ENGINEERING CHANGE NOTICE

1. ECN 635444

Proj. ECN

2. ECN Category (mark one) Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	3. Originator's Name, Organization, MSIN, and Telephone No. R. Rex Thompson, Data Assessment and Interpretation, R2-12, 376-6914	4. USQ Required? [] Yes [X] No	5. Date 03/10/97
	6. Project Title/No./Work Order No. Tank 241-AP-106	7. Bldg./Sys./Fac. No. 241-AP-106	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-361, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

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

13a. Description of Change

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

This ECN was generated in order to revise the document to the new format per Department of Energy performance agreements.

14a. Justification (mark one)

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

14b. Justification Details

This document was revised per Department of Energy performance agreements and direction from the Washington State Department of Ecology to revise 23 tank characterization reports (letter dated 7/6/95).

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

See attached distribution.

RELEASE STAMP

DATE: MAR 18 1997

STA: 4

HANFORD RELEASE

ID: 3

A-7900-013-2 (05/96) GEF095

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): ECN-635444

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

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

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

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

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

21. Approvals

Signature	Date	Signature	Date
Design Authority		Design Agent	
Cog. Eng. R.R. Thompson *R.R. Thompson*	3/18/97	PE	
Cog. Mgr. K.M. Hall *Kathleen M. Hall*	3/18/97	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other R.J. Cash *R.J. Cash*	3/18/97	Other	
N.W. Kirch *NWKirch*	3-18-97	DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

Tank Characterization Report for Double-Shell Tank 241-AP-106

R. Rex Thompson
Lockheed Martin Hanford Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: ECN-635444 UC: 2070
Org Code: 74620 Charge Code: N4G4C
B&R Code: EW 3120074 Total Pages: 127

Key Words: Waste Characterization, Double-Shell Tank, DST, Tank 241-AP-106, Tank AP-106, AP-106, AP Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-AP-106. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

DATE: HANFORD RELEASE
STA. 4 ID:
MAR 18 1997

Release Approval 3/18/97 Date Release Stamp

Approved for Public Release

RECORD OF REVISION

(1) Document Number: HNF-SD-WM-ER-361

(2) Title
Tank Characterization Report for Double-Shell Tank 241-AP-106

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 09/06/94 on EDT-608064.	B.C. Simpson	C.S. Haller
1 RS	Incorporate per ECN-635444.	R.R. Thompson (signature)	K.M. Hall Kathleen M. Hall 3/18/97

HNF-SD-WM-ER-361, Rev. 1
Formerly WHC-SD-WM-ER-361, Rev. 0

UC-2070

Tank Characterization Report for Double-Shell Tank 241-AP-106

R. R. Thompson
L. W. Shelton
Lockheed Martin Hanford Corporation

R. H. Stephens
Los Alamos Technical Associates

T. L. Welsh
B&W Protec, Inc.

Date Published
March 1997

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

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

CONTENTS

1.0 INTRODUCTION . . . 1-1
1.1 SCOPE . . . 1-1
1.2 TANK BACKGROUND . . . 1-2

2.0 RESPONSE TO TECHNICAL ISSUES . . . 2-1
2.1 WASTE COMPATIBILITY EVALUATION . . . 2-1
2.1.1 Safety Decision Rules Evaluation . . . 2-1
2.1.2 Operations Decision Rules Evaluation . . . 2-3
2.2 SAFETY SCREENING . . . 2-4
2.2.1 Exothermic Conditions (Energetics) . . . 2-5
2.2.2 Flammable Gas . . . 2-5
2.2.3 Criticality . . . 2-5
2.3 OTHER TECHNICAL ISSUES . . . 2-5
2.4 SUMMARY . . . 2-6

3.0 BEST-BASIS INVENTORY ESTIMATE . . . 3-1

4.0 CONCLUSIONS AND RECOMMENDATIONS . . . 4-1

5.0 REFERENCES . . . 5-1

APPENDIXES

APPENDIX A: HISTORICAL TANK INFORMATION . . . A-1

A1.0 CURRENT TANK STATUS . . . A-3

A2.0 TANK DESIGN AND BACKGROUND . . . A-4

A3.0 PROCESS KNOWLEDGE . . . A-9
A3.1 WASTE TRANSFER HISTORY . . . A-9
A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS . . . A-11

A4.0 SURVEILLANCE DATA . . . A-14
A4.1 SURFACE-LEVEL READINGS . . . A-14
A4.2 INTERNAL TANK TEMPERATURES . . . A-16
A4.3 TANK PHOTOGRAPHS . . . A-16

A5.0 APPENDIX A REFERENCES . . . A-18

CONTENTS (Continued)

APPENDIX B: SAMPLING OF TANK 241-AP-106 . . . . . B-1

B1.0 TANK SAMPLING OVERVIEW B-3
B1.1 DESCRIPTION OF SAMPLING EVENT B-3
B1.2 SAMPLE HANDLING B-5
B1.3 SAMPLE ANALYSIS B-5
B1.4 DESCRIPTION OF HISTORICAL SAMPLING EVENTS B-6
B1.4.1 Description of 1993 Historical Sampling Event B-7
B1.4.2 Description of 1994 Historical Sampling Event B-9

B2.0 ANALYTICAL RESULTS B-10
B2.1 OVERVIEW B-10
B2.2 INORGANIC ANALYSES B-11
B2.2.1 Inductively Coupled Plasma B-11
B2.2.2 Ion Chromatography B-18
B2.2.3 Potentiometric Titration B-20
B2.3 CARBON ANALYSES B-21
B2.3.1 Total Inorganic Carbon B-21
B2.3.2 Total Organic Carbon B-21
B2.4 RADIONUCLIDE ANALYSES B-22
B2.4.1 Alpha Proportional Counting B-22
B2.4.2 Beta Proportional Counting B-23
B2.4.3 Gamma Energy Analysis B-23
B2.5 PHYSICAL ANALYSES B-24
B2.5.1 pH B-24
B2.5.2 Specific Gravity B-25
B2.6 THERMODYNAMIC ANALYSES B-25
B2.6.1 Thermogravimetric Analysis B-25
B2.6.2 Differential Scanning Calorimetry B-26
B2.7 VAPOR PHASE MEASUREMENT B-27
B2.8 HISTORICAL SAMPLE RESULTS B-27
B2.8.1 Results of the 1993 Historical Sampling Event B-27
B2.8.2 Results of the 1994 Historical Sampling Event B-31

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS B-34
B3.1 FIELD OBSERVATIONS B-34
B3.2 QUALITY CONTROL ASSESSMENT B-34
B3.3 DATA CONSISTENCY CHECKS B-35
B3.3.1 Comparison of Results from Different Analytical Methods B-35
B3.3.2 Mass and Charge Balances B-35

CONTENTS (Continued)

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS B-37
B3.4.1 Mean Concentrations B-38
B3.4.2 Analysis of Variance Model B-41
B3.4.3 Sampling-Based Tank Inventory B-42

B4.0 APPENDIX B REFERENCES B-43

APPENDIX C: STATISTICAL ANALYSIS FOR ISSUE RESOLUTION C-1

C1.0 APPENDIX C REFERENCE C-4

APPENDIX D: EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-106 .... D-1

D1.0 CHEMICAL INFORMATION SOURCES D-3

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES D-4

D3.0 COMPONENT INVENTORY EVALUATION D-6
D3.1 CONTRIBUTING WASTE TYPES D-6
D3.2 EVALUATION OF HISTORICAL DATA D-7

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES D-13

D5.0 APPENDIX D REFERENCES D-16

APPENDIX E: BIBLIOGRAPHY FOR TANK 241-AP-106 .... E-1

LIST OF FIGURES

A2-1 Riser Configuration for Tank 241-AP-106 . . . . A-7

A2-2 Tank 241-AP-106 Cross Section and Schematic A-8

A4-1 Tank 241-AP-106 Level History A-15

A4-2 Tank 241-AP-106 High Temperature Plot A-17

LIST OF TABLES

1-1 Summary of Recent Sampling 1-2

1-2 Description of Tank 241-AP-106. 1-4

2-1 Safety Decision Variables and Criteria for the Waste Compatibility Data Quality Objective 2-2

2-2 Waste Compatibility Operations Decision Rules 2-3

2-3 Summary of Waste Compatibility and Safety Screening Results 2-6

3-1 Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-106 as of September 30, 1996 3-2

3-2 Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-106 as of September 30, 1996 3-4

4-1 Acceptance of Tank 241-AP-106 Sampling and Analysis 4-1

4-2 Acceptance of Evaluation of Characterization Data and Information for Tank 241-AP-106 4-2

A1-1 Tank Contents Status Summary A-4

A2-1 Tank 241-AP-106 Risers A-5

A3-1 Summary of Tank 241-AP-106 Major Waste Transfers A-10

A3-2 Historical Tank Inventory Estimate A-12

LIST OF TABLES (Continued)

B1-1 Integrated Data Quality Objective Requirements for Tank 241-AP-106 . . . . . . B-4

B1-2 Tank 241-AP-106 Subsampling Scheme and Sample Description B-5

B1-3 Tank 241-AP-106 Sample Analysis Summary B-6

B1-4 222-S Laboratory Sample Numbers from the 1993 Historical Sampling Event for Tank 241-AP-106 . . . . B-8

