Tank 241-TY-104.* (2 sheets)

Analyte	211D	232D	241D	Average	RSD
Metals	μg/ml	μg/ml	μg/ml	μg/ml	%
Aluminum	0.508	0.628	0.573	0.570	10.5
Barium	1.39 E-04	2.00 E-04	1.3 E-04	1.56 E-04	24.4
Bismuth	<0.00220	0.00260	<0.00110	0.00197	—
Cadmium	<5.00 E-04	<5.00 E-04	<2.50 E-04	<5.00 E-04	—
Chromium	1.46	1.89	1.66	1.67	12.9
Iron	0.206	0.264	0.233	0.234	12.4
Lead	0.00727	<0.00160	9.60 E-04	0.00328	106
Manganese	<0.00400	<0.00400	<0.00200	<0.00116	—
Nickel	0.178	0.0267	0.0177	0.0207	24.9
Phosphorus	3.62	4.10	4.04	3.92	6.67
Silicon	0.041	0.00860	0.00610	0.0186	105
Silver	0.0038	0.0072	0.0047	0.00523	33.7
Sodium	87.1	74.8	89.1	83.7	9.26
Uranium	220	37	40	99.0	106
Zirconium	<9.20 E-04	<9.20 E-04	<4.60 E-04	<7.67 E-04	—
Anions	μg/ml	μg/ml	μg/ml	μg/ml	%
Carbonate	30,800	40,000	35,000	35,300	13
Chloride	1,170	1,530	1,280	1,330	13.9
Fluoride	456	589	513	519	12.8
Hydroxide	272	221	221	238	12.4
Nitrate	85,600	114,000	97,300	99,000	14.4
Nitrite	15,700	6,900	11,200	11,300	39
Sulfate	4,710	6,250	5,380	5,450	14.2
Total carbon	μg C/ml	μg C/ml	μg C/ml	μg C/ml	%
Total organic carbon	1,860	2,050	2,410	2,107	13.3

Table A-1. 1985 Aqueous Liquid Sample Data for Tank 241-TY-104.* (2 sheets)

Analyte	211D	232D	241D	Average	RSD
Radionuclides	μCi/ml	μCi/ml	μCi/ml	μCi/ml	%
^{241}Am	<2.82 E-04	<3.05 E-04	<3.01 E-04	<2.96 E-04	—
^{14}C	9.28 E-04	0.00117	0.00102	0.00104	11.6
^{137}Cs	16.2	19.1	17.1	17.5	8.50
^{60}Co	<0.00210	<0.00238	0.00714	0.00387	73.1
$^{239/240}$Pu	0.00145	0.00191	0.00149	0.00162	15.8
^{90}Sr	0.0828	0.111	0.0885	0.0941	15.8
^{99}Tc	0.449	0.559	0.486	0.511	15.3
Total alpha	0.00641	<0.00377	0.00229	0.00416	50.2
Total beta	20.7	21.1	28.3	23.4	18.3
Total gamma	16.2	19.1	17.3	17.5	8.35
Physical					%
pH	12.2	12.1	12.1	12.1	0.48
Density (g/mL)	1.16	1.21	1.18	1.18	2.13

*Weiss, R. L., 1986, *TY Tank Farm Waste Characterization Data*, RHO-WM-TI-1P, Rockwell Hanford Operations, Richland, Washington.

RSD = relative standard deviation (standard deviation/mean) of the data.
μg/ml = microgram/milliliter.
% = percent.
μg C/ml = microgram carbon/milliliter.
μCi/ml = microcuries/milliliter.

APPENDIX B

ANALYTICAL PROCEDURES FOR 1985 CORE SAMPLES AND 1995 AUGER SAMPLES

This page intentionally left blank.

Table B-1. Analytical Methods For 1995 Auger Samples.*

Analyte	Method	Procedure
Total organic carbon; total inorganic carbon	Hot persulfate	LA-342-100
Total organic carbon	Furnace oxidation	LA-504-101
Total alpha	Proportional counting	LA-508-101
Energetics content	Differential scanning calorimetry	LA-514-113
Moisture content	Thermogravimetric analysis	LA-560-112

*Schreiber, R. D., 1995, *Tank 241-TY-104 Tank Characterization Plan*, WHC-SD-WM-TP-301, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Table B-2. Analytical Methods for 1985 Core Samples.*