B1-5 PNNL Sample Numbers from the 1993 Historical Sampling Event for Tank 241-AP-106. . . . . B-8

B1-6 Tank 241-AP-106 Sample Analysis Summary for the 1994 Historical Sampling Event B-9

B2-1 Analytical Presentation Tables B-10

B2-2 Tank 241-AP-106 Nondetected ICP Analytes B-12

B2-3 Tank 241-AP-106 Analytical Results: Aluminum B-13

B2-4 Tank 241-AP-106 Analytical Results: Boron B-13

B2-5 Tank 241-AP-106 Analytical Results: Cadmium B-13

B2-6 Tank 241-AP-106 Analytical Results: Chromium B-14

B2-7 Tank 241-AP-106 Analytical Results: Copper B-14

B2-8 Tank 241-AP-106 Analytical Results: Lithium B-14

B2-9 Tank 241-AP-106 Analytical Results: Molybdenum B-15

B2-10 Tank 241-AP-106 Analytical Results: Nickel B-15

B2-11 Tank 241-AP-106 Analytical Results: Phosphorus B-15

B2-12 Tank 241-AP-106 Analytical Results: Potassium B-16

B2-13 Tank 241-AP-106 Analytical Results: Silicon B-16

B2-14 Tank 241-AP-106 Analytical Results: Silver B-16

LIST OF TABLES (Continued)

B2-15 Tank 241-AP-106 Analytical Results: Sodium B-17

B2-16 Tank 241-AP-106 Analytical Results: Sulfur B-17

B2-17 Tank 241-AP-106 Analytical Results: Zinc B-17

B2-18 Tank 241-AP-106 Analytical Results: Zirconium B-18

B2-19 Tank 241-AP-106 Analytical Results: Bromide B-18

B2-20 Tank 241-AP-106 Analytical Results: Chloride B-18

B2-21 Tank 241-AP-106 Analytical Results: Fluoride B-19

B2-22 Tank 241-AP-106 Analytical Results: Nitrate B-19

B2-23 Tank 241-AP-106 Analytical Results: Nitrite B-19

B2-24 Tank 241-AP-106 Analytical Results: Oxalate B-20

B2-25 Tank 241-AP-106 Analytical Results: Phosphate B-20

B2-26 Tank 241-AP-106 Analytical Results: Sulfate B-20

B2-27 Tank 241-AP-106 Analytical Results: Hydroxide B-21

B2-28 Tank 241-AP-106 Analytical Results: Total Inorganic Carbon B-21

B2-29 Tank 241-AP-106 Analytical Results: Total Organic Carbon B-22

B2-30 Tank 241-AP-106 Analytical Results: Americium-241 . . . . B-22

B2-31 Tank 241-AP-106 Analytical Results: Plutonium-239/40 . . . . B-23

B2-32 Tank 241-AP-106 Analytical Results: Strontium-89/90 . . . . B-23

B2-33 Tank 241-AP-106 Analytical Results: Cesium-137 . . . . B-24

B2-34 Tank 241-AP-106 Analytical Results: Cobalt-60 . . . . B-24

B2-35 Tank 241-AP-106 Analytical Results: pH B-25

LIST OF TABLES (Continued)

B2-36 Tank 241-AP-106 Analytical Results: Specific Gravity B-25

B2-37 Tank 241-AP-106 Analytical Results: Percent Water B-26

B2-38 Results of Vapor Phase Measurements of Tank 241-AP-106 . . . . B-28

B2-39 Results from the 1993 Historical Sampling Event for Tank 241-AP-106 . . . . . B-29

B2-40 Results from November 1994 Grab Sampling B-32

B3-1 Cation Mass and Charge Data B-36

B3-2 Anion Mass and Charge Data B-37

B3-3 Mass Balance Totals B-37

B3-4 Summary Statistics - Mean Concentrations B-39

B3-5 Analytes with > 50 Percent "Less Than" Values B-40

C1-1 Summary Statistics - DSC - Tank 241-AP-106 . . . . C-4

C1-2 Summary Statistics - $^{239/240}$Pu - Tank 241-AP-106 . . . . C-4

D2-1 Sampling and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Double-Shell Tank 241-AP-106. . . . . D-5

D2-2 Sampling and Hanford Defined Waste Model Inventory Estimates for Radioactive Components in Double-Shell Tank 241-AP-106. . . . . D-6

D3-1 Analytical Results from September 1996 Sampling of Tank 241-AP-106 . . . . . D-8

D3-2 Comparison of Analytical Results for Tank 241-AP-106 to Tank 241-AP-108 as of May 1995 . . . . D-11

D4-1 Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-106 as of September 30, 1996 . . . . D-13

D4-2 Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-106 as of September 30, 1996 . . . . D-14

LIST OF TERMS

ANOVA	analysis of variance
Btu/hr	British thermal units per hour
Ci	curies
Ci/g	curies per gram
Ci/L	curies per liter
cm	centimeter
DFB	depth from bottom of tank
df	degrees of freedom
DN	dilute non-complexed
DOE	U.S. Department of Energy
DQO	data quality objectives
DSC	differential scanning calorimetry
FIC	Food Instrument Corporation
ft	feet
g	gram
GEA	gamma energy analysis
g/L	grams per liter
g/mL	grams per milliliter
HDW	Hanford defined waste
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
J/g	joules per gram
kg	kilogram
kgal	kilogallon
kL	kiloliter
LANL	Los Alamos National Laboratory
LFL	lower flammability limit
m	meter
M	moles per liter
mL	milliliter
mm	millimeter
mR	millirad
mR/hr	millirads per hour
n/a	not applicable
n/r	not reported

LIST OF TERMS (Continued)

PCN	partially concentrated non-complexed waste
PHMC	Project Hanford Management Contractor
PNNL	Pacific Northwest National Laboratory
ppb	parts per billion
ppm	parts per million
QC	quality control
REML	restricted maximum likelihood estimation
RPD	relative percent difference
SAP	sampling and analysis plan
SMM	supernatant mixing model
SpG	specific gravity
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TRU	transuranic
TWRS	Tank Waste Remediation System
W	watts
WSTRS	Waste status and transaction record summary
wt%	weight percent
wt% C	weight percent carbon
°C	degrees centigrade
°F	degrees Fahrenheit
$\hat{\mu}$	arithmetic mean of the data
μCi/g	microcuries per gram
μCi/L	microcuries per liter
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg	microgram
μg/g	micrograms per gram
μg C/mL	micrograms carbon per milliliter
μg/L	micrograms per liter
μg/mL	micrograms per milliliter
$\hat{\sigma}_{\hat{\mu}}$	estimate of the standard deviation of the mean

This page left blank intentionally.

1.0 INTRODUCTION

One of the major functions of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis, along with other available information about a tank, are compiled and maintained in a tank characterization report (TCR). This report and its appendixes serve as the TCR for double-shell tank 241-AP-106.

The objectives of this report are: 1) to use characterization data in response to technical issues associated with 241-AP-106 waste; and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. The response to technical issues is summarized in Section 2.0, and the best-basis inventory estimate is presented in Section 3.0. Recommendations regarding safety status and additional sampling needs are provided in Section 4.0. Supporting data and information are contained in the appendixes. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996) milestone M-44-05.

1.1 SCOPE

Characterization information presented in this report originated from sample analyses and known historical sources. While only the results of recent sample events will be used to fulfill the requirements of the applicable safety screening data quality objectives (DQOs), other information can be used to support (or question) conclusions derived from these results. Historical information for tank 241-AP-106, provided in Appendix A, includes surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

The recent sampling events listed in Table 1-1, as well as sample data obtained prior to 1996, are summarized in Appendix B along with the sampling results. The results of the 1996 grab sampling event (Esch 1996) satisfied the data requirements specified in the sampling and analysis plan (SAP) for this tank (Sasaki 1996). In addition, the tank headspace flammability was measured just prior to the 1996 grab sampling. This measurement addressed one of the requirements specified in the safety screening DQO (Dukelow et al. 1995). The statistical analysis and numerical manipulation of data used in issue resolution are reported in Appendix C. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. A bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-AP-106 and its respective waste types is contained in Appendix E. Most of the documents listed in Appendix E are in the Tank Characterization Resource Center.