Analyte	Method	Procedure
Chloride, fluoride, nitrate, sulfate	Ion chromatography	LA-553-105
Nitrite	Spectrophotometer	LA-645-001
Metals	Inductively coupled plasma	LA-505-143
^{14}C ^{99}Tc	Liquid scintillation counting	LA-348-102 LA-438-101
^{90}Sr	Beta proportional counting	LA-220-101
$^{239/240}Pu$ ^{241}Am	Alpha proportional counting	LA-503-155 LA-503-154
^{60}Co, ^{137}Cs, total gamma	Gamma energy analysis	LA-548-121
Total alpha Total beta	Alpha proportional counting Beta proportional counting	LA-548-103
Carbonate	Total inorganic carbon	LA-622-101
Total organic carbon	Total organic carbon	LA-344-101
pH	pH meter	LA-212-102
Hydroxide	Autotitration	LA-332-112
Uranium	Laser fluorimetery	LA-925-106
Density	Density	LA-510-112

*Weiss, R. L., and B. M. Mauss, 1987, *Data Transmittal Package for 241-TY-104 Waste Tank Characterization*, SD-RE-TI-182, Rockwell Hanford Operations, Richland, Washington.

This page intentionally left blank

APPENDIX C

PHOTOGRAPHS OF EXTRUDED AUGER SAMPLES (FEBRUARY 1995)

This page intentionally left blank.

9613456.0669

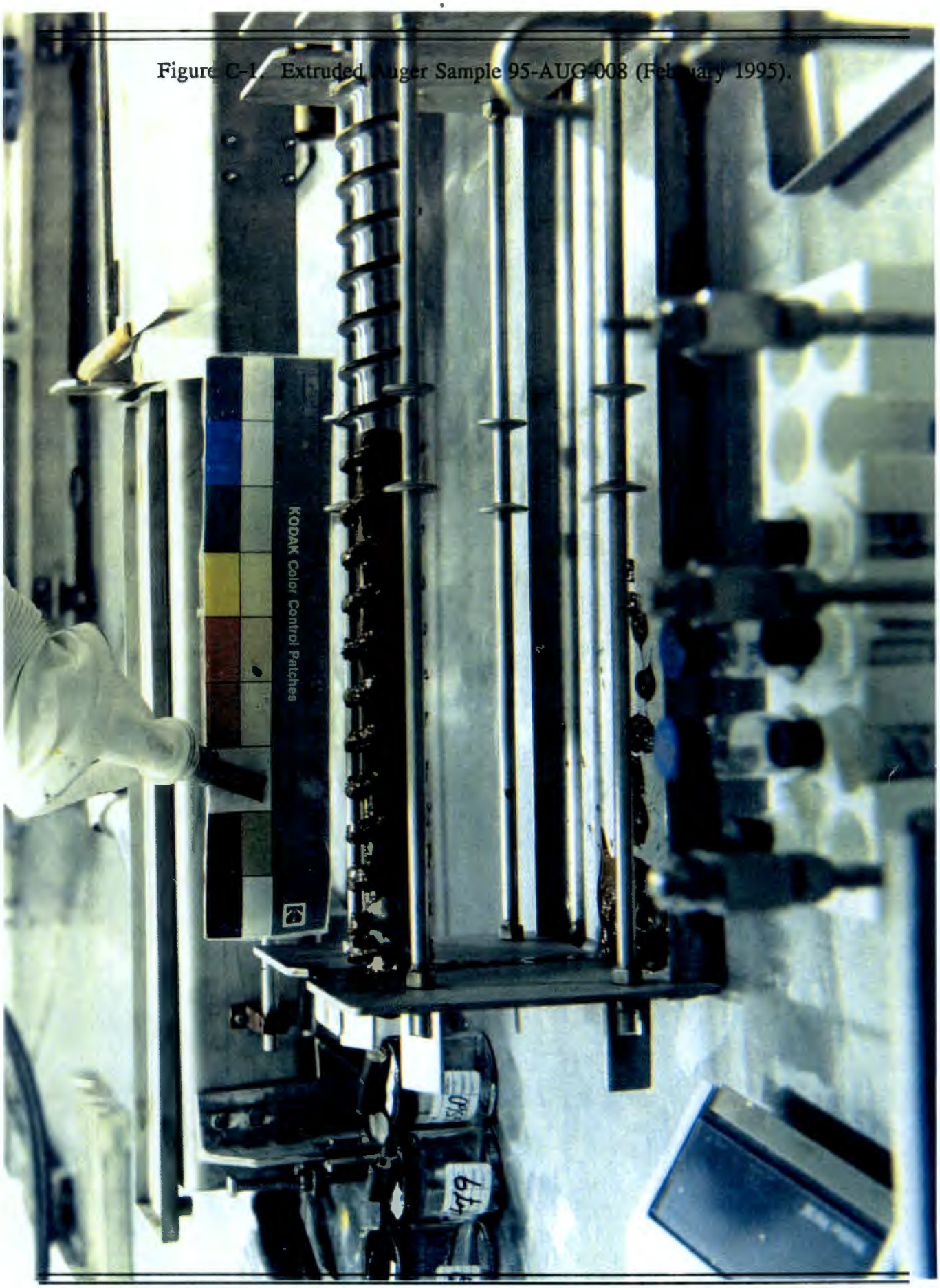


Figure C-1. Extruded Auger Sample 95-AUG-008 (February 1995).