Table 1-1. Summary of Recent Sampling.[1]

Sample/Date	Phase	Location	Segmentation	Percent Recovery
Grab sample 6AP-96-1 September 12, 1996	Liquid	Riser 1 at 150° (from north), 178 cm (70 in.) from tank bottom	No segmentation	100
Grab sample 6AP-96-2 September 12, 1996	Liquid	Riser 1 at 150°, 102 cm (40 in.) from tank bottom	No segmentation	100
Grab sample 6AP-96-3 September 12, 1996	Liquid	Riser 1 at 150°, 25 cm (10 in.) from tank bottom	No segmentation	100
Headspace flammability September 9, 1996	Gas	Riser 1 at 30°: tank headspace at 0.91 m (3 ft) below top of riser, breather/vent, and sample riser	n/a	n/a
Headspace flammability September 9, 1996	Gas	Riser 1 at 150°: tank headspace at 0.9 m (3 ft) below top of riser, breather/vent, and sample riser	n/a	n/a

Notes:

n/a = not applicable

[1]Esch (1996)

1.2 TANK BACKGROUND

Tank 241-AP-106 is located in the 200 East Area AP Tank Farm on the Hanford Site. According to the historical tank content estimate (HTCE), the tank went into service in July 1986 when it received a small amount of flush water. In the third quarter of 1988, the tank received dilute noncomplexed (DN) waste from tank 241-AW-102. In early 1989, the entire tank contents were transferred to tank 241-AW-102, the 242-A Evaporator feed tank, and waste from tank 241-AW-102 was returned to tank 241-AP-106. Throughout 1989, large quantities of supernatant from tanks 241-AW-106 and 241-AY-102 were received by and transferred out of tank 241-AP-106. The tank was relatively inactive until early 1995, when all but 409 kL (108 kgal) of waste was removed. Since that time, the tank has received and continues to receive small amounts of DN wastes from several sources, including B Plant cells, the 300 and 400 areas, the 222-S Laboratory, T Plant, and the Plutonium Finishing Plant laboratories.

Table 1-2 contains a description of tank 241-AP-106. The tank has an operating capacity of 4,390 kL (1,160 kgal), and contained an estimated 931 kL (246 kgal) of DN waste as of September 30, 1996 (Hanlon 1996). The tank continues to receive liquid, and as of November 19, 1996 contained 1,021 kL (270 kgal). The tank is not on any Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-AP-106.

TANK DESCRIPTION	
Type	Double-shell
Constructed	1983-1986
In-service	1986
Diameter	22.9 m (75 ft)
Operating depth	10.7 m (35.2 ft)
Capacity	4,390 kL (1,160 kgal)
Bottom shape	Flat
Ventilation	Active
TANK STATUS	
Waste classification	Dilute non-complexed
Total waste volume[1]	931 kL (246 kgal)
Supernatant volume	931 kL (246 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	0 kL (0 kgal)
Drainable interstitial liquid volume	0 kL (0 kgal)
Waste surface level (November 19, 1996)	249 cm (98.1 in.)
Temperature (July 1989 to November 1996)	12.2 °C (54 °F) to 41.1 °C (106 °F)
Integrity	Sound
Watch List	None
SAMPLING DATE	
Grab samples	September 1996
Grab samples	November 1994
Grab samples	March 1993
Headspace flammability	September 1996
SERVICE STATUS	
In service	1986 to present

Note:

[1]Waste volume is estimated from surface-level measurements. Additional waste has been added to this tank since September 30, 1996. Transfer into and out of the tank must be considered for future inventory determinations or composition estimates.

2.0 RESPONSE TO TECHNICAL ISSUES

Three technical issues have been identified for tank 241-AP-106 (Brown et al. 1996). They are:

- Are safety or operational problems created as a result of commingling wastes?
- Does the waste pose or contribute to any recognized potential safety problems?
- Is the waste inventory generated by a model based on process knowledge and historical information (Agnew et al. 1996) representative of the current tank waste inventory?

Safety issues are addressed in the safety screening DQO (Dukelow et al. 1995). The SAP (Sasaki 1996) specifies the sampling and analysis used to address the waste compatibility issue. Data from the recent analysis of three grab samples and tank headspace flammability measurements, as well as available historical information, provided the means to respond to these three issues. The response is detailed in the following sections. Sample and analysis data for tank 241-AP-106 are included in Appendix B.

2.1 WASTE COMPATIBILITY EVALUATION

In accordance with Fowler (1995), tank 241-AP-106 was analyzed to enable assessment of the safety and operational implications of commingling the wastes in the tank with other wastes in the double-shell tank systems. Safety considerations included energetics, criticality, flammable gas generation and accumulation, corrosion and leakage, and unwanted chemical reactions. Operational considerations included transuranic (TRU) segregation, heat load limits of the receiving tank, plugged or fouled pipelines and equipment, and complexant waste segregation. Not all of the operational considerations were within the scope of this report, notably the potential chemical reactivity of the waste in a variety of conditions, and the tendency of the waste to plug or foul piping and equipment.

2.1.1 Safety Decision Rules Evaluation

The analyses used to evaluate the waste in terms of the safety considerations for waste compatibility are included in Table 2-1. The primary decision variable, the decision criteria threshold, and the supernatant mean analytical results from the 1996 grab sampling event are listed for each safety issue.

Table 2-1. Safety Decision Variables and Criteria for the Waste Compatibility Data Quality Objective.

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Analytical Result
Energetics/ organic layer	Total fuel content/ organic layer	1.0 exotherm/endotherm ratio; presence of organic layer	No exotherms; no organic layer
Criticality	$^{239/240}Pu$	0.800 μCi/mL[1]	6.81E-05 μCi/mL[2]
Flammable gas accumulation	Waste specific gravity	Specific gravity < 1.30 g/mL	1.07 g/mL
Corrosion[3]	Concentration of nitrate, hydroxide, and nitrite	$[NO_3^-] \leq 1.0\ M$; and $0.01\ M \leq [OH^-] \leq 5.0\ M$; and $0.011\ M \leq [NO_2^-] \leq 5.5\ M$	$[NO_3^-] = 0.876\ M$ $[OH^-] = 0.724\ M$ $[NO_2^-] = 0.291\ M$

Notes:

[1]Although the actual decision criterion listed in the DQO was 0.013 g/L, $^{239/240}Pu$ was measured in μCi/mL. To convert the notification limit for $^{239/240}Pu$ into the same units as those used by the laboratory, it was assumed that all alpha decay originated from ^{239}Pu. Using the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criterion may be converted to 0.800 μCi/mL as shown:

$$\left(\frac{0.013\ g}{L}\right)\left(\frac{1\ L}{10^3\ mL}\right)\left(\frac{0.0615\ Ci}{1\ g}\right)\left(\frac{10^6\ \mu Ci}{1\ Ci}\right) = 0.800\ \frac{\mu Ci}{mL}.$$

[2]This overall mean estimate was computed without using any "less than" values.

[3]These criteria apply for receiving tank operating temperatures of ≤ 100 °C (212 °F).

The waste compatibility DQO decision criteria threshold specifies that the absolute value of the exotherm/endotherm ratio must be < 1.0 for any transfer to be allowed. Because there were no exothermic reactions, the analytical results for all samples were less than this limit (Esch 1996). Also, no organic layers were present in the waste.

The waste compatibility DQO establishes the decision threshold of potential for criticality for plutonium at 0.013 g/L. This threshold is equivalent to 0.800 μCi/mL (using the ^{239}Pu specific activity of 0.0615 Ci/g), as displayed in note 1 of Table 2-1. The analytical mean result of 6.81E-05 μCi/mL for $^{239/240}Pu$ was well below this threshold.

The waste compatibility DQO flammable gas decision threshold requires that the specific gravity weighted mean for the waste be < 1.30 g/mL before any transfer is allowed. The analytical result was 1.07 g/mL, well below this limit.

The waste's corrosivity must be controlled to prolong the life of the tanks' carbon steel components. The limits for corrosion protection as stated in the waste compatibility DQO are based on the receiving tank temperature and the concentrations of corrosion-inhibiting chemicals, such as sodium hydroxide and nitrate and nitrite salts, in the waste. The limits given in Table 2-1 apply to tanks with operating temperatures of ≤ 100 °C (212 °F). The mean analytical results from the 1996 grab samples met all of the criteria listed.

The waste compatibility DQO specifies two additional decision rules regarding safety. The first decision rule states that no high-level waste will be accepted for transfer to a tank identified as a Watch List tank without U.S. Department of Energy (DOE) approval. The final decision rule states that potential chemical compatibility hazards are to be identified prior to acceptance of waste into any double-shell tank, and that the source wastes shall be categorized according to a compatibility matrix specified in Fowler (1995).

2.1.2 Operations Decision Rules Evaluation

The waste compatibility program requires a formal operations analysis of non-routine transfers before they are approved. Several criteria are applicable when evaluating the feasibility of a waste transfer between tanks: the segregation of TRU and non-TRU waste, avoiding excess heat generation, high-phosphate waste, complexant waste segregation, tank waste type, and waste pumpability. Three of these criteria are listed and compared to the mean analytical results in Table 2-2.

Table 2-2. Waste Compatibility Operations Decision Rules.

Operations Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Transuranics	TRU elements: [^{241}Am], [$^{239/240}$Pu]	0.1 μCi/g [TRU]	9.68E-04 μCi/g[1]
Heat load	Heat generation rate	20,500 W (70,000 Btu/hr)	217 W (741 Btu/hr)
High-phosphate waste	[PO_4^{-3}]	0.1 *M* [PO_4^{-3}]	0.0112 *M*

Note:

[1]The analytical result of 9.00E-04 μCi/mL for ^{241}Am was obtained from Table B3-5, and the analytical result of 6.81E-05 μCi/mL for $^{239/240}$Pu was obtained from Table B3-4. The sum of these two values, 9.68E-04 μCi/mL, was converted to 9.05E-04 μCi/g by dividing by the supernatant density of 1.07 g/mL.