TY-104 95-AUG-008 Riser #18

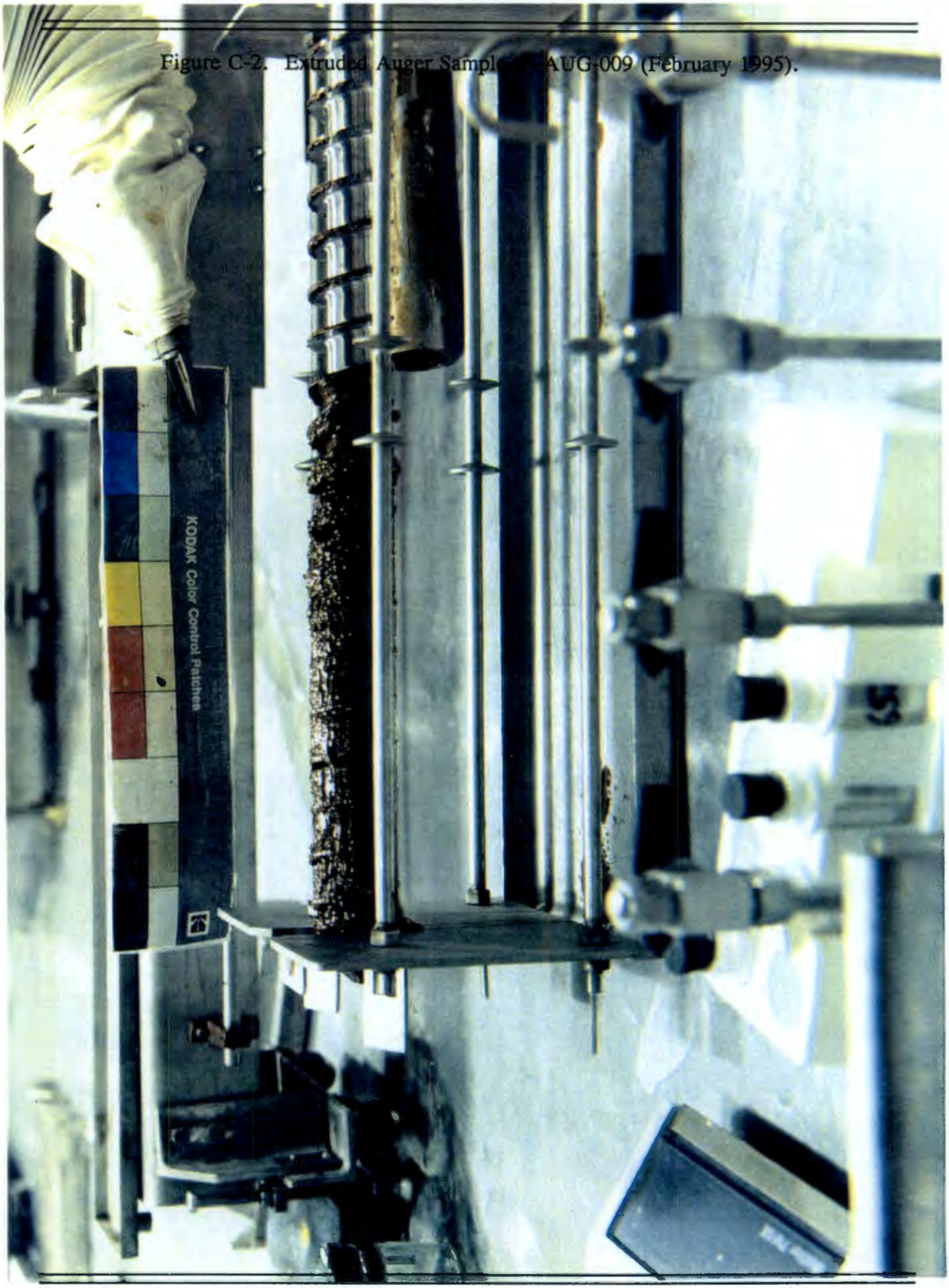


Figure C-2. Extruded Auger Sample [illegible]AUG-009 (February 1995).

TY-104 95-AUG-009 RKER 15

This page intentionally left blank.