The first criterion listed called for the segregation of TRU from non-TRU elements in the waste. If the TRU concentration in the tank is ≥ 0.1 μCi/g, then the waste must be transferred to a TRU storage tank only. The mean analytical result of 9.68E-04 μCi/g, which was based on ^{241}Am and $^{239/240}$Pu data, was well below the TRU threshold, indicating that the waste may be transferred to a non-TRU tank.

The heat generation threshold depends on the operating specification document limit for a given tank. The heat generation limit for tank 241-AP-106 was 20,500 W (70,000 Btu/hr) (Fowler 1995). The estimated tank heat load based on the analytical results was 217 W (741 Btu/hr), far below this limit (see Section 2.3).

High-phosphate waste, defined as > 0.1 *M* phosphate, is not to be mixed with defined concentrations of certain other waste types. If mixed with high-salt-content waste, it can cause crystallization, resulting in plugged pumps and equipment that make future waste handling difficult. The phosphate concentration of tank 241-AP-106 was 0.0112 *M*, and is not a concern.

The last three operations issues are not comparable to analytical results, and are thus outside the scope of this report. They are mentioned for informational purposes only. The first of these operations issues is that if a source waste stream is designated as complexant, then any waste transfer must be to a complexant waste receiver tank. Second, the tank waste types have been categorized according to a compatibility matrix, and all transfers must be in accordance with this matrix. Finally, the inputs to the waste pumpability issue are density, viscosity, and volume percent solids, along with the pipe diameter and pump velocity (Fowler 1995).

2.2 SAFETY SCREENING

The data needed to screen the waste in tank 241-AP-106 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, and criticality conditions in the waste. Each of these conditions is addressed separately below. Because tank 241-AP-106 is not a Watch List tank, the safety screening DQO is the only safety-related DQO with which the grab sampling data will be compared.

In addition to the analytical requirements, the safety screening DQO specifies that an optimum number of vertical profiles of the waste must be taken, as given in the SAP. Because there is no plausible mechanism by which a tank known to contain entirely liquid could become horizontally heterogeneous to any substantial degree, the SAP does not require sampling from more than one riser location at multiple depths within the waste.

2.2.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO is to ensure that there are not sufficient exothermic constituent concentrations (organic or ferrocyanide) in tank 241-AP-106 to cause a safety hazard. The threshold limit for energetics is 480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) showed no exotherms for any of the samples (Esch 1996).

Historically, there is no evidence that any exothermic agent should exist in this waste. Waste transfer records and Hanlon (1996) indicate that the only waste type expected to be in the tank is DN waste, which is not expected to have organic or ferrocyanide constituents. The DN waste is defined as containing < 1 weight percent (wt%) total organic carbon (TOC) (Agnew et al. 1996).

2.2.2 Flammable Gas

Vapor phase measurements, taken in the tank headspace prior to the September 1996 grab sampling, indicated that no flammable gas was detected (0 percent of the lower flammability limit [LFL]). Data from these vapor phase measurements are presented in Appendix B.

2.2.3 Criticality

The safety threshold limit is 1 g ^{239}Pu per liter of waste, and is usually compared against total alpha activity results. Because the safety screening DQO was not required by the SAP for the September 1996 grab sampling event, total alpha activity was not measured. Thus, this comparison is based on the $^{239/240}$Pu analytical results. Concentrations in all samples were well below this limit, the largest sample mean being 1.89E-06 g/L. Additionally, as required by the DQO, the upper limit of a one-sided 95 percent confidence interval was also calculated, and all results were much lower than 1 g/L. Therefore, criticality is not an issue for this tank.

2.3 OTHER TECHNICAL ISSUES

Other factors in assessing tank safety are the waste's heat generation properties and temperature. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load based on ^{90}Sr and ^{137}Cs, the only two radionuclides with estimated inventories above the detection limit (Table 3-2), yielded 217 W (741 Btu/hr). The heat load estimate based on the tank process history was 2,020 W (6,890 Btu/hr) (Agnew et al. 1996). Both of these estimates are well below the 20,500 W (70,000 Btu/hr) limit that separates high- and low-heat-load tanks (Fowler 1995). The heat load estimate based on the tank headspace temperature was not available for tank 241-AP-106 (Kummerer 1994).

2.4 SUMMARY

The results from all analyses performed to address potential safety and operational issues showed that no primary analyte exceeded any decision threshold limits. Headspace flammability tests were conducted separately. The analytical results are summarized in Table 2-3.

Table 2-3. Summary of Waste Compatibility and Safety Screening Results.

Issue	Sub-issue	Result
Waste compatibility	Energetics/ organic layer	No exotherms observed in any sample. No organic layer.
	Criticality	All results far below upper limit of 0.800 μCi/mL.
	Flammable gas accumulation	Analytical result of 1.07 g/mL far below upper limit of 1.41 g/mL.
	Corrosion	All analytical results met the DQO safety specifications.
	Transuranics	Analytical mean far below upper limit of 0.1 μCi/g.
	Heat load	Estimate far below upper limit of 20,500 W (70,000 Btu/hr).
	High-phosphate waste	Analytical mean far below upper limit of 0.1 *M*.
Safety screening	Energetics	No exotherms observed in any sample.
	Flammable gas	Headspace flammability was 0 percent of the LFL.
	Criticality	All analyses far below 1 g of ^{239}Pu per liter of waste (including the 95 percent confidence interval upper limits).

3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1996). Information derived from these two approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available chemical information for tank 241-AP-106 was performed. Information evaluated included the following.

- Characterization results from the March 1993 "bottle-on-a-string" sampling event. The results are summarized in the statistical analysis of data from the sample event (Welsh 1994).

- Characterization results for the 3,535 kL (934 kgal) of waste transferred from tank 241-AP-106 to tank 241-AP-108 in May 1995 (Baldwin and Stephens 1996).

- The waste compatibility results for the September 1996 sampling event. This event provided the most recent data on the contents of tank 241-AP-106 (Esch 1996).

- The Hanford defined waste (HDW) model document (Agnew et al. 1996) provides tank content estimates derived from the LANL model, in terms of component concentrations and inventories. A list of data sources used in this evaluation is provided in Section 5.0.

Results from this evaluation, detailed in Appendix D, indicate that inventories based on the September 1996 sampling event and waste layer volumes derived in this engineering assessment should serve as the basis for the best estimate inventory to tank 241-AP-106 for the following reasons.

1. The HDW model estimate is outdated because of subsequent waste transfers.

2. The September 1996 sampling event provides the most recent data for the waste.

3. The estimated waste layer volumes produce inventories consistent with available data from other sources.

Best-basis inventory estimates for tank 241-AP-106 are presented in Tables 3-1 and 3-2. Radionuclide values are decayed to January 1, 1994. These estimates are based on the conclusion that a dense heel (approximately 1.2 specific gravity) of liquid remained after most of the tank content was transferred in 1995, and lies under the dilute waste added since that transfer.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-106 as of September 30, 1996. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1,2]
Al	2,610	S/E
Bi	< 9.44	S/E
Ca	< 9.44	S/E
Cl	634	S/E
TIC as CO_3	7,280	S/E
Cr	52.3	S/E
F	824	S/E
Fe	< 4.73	S/E
Hg	n/r	
K	7,010	S/E
La	< 4.73	S/E
Mn	< 0.944	S/E
Na	35,900	S/E
Ni	2.12	S/E
NO_2	10,400	S/E

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-106 as of September 30, 1996. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1,2]
NO_3	41,750	S/E
OH	9,657	S/E
Pb	< 9.44	S/E
P as PO_4	919	S/E
Si	21.5	S/E
S as SO_4	1,350	S/E
Sr	< 0.944	S/E
TOC	1,340	S/E
U_{TOTAL}	< 47.1	S/E
Zr	< 0.944	S/E

Notes:

[1]S = Sample-based - see Appendix B
M = HDW model-based
E = Engineering assessment-based
n/r = Not reported

[2]Based on September 1996 grab sample results (see Appendix B) This is an active tank and future estimates of inventory or composition must consider the effect of transfers into and out of the tank.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-106 as of September 30, 1996. (Decayed to January 1, 1994)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1,2]
^{60}Co	< 6.84	S
^{79}Se	n/r	S
^{90}Sr	149	S
^{90}Y	149	S
^{137}Cs	45,740	S
^{137m}Ba	43,500	S
$^{239/240}Pu$	< 0.0365	S
^{241}Am	< 0.226	S

Notes:

[1]S = Sample-based - see Appendix B
M = HDW model-based
E = Engineering assessment-based

[2]Based on September 1996 grab sample results (see Appendix B).

4.0 CONCLUSIONS AND RECOMMENDATIONS

The sampling and analysis activities performed for tank 241-AP-106 have met all requirements of the safety screening DQO, the waste compatibility DQO, and the SAP. All analytical results were well within safety and operational notification limits. Based on current waste content, grab sample results, and engineering flow models, a best-basis inventory was developed for the tank contents.

Table 4-1 summarizes the status of the Project Hanford Management Contractor (PHMC) TWRS Program review and acceptance of the sampling and analysis results reported in this tank characterization report. All DQO issues required to be addressed by sampling and analysis are listed in column one of Table 4-1. The second column indicates with a "Yes" or a "No" whether the requirements of the DQO were met by the sampling and analysis activities performed. The third column indicates concurrence and acceptance by the program in PHMC TWRS that is responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "Yes" or "No" in column three indicates acceptance or disapproval of the sampling and analysis information presented in the TCR. If the results/information have not yet been reviewed, "N/R" is shown in the column. If the results/information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown in the column.

Table 4-1. Acceptance of Tank 241-AP-106 Sampling and Analysis.

Issue	Sampling and Analysis Performed	PHMC TWRS Program Acceptance
Waste compatibility DQO	Yes	Yes
Safety screening DQO	Yes	Yes

Table 4-2 summarizes the status of the PHMC TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations specifically outlined in this report are the waste compatibility analysis and the safety screening analysis. Column one lists the different evaluations performed in this report. Columns two and three are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as that in Table 4-1. None of the analyses performed on the grab samples indicated any safety problems.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-AP-106.

Issue	Evaluation Performed	PHMC TWRS Program Acceptance
Waste compatibility assessment	Yes	Yes
Safety screening assessment	Yes	Yes

Because tank 241-AP-106 is active and the contents are continually changing, it will need to be resampled in accordance with operations and safety procedures. Contents are projected on the basis of analysis of transferred material. Active tanks are typically sampled and rebaselined each year.

At this time, the waste appears to be stratified with a dilute, lower density supernatant above a more concentrated heel of denser liquid.

5.0 REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

Baldwin, J. H., and R. H. Stephens, 1996, *Tank Characterization Report for Double-Shell Tank 241-AP-108*, WHC-SD-WM-ER-593, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Brown, T. M., S. J. Eberlein, J. W. Hunt and T. J. Kunthara, 1996, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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

Esch, R. A., 1996, *Tank 241-AP-106 Grab Samples 6AP-96-1, 6AP-96-2, and 6AP-96-3 Analytical Results for the Final Report*, WHC-SD-WM-DP-217, Rev. 0, Rust Federal Services of Hanford, Richland, Washington.

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

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

Kummerer, M., 1995, *Topical Report on Heat Removal Characteristics of Waste Storage Tanks*, WHC-SD-WM-SARR-010, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

Sasaki, L. M., 1996, *Compatibility Grab Sampling and Analysis Plan*, WHC-SD-WM-TSAP-037, Rev. 2D, Westinghouse Hanford Company, Richland, Washington.

Welsh, T. L., 1994, *Tank 241-AP-106 Characterization Results*, WHC-SD-WM-TRP-170, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

HISTORICAL TANK INFORMATION

This page intentionally left blank.

APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-AP-106 based on historical information. For this report, historical information includes any information about the fill history, waste types, surveillance, or modeling data about the tank. This information is necessary for providing a balanced assessment of the sampling and analytical results.

This appendix contains the following information:

- **Section A1:** Current status of the tank, including the current waste levels as well as the tank's stabilization and isolation status.
- **Section A2:** Information about the tank's design.
- **Section A3:** Process knowledge of the tank; i.e., the waste transfer history and the estimated tank contents based on modeling data.
- **Section A4:** Surveillance data for tank 241-AP-106, including surface-level readings, temperatures, and a description of the waste surface based on photographs.
- **Section A5:** References for Appendix A.

Sampling results for samples obtained prior to 1996 are included in Appendix B.

A1.0 CURRENT TANK STATUS

As of September 30, 1996, tank 241-AP-106 contained an estimated 931 kL (246 kgal) of DN waste (Hanlon 1996). The liquid waste volume was estimated using automatic and manual tape surface-level gauges, and the absence of solids was determined using a sludge level measurement device. The volumes of the waste phases found in the tank are shown in Table A1-1.

Tank 241-AP-106 went into service in 1986 and remains in service today. The tank is actively ventilated and is not on the Watch List (Public Law 101-510).

Table A1-1. Tank Contents Status Summary (Hanlon 1996).

Waste Type	kL (kgal)
Total waste	931 (246)
Supernatant	931 (246)
Sludge	0 (0)
Saltcake	0 (0)
Drainable interstitial liquid	0 (0)
Drainable liquid remaining	931 (246)
Pumpable liquid remaining	931 (246)

A2.0 TANK DESIGN AND BACKGROUND

The AP Tank Farm was constructed from 1983 to 1986 in the 200 East Area (Leach and Stahl 1996). The tank farm contains eight double-shell tanks. Each tank has a capacity of 4,390 (1,160 kgal), a diameter of 22.9 m (75.0 ft), and an operating depth of 10.7 m (35.2 ft). These tanks were designed to hold concentrated supernatant. The maximum design temperature for liquid storage is 149 °C (300 °F) (Brevick et al. 1995).

Tank 241-AP-106 was constructed with a primary carbon steel liner (heat-treated and stress-relieved), a secondary carbon steel liner (not heat-treated), and a reinforced concrete shell. The bottom of the primary liner is 13 mm (0.5 in.) thick, the lower portion of the sides is 19 mm (0.75 in.) thick, the upper portion of the sides is 13 mm (0.5 in.) thick, and the dome liner is 9.5 mm (0.375 in.) thick. The secondary liner is 9.5 mm (0.375 in.) thick. The concrete walls are 460 mm (1.5 ft) thick and the dome is 380 mm (1.25 ft) thick. The tank has a flat bottom. The bottoms of the primary and secondary liners are separated by an insulating concrete layer. There is a grid of drain slots in the concrete foundation beneath the secondary steel liner. The grid's function is to collect any waste that may leak from the tank and divert it to the leak detection well.

Tank 241-AP-106 has 29 risers ranging in diameter from 10 cm (4 in.) to 110 cm (42 in.) that provide access to the tank, and 42 risers that provide access to the annulus. Table A2-1 shows numbers, diameters, and descriptions of the risers (annular risers not included). Figure A2-1 is a plan view that depicts the riser configuration. Thirteen of the risers are available for sampling: ten 10-cm (4-in.)-diameter risers (all three riser 1's, riser 15, riser 21, riser 24, all three riser 27's, and riser 28) and three 30-cm (12-in.)-diameter risers (both riser 10's and riser 12) (Lipnicki 1996). A tank cross section showing the approximate waste level, along with a schematic of the tank equipment, is in Figure A2-2.

Table A2-1. Tank 241-AP-106 Risers.[1,2,3,4] (2 sheets)

Number	Diameter		Description and Comments[5]
	cm	in.	
1	10	4	Sludge measurement port (30°)
1	10	4	Sludge measurement port (150°)
1	10	4	Sludge measurement port (270°)
2	10	4	Liquid level, level indicating transmitter
3	30	12	Supernatant pump, central pump pit (pit)
4	30	12	Thermocouple tree
5	110	42	Manhole; riser plug (50°)
5	110	42	Manhole; riser plug (180°)
7	30	12	Spare; riser plug (265°)
7	30	12	Primary tank exhaust (290°)
10	30	12	Spare; riser plug (210°)
10	30	12	Spare; riser plug (330°)
11	110	42	Slurry distributor, central pump pit (pit)
12	30	12	Observation port, spare
13	30	12	Tank pressure
14	10	4	Supernatant return
15	10	4	Spare; riser plug
16	30	12	Sludge measurement port (30°)
16	30	12	Sludge measurement port (150°)
16	30	12	Sludge measurement port (270°)
21	10	4	Spare; riser plug
22	10	4	Sludge measurement port
24	10	4	Spare; riser plug
25	10	4	High liquid level sensor
26	10	4	Liquid level indicator

Table A2-1. Tank 241-AP-106 Risers.[1,2,3,4] (2 sheets)

Number	Diameter		Description and Comments[5]
	cm	in.	
27	10	4	Spare; riser plug (240°)
27	10	4	Spare; riser plug (270°)
27	10	4	Spare; riser plug (300°)
28	10	4	Spare; riser plug

Notes:

[1]Salazar (1994)

[2]WHC (1994)

[3]Braun Hanford Company (1985)

[4]If a discrepancy existed between the documents and the drawing, the drawing took precedence.

[5]Coordinates in degrees clockwise from north where multiple risers with the same number occur.

Figure A2-1. Riser Configuration for Tank 241-AP-106.