9613456.0671

DISTRIBUTION SHEET

To	From	Page 1 of 4
Distribution	Characterization Plans, Coordination and Reports	Date 07/28/95
Project Title/Work Order		**EDT No.** EDT-612172
Tank Characterization Report for Single-Shell Tank 241-TY-104, WHC-SD-WM-ER-481, Rev. 0		**ECN No.** N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
OFFSITE					
Sandia National Laboratory P.O. Box 5800 MS-0744, Dept. 6404 Albuquerque, NM 87815					
D. Powers		X			
Nuclear Consulting Services Inc. P. O. Box 29151 Columbus, OH 43229-01051					
J. L. Kovach		X			
Chemical Reaction Sub-TAP 202 Northridge Court Lindsborg, KS 67456					
B. C. Hudson		X			
Tank Characterization Panel Senior Technical Consultant Contech 6301 Indian School Road, NW, Suite 614 Albuquerque, NM 87110					
J. Arvisu		X			
U. S. Department of Energy - Headquarters Office of Environmental Restoration and Waste Management EM-563 12800 Middlebrook Road Germantown, MD 20874					
K. T. Lang		X			
J. A. Poppitti		X			

SAIC
20300 Century Boulevard, Suite 200-B
Germantown, MD 20874

H. Sutter		X

Los Alamos Laboratory
CST-14 MS-J586
P. O. Box 1663
Los Alamos, NM 87545

S. F. Agnew (6)		X

Los Alamos Technical Associates
750 Swift Boulevard, Suite 4
Richland, WA 99352

T. T. Tran		X

Ogden Environmental
101 East Wellsian Way
Richland, WA 99352

R. J. Anema		X

CH2M Hill
P. O. Box 91500
Bellevue, WA 98009-2050

M. McAfee		X

Tank Advisory Panel
102 Windham Road
Oak Ridge, TN 37830

D. O. Campbell		X

ONSITE

Department of Ecology

A. B. Stone	B5-18	X

Department of Energy - Richland Operations

L. Erickson	S7-53	X
W. S. Liou	S7-54	X
N. W. Willis	S7-54	X

ICF-Kaiser Hanford Company

L. A. Gaddis	S3-09	X
W. W. Pickett	S3-09	X

Pacific Northwest Laboratory

G. H. Beeman	S7-71	X	
S. F. Bobrowski	K7-28	X	
N. G. Colton	K3-75	X	
J. R. Gormsen	K7-28		X
S. A. Hartley	K5-12	X	
J. G. Hill	K7-94	X	
L. K. Holton	K9-73	X	
G. J. Lumetta	P7-25	X	
B. D. McVeety	K6-84	X	
A. F. Noonan	K9-81	X	
K. M. Remund	K5-12	X	
J. T. Slankas	K9-81	X	

Westinghouse Hanford Company

D. A. Barnes	R1-80	X	
G. R. Bloom	H5-61	X	
T. M. Brown	R2-12	X	
T. H. Bushaw	T6-30	X	
R. J. Cash	S7-15	X	
C. S. Chongsoo	G3-20	X	
W. L. Cowley	H4-65	X	
M. L. Dexter	R1-51	X	
R. A. Dodd	S5-07	X	
G. L. Dunford	S7-81	X	
S. J. Eberlein	R2-12	X	
D. B. Engelman	R1-49	X	
K. O. Fein	H4-65		X
G. D. Forehand	S7-21	X	
J. S. Garfield	H5-49	X	
J. D. Guberski	R2-06		X
R. D. Gustavson	R1-51	X	
D. L. Herting	T6-09	X	
B. A. Higley	H5-27	X	
G. Jansen	H6-33	X	
L. Jensen	T6-07	X	
G. D. Johnson	S7-15	X	
K. K. Kawabata	S7-55	X	
T. J. Kelley	S7-21	X	
N. W. Kirch	R2-11	X	
J. G. Kristofzski	T6-06	X	
M. J. Kupfer	H5-49	X	
D. L. McGrew	R3-25	X	
W. C. Miller	R1-30	X	
C. T. Narquis	T6-16	X	
D. E. Place	H5-27	X	
D. A. Reynolds	R2-11	X	
G. W. Ryan	H4-65	X	
L. M. Sasaki (10)	R2-12	X	
F. A. Schmittroth	H0-35	X	
N. J. Scott-Proctor	S5-01	X	
L. W. Shelton, Jr.	H5-49	X	
B. C. Simpson	R2-12	X	
G. L. Smith	H4-62		X
G. L. Troyer	T6-50	X	

D. A. Turner	S7-15	X
D. J. Washenfelder	H5-27	X
M. S. Waters	S6-30	X
W. I. Winters (3)	T6-50	X
TFIC (Tank Farm Information Center)	R1-20	X
Central Files	A3-88	X
EDMC	H6-08	X
TCRC (2)	R2-12	X

THIS PAGE INTENTIONALLY
LEFT BLANK