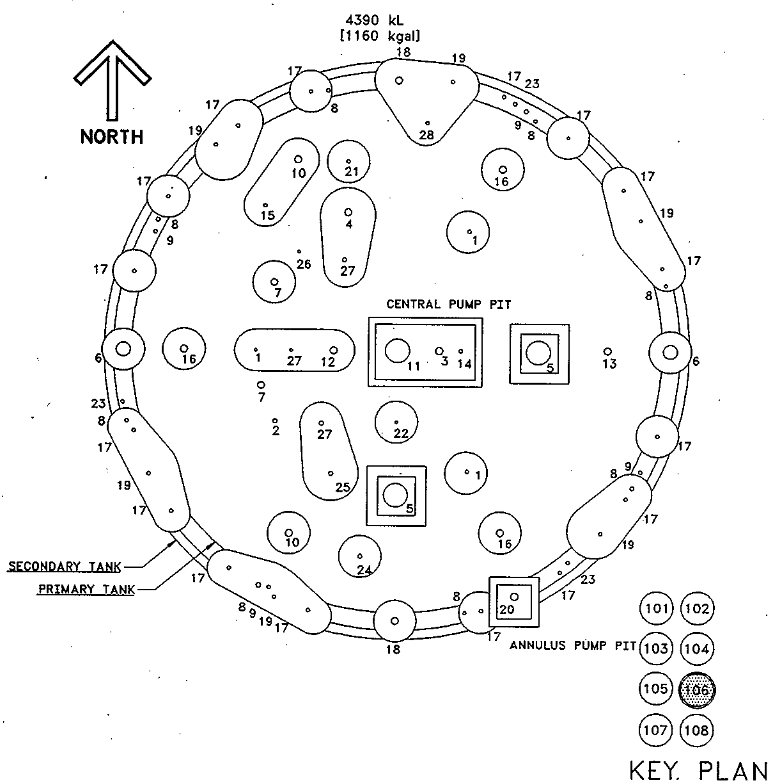
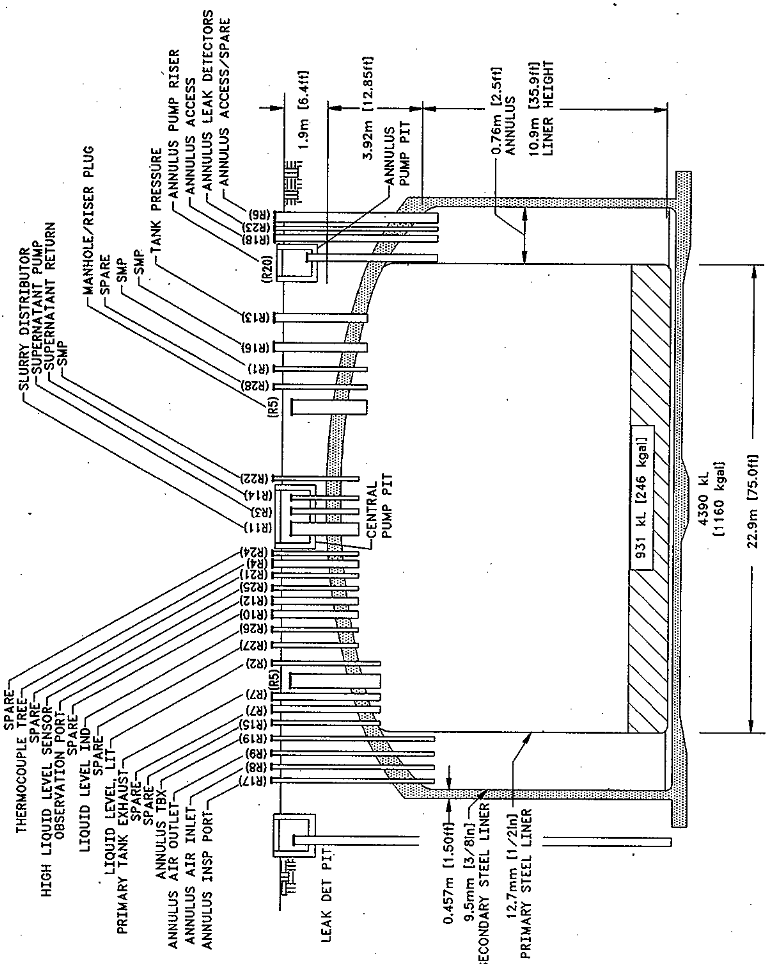


Figure A2-2. Tank 241-AP-106 Cross Section and Schematic.



A3.0 PROCESS KNOWLEDGE

The sections below: 1) provide information about the transfer history of tank 241-AP-106; 2) describe the process wastes that made up the transfers; and 3) give an estimate of the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-AP-106 (Agnew 1996b). The tank entered service in July 1986 with the introduction of 72 kL (19 kgal) of flush water. In July and August 1988, the tank received a total of 2,130 kL (564 kgal) of dilute non-complexed waste from the 242-A Evaporator by way of tank 241-AW-106. In September 1988, 11 kL (3 kgal) of waste was sent from tank 241-AP-106 to the Hanford Grout Treatment Facility.

The entire contents of the tank, 2,200 kL (580 kgal), were sent to tank 241-AW-102 in February 1989; 1,860 kL (492 kgal) were returned from the 242-A Evaporator via tank 241-AW-102. In July 1989, tank 241-AP-106 received 314 kL (83 kgal) of dilute non-complexed supernatant from tank 241-AW-106. Also, 1,340 kL (355 kgal) of waste was transferred from tank 241-AP-106 to tank 241-AP-105. In late July 1989, the tank received its largest transfer; 2,680 kL (709 kgal) of supernatant was transferred from tank 241-AY-102. At the time of transfer, tank 241-AY-102 contained mostly B Plant vessel cleanout and B Plant strontium processing wastes. Tank 241-AP-106 received another 810 kL (214 kgal) from tank 241-AY-102 in October 1989. Tank 241-AY-102's waste sources had changed considerably since the earlier transfer, because of the addition of waste from tank 241-SY-102.

In March 1995, 314 kL (83 kgal) of waste was removed and sent to tank 241-AW-102. Two months later, 3,540 kL (934 kgal) was sent to tank 241-AP-108. This transfer lowered the waste level in tank 241-AP-106 to 409 kL (108 kgal). Since that time, the tank has received 583 kL (154 kgal) of dilute non-complexed waste from various sources, including B Plant cells (drainage), the 300 and 400 areas, the 222-S Laboratory, T Plant, and the Plutonium Finishing Plant laboratories. A portion of this 583 kL (154 kgal) has also been water and small unknown gains. Table A3-1 displays the transfer history through October 21, 1996. Further waste transfer activity can be expected because tank 241-AP-106 remains in service.

Table A3-1. Summary of Tank 241-AP-106 Major Waste Transfers.

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Volume[1,2] kL	Estimated Volume[1,2] kgal
Unknown	---	Water	1986 - 1987	79	21
241-AW-106	---	Dilute non-complexed waste	1988 - 1989	2,450	647
---	Grout facility	Supernatant	1988	-11	-3
---	241-AW-102	Supernatant	1989	-2,200	-580
241-AW-102	---	Supernatant	1989	1,860	492
---	241-AP-105	Supernatant	1989	-1,340	-355
241-AY-102	---	Dilute non-complexed waste	1989	3,490	923
---	241-AW-102	Supernatant	1995	-314	-83
---	241-AP-108	Supernatant	1995	-3,540	-934
B Plant	---	Cell drainage	1996	189	50
300 and 400 area laboratory waste	---	Dilute non-complexed waste	1996	129	34
Miscellaneous	---	Water	1996	144	38
222-S Laboratory	---	Dilute non-complexed waste	1996	45	12
T Plant	---	Dilute non-complexed waste	1996	38	10
Plutonium Finishing Plant laboratores	---	Dilute non-complexed waste	1996	8	2
Miscellaneous	---	Other small transfers	1996	8	2

Notes:

[1]Derived from invalidated data taken from the Operational Waste Volume Projection database 1989 to present. Data from 1986 through 1993 were also taken from Agnew et al. (1996b).

[2]Because only major transfers are listed, the sum of these transfers will not equal the current waste volume.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The historical transfer data used for this estimate are from the following sources:

- *Waste Status and Transaction Record Summary for the Southwest Quadrant of the Hanford 200 East Area* (WSTRS) (Agnew et al. 1996b). WSTRS is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996a). This document contains the Hanford defined waste (HDW) list, the supernatant mixing model (SMM), and the tank layer model (TLM).

- *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 East Area* (Brevick et al. 1996). This document compiles and summarizes much of the process history, design, and technical information regarding the underground waste storage tanks in the 200 East Area.

- Tank layer model (TLM). The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

- Supernatant mixing model (SMM). This is a subroutine within the HDW model that calculates the volume and composition of certain supernatant blends and concentrates.

The TLM uses the waste composition and transfer information from these records to define the sludge and saltcake layers in each tank. The SMM uses information from both the WSTRS and the TLM to describe the supernatants and concentrates in each tank. Together, the WSTRS, TLM, and SMM determine each tank's inventory estimate. These model predictions are considered estimates that require further evaluation using analytical data.

The information based on the TLM and SMM is combined in a spreadsheet to produce the historical tank inventory estimate for each of the 177 tanks. These estimates have not been validated and should be used with caution. In some cases, the available data are incomplete, thus reducing the reliability of the transfer data and the modeling results derived from them.

Because tank 241-AP-106 contains only liquid, no TLM prediction or figure is available. The historical tank inventory estimate of the expected waste constituents and concentrations of tank 241-AP-106 as of January 1, 1994 is shown in Table A3-2. The tank has been active since then, and a substantial portion of the contents have been transferred to tank 241-AP-108. Significant quantities of dilute, non-complexed waste subsequently were added to the tank. Updated estimates are not yet available for this tank.

Table A3-2. Historical Tank Inventory Estimate.[1] (2 sheets)

Total Inventory Estimate[2]			
Physical Properties			
Total waste	4.91E+06 kg (1,130 kgal)		
Heat load	2,020 W (6,890 Btu/hr)		
Bulk density[3]	1.15 g/mL		
Water wt %[3]	76.2		
TOC wt % carbon (wet)[3]	0.390		
Chemical Constituents	***M***	**μg/g**	**kg**
Na^{+}	3.31	66,200	3.25E+05
Al^{3+}	0.400	9,380	46,000
Fe^{3+} (total Fe)	0.00390	189	930
Cr^{3+}	0.0105	473	2,320
Bi^{3+}	1.33E-04	24.2	119
La^{3+}	3.41E-06	0.411	2.02
Hg^{2+}	3.53E-06	0.616	3.02
Zr (as $ZrO(OH)_2$)	8.31E-04	65.9	323
Pb^{2+}	1.52E-04	27.3	134
Ni^{2+}	0.00257	131	643
Sr^{2+}	1.14E-06	0.0865	0.425
Mn^{4+}	0.00334	159	782
Ca^{2+}	0.0176	613	3,010
K^{+}	0.0723	2,460	12,100
OH^{-}	1.81	26,700	1.31E+05
NO_3^{-}	1.59	85,800	4.21E+05
NO_2^{-}	0.282	11,300	55,300
CO_3^{2-}	0.233	12,100	59,500

Table A3-2. Historical Tank Inventory Estimate.[1] (2 sheets)

Total Inventory Estimate[2]			
Chemical Constituents (cont'd)	*M*	μg/g	kg
PO_4^{3-}	0.0484	3,990	19,600
SO_4^{2-}	0.0486	4,050	19,900
Si (as SiO_3^{2-})	0.0220	536	2,630
F^-	0.0681	1,130	5,520
Cl^-	0.0575	1,770	8,690
$C_6H_5O_7^{3-}$	0.00951	1,560	7,670
$EDTA^{4-}$	0.00253	632	3,100
$HEDTA^{3-}$	0.00446	1,060	5,220
$glycolate^-$	0.0978	6,370	31,300
$acetate^-$	0.00188	96.4	473
$oxalate^{2-}$	2.92E-06	0.223	1.09
DBP	0.00401	561	2,750
butanol	0.00401	258	1,270
NH_3	0.213	3,150	15,500
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	Ci/L	μCi/g	Ci
Pu	---	0.0278	2.28 (kg)
U	0.00386 (*M*)	798 (μg/g)	3,920 (kg)
Cs	0.0458	39.8	1.95E+05
Sr	0.0384	33.4	1.64E+05

Notes:

[1]Agnew et al. (1996). Since the January 1, 1994 estimate, the tank contents have undergone major changes, and these figures do not represent current tank contents.

[2]Unknowns in the tank solids inventory are assigned by the TLM.

[3]Volume average for density, mass average water wt% and TOC wt% C.

A4.0 SURVEILLANCE DATA

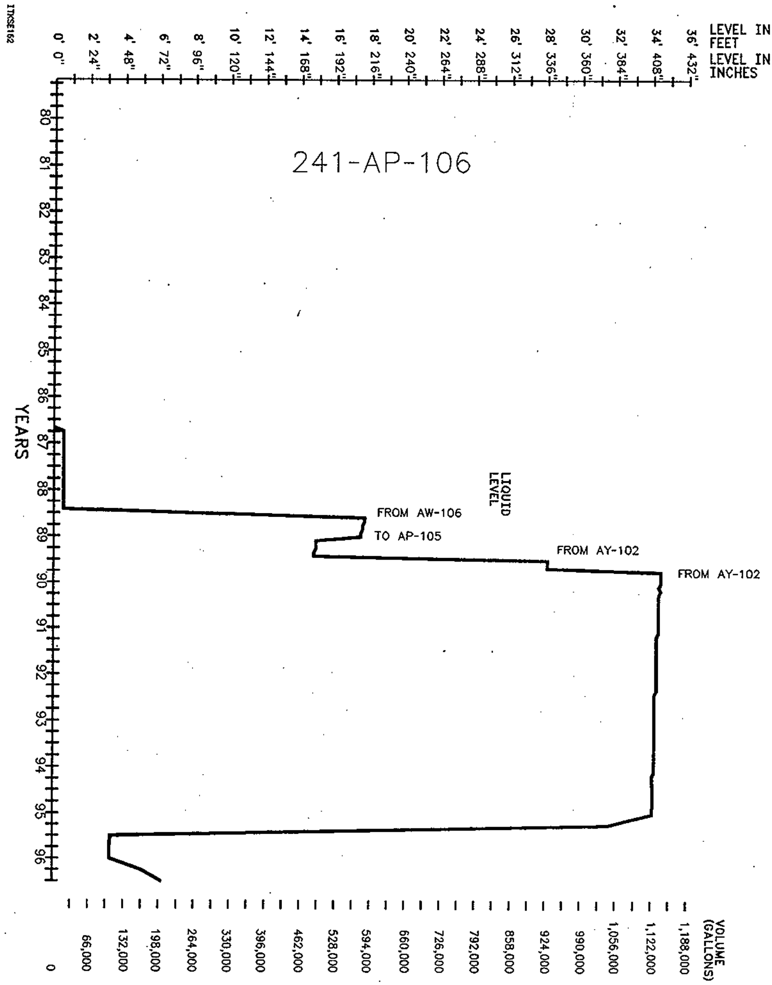
Tank 241-AP-106 surveillance consists of surface-level measurements, temperature monitoring inside the tank (waste and headspace) and the annulus, and leak detection pit monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate if the tank has a major leak. The AP Tank Farm also has two leak detection pits to detect waste leakage from the tanks. The leak detection pits monitor both the radioactivity and a weight factor as indicators of a leak (Welty 1988). As of September 30, 1996, the radiation monitoring system was out of service (Hanlon 1996). All other surveillance equipment was in compliance with the applicable documentation.

A4.1 SURFACE-LEVEL READINGS

Tank 241-AP-106 is equipped with a liquid level gauge manufactured by the Food Instrument Corporation (FIC) that can be monitored either automatically or manually. The FIC indicator uses a conductivity probe to detect the level of the tank's contents and, in the automatic mode, is electrically connected to a computer for data transmission via the Computer Automated Surveillance System. Tank 241-AP-106 is also equipped with a manual tape, from which readings are taken when the FIC indicator is out of service. Both devices are currently operable. The most recent automatic FIC liquid level measurement available was 249 cm (98.1 in.) on November 19, 1996. The manual tape reading on the same day was 250 cm (98.5 in.). A level history graph of the volume measurements is presented in Figure A4-1.

Figure A4-1. Tank 241-AP-106 Level History.



A4.2 INTERNAL TANK TEMPERATURES

Tank 241-AP-106, like the other AP Tank Farm double-shell tanks, is equipped with approximately 100 thermocouples (thermoelectric temperature measuring devices) in the tank interior, the annular space, and the concrete outer shell. A single thermocouple tree, with 18 thermocouples assembled in a pipe at various elevations and inserted into a waste tank, is used to monitor the waste temperatures in the primary tank. Thermocouple 18 is the lowest in the tank, located 15 cm (6 in.) above the tank bottom. Thermocouples 17 through 3 are spaced at 61-cm (2-ft) intervals above thermocouple 18. Thermocouples 1 and 2 are separated by 122-cm (4-ft) intervals (Tran 1993). Currently, readings are available for thermocouples 1, 3, 5, 7, 11, and 17. Temperature readings in the waste are only available from thermocouple 17.

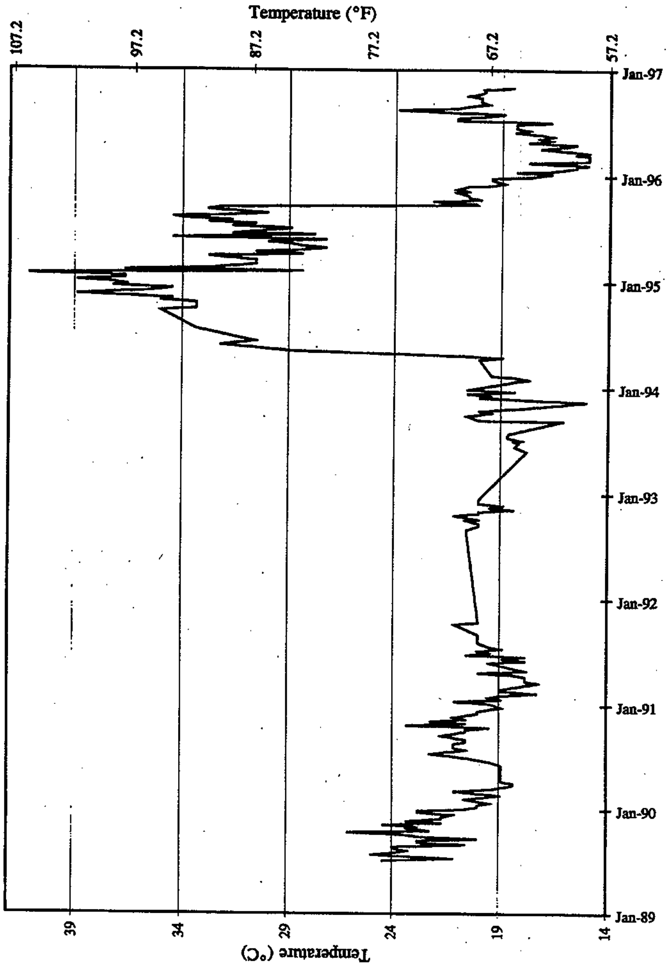
Temperature readings for the tank have been automatically and manually recorded since July 1989 by the Surveillance Analysis Computer System. The maximum weekly waste temperatures over time are presented in Figure A4-2. Except for three periods when the thermocouple equipment was out of service, tank 241-AP-106's internal temperature has been monitored weekly. The three periods with no thermocouple data are from the end of the fourth quarter of 1990 to the second quarter of 1991, from the third quarter of 1991 to the fourth quarter of 1992, and from the end of the fourth quarter of 1992 to the middle of the second quarter of 1993.

The average high temperature from July 1989 through November 1996 was 21.4 °C (70.5 °F), with a maximum of 41.1 °C (106 °F) and a minimum of 12.2 °C (54 °F). Over the last year, calendar year 1996, the average has been 17.2 °C (62.9 °F), with a maximum of 23.9 °C (75 °F) and a minimum of 12.2 °C (54 °F). The most recent temperature profile noted was for November 18, 1996 when the high temperature was 184 °C (65.2 °F) and the low was 181 °C (64.6 °F). Plots of the thermocouple readings can be found in the supporting document for the Historical Tank Content Estimate for the AP Tank Farm (Brevick et al. 1995).

A4.3 TANK PHOTOGRAPHS

No photographs of the tank 241-AP-106 interior are available (Brevick et al. 1995).

Figure A4-2. Tank 241-AP-106 High Temperature Plot.



A5.0 APPENDIX A REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996b, *Waste Status and Transaction Record Summary for the Southeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-TI-689, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Braun Hanford Company, 1985, *Plan Tank Penetrations 241-AP-106 & 108*, Drawing H-2-90536, Rev. 2, Braun Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis, and S. D. Consort, 1995, *Supporting Document for the Southeast Quadrant Historical Tank Content Estimate Report for AP-Tank Farm - Volume 1 and 2*, WHC-SD-WM-ER-315, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Brevick, C. H., L. A. Gaddis and W. W. Pickett, 1996, *Historical Tank Content Estimate for the Southeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-ER-350, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

Leach, C. E. and S. M. Stahl, 1996, *Hanford Site Tank Farm Facilities Interim Safety Basis Volume I and II*, WHC-SD-WM-ISB-001, Rev. 0L, Westinghouse Hanford Company, Richland, Washington.

Lipnicki, J., 1996, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

Public Law 101-510, 1990, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 of *National Defense Authorization Act for Fiscal Year 1991*.

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

Tran, T. T., 1993, *Thermocouple Status Single Shell and Double Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-356, Vol. I and II, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994, *Piping Plan Tank 106*, Drawing H-2-90558, Westinghouse Hanford Company, Richland, Washington.

This page intentionally left blank.

APPENDIX B

SAMPLING OF TANK 241-AP-106

This page intentionally left blank.

APPENDIX B

SAMPLING OF TANK 241-AP-106

Appendix B includes sampling and analysis information for each known sampling event for tank 241-AP-106 and provides an assessment of the 1996 grab sampling results.

- **Section B1:** Tank Sampling Overview
- **Section B2:** Analytical Results
- **Section B3:** Assessment of Characterization Results
- **Section B4:** References for Appendix B.

Future sampling of tank 241-AP-106 will be appended to the above list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the September 1996 sampling and analysis event for tank 241-AP-106. Grab samples were taken to satisfy the requirements of the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). The sampling and analyses were performed in accordance with the *Compatibility Grab Sampling and Analysis Plan* (Sasaki 1996). In addition, the safety thresholds specified in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) were applied. Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (De Lorenzo et al. 1994a). Previous grab samples were taken from this tank in March 1993 and November 1994; these sampling events are discussed in Section B1.4.

B1.1 DESCRIPTION OF SAMPLING EVENT

Three grab samples (6AP-96-1, 6AP-96-2, and 6AP-96-3) were collected from riser 1 of tank 241-AP-106 located at 150° from north on September 12, 1996. The "bottle on a string" method was used to obtain these samples. All three samples were received by the 222-S Laboratory on September 13, 1996. Difficulties in sample recovery from riser 1 at 30° from north caused the decision to sample from riser 1 at 150°.

Prior to the grab sampling event, the tank headspace vapors were sampled at riser 1 at 30° and at 150°. These measurements for the presence of flammable gases fulfilled one of the requirements of the safety screening DQO.

Sampling and analytical requirements from the waste compatibility and safety screening DQOs are summarized in Table B1-1.

Table B1-1. Integrated Data Quality Objective Requirements for Tank 241-AP-106.

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
September 1996 grab sampling	Safety screening	Vertical waste profiles. Flammability measurements made in tank headspace.	(Dukelow et al. 1995) ▶ Energetics ▶ Moisture content ▶ Total alpha activity ▶ Specific gravity ▶ Visual check for organic layer
	Waste compatibility	Grab samples from different depths	(Fowler 1995) ▶ Energetics ▶ Moisture content ▶ Visual check for organic layer ▶ Metals by ICP ▶ Anions by IC ▶ Radionuclides ▶ TIC, TOC ▶ Hydroxide ▶ Specific gravity ▶ pH ▶ Percent solids
Combustible gas meter reading	Safety screening	Measurement in a minimum of one location within tank headspace.	▶ Flammable gas concentration

Notes:

ICP = inductively coupled plasma
IC = ion chromatography
TIC = total inorganic carbon

B1.2 SAMPLE HANDLING

The samples were shipped to the 222-S Laboratory for subsampling and analysis. The sampling bottles were 125 mL in size, and full recovery was obtained from all three. All samples were visually inspected for color, clarity, solids content, and the presence of an organic layer. The three supernatant samples were all described as yellow and clear, with no organic layer present. A trace of settled solids was observed in samples 6AP-96-1 and 6AP-96-3. The radiation dose rate on contact was also measured. Table B1-2 summarizes the sampling information.

Table B1-2. Tank 241-AP-106 Subsampling Scheme and Sample Description.[1]

Sample Number	Sampling Depth[2]	Sampling Elevation[3]	Dose Rate (mR/hr)	Percent Settled Solids	Sample Description
6AP-96-1	1,473 cm (580 in.)	178 cm (70 in.)	24	Trace	Clear yellow liquid, no organic layer, trace amount of solids
6AP-96-2	1,549 cm (610 in.)	102 cm (40 in.)	150	None	Clear yellow liquid, no organic layer, no solids
6AP-96-3	1,626 cm (640 in.)	25 cm (10 in.)	700	Trace	Clear yellow liquid, no organic layer, trace amount of solids

Notes:

[1]Esch (1996)

[2]Sampling depth is measured from the top of the riser to the mouth of the sample bottle.

[3]Sampling elevation is measured from the tank bottom to the mouth of the sample bottle.

B1.3 SAMPLE ANALYSIS

All of the analyses required by the waste compatibility DQO were performed on the grab samples. In addition to the analyses requested in the SAP, many inductively coupled plasma spectroscopy (ICP) analytes as well as bromide, oxalate, and ^{60}Co were obtained on an opportunistic basis. These were reported in accordance with Kristofzski (1996) because doing so required little additional effort. The analyses required by the waste compatibility DQO included safety parameters such as thermal properties by DSC, content of fissile material from $^{239/240}$Pu, specific gravity, and the concentration of several anions to assess corrosivity.

All analyses on the samples were performed directly with the exception of the ICP analyses, which were performed following an acid dilution.

All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table B1-3. The procedure numbers are presented in the discussion in Section B2.0

Table B1-3. Tank 241-AP-106 Sample Analysis Summary.[1]

Customer Identification Number	Laboratory Identification Number	Analyses
6AP-96-1	S96T005181	DSC, TGA, TIC, TOC, ICP, IC, pH, OH^-, specific gravity
	S96T005184	^{241}Am, ^{137}Cs, ^{60}Co, $^{239/240}Pu$, $^{89/90}Sr$
6AP-96-2	S96T005183	DSC, TGA, TIC, TOC, ICP, IC, pH, OH^-, specific gravity
	S96T005186	^{241}Am, ^{137}Cs, ^{60}Co, $^{239/240}Pu$, $^{89/90}Sr$
6AP-96-3	S96T005182	DSC, TGA, TIC, TOC, ICP, IC, pH, OH^-, specific gravity
	S96T005185	^{241}Am, ^{137}Cs, ^{60}Co, $^{239/240}Pu$, $^{89/90}Sr$
Vapor tests	---	Combustible gas meter readings

Notes:

TGA = thermogravimetric analysis

[1]Esch (1996)

In addition to the grab samples, the tank headspace flammability was measured in the field by means of a combustible gas meter. Results of the headspace sampling are discussed in Section B2.7 of this report.

B1.4 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

Sampling data from tank 241-AP-106 were obtained on two occasions prior to September 1996. The first sampling event occurred on March 16 and 17, 1993. This event is described in Section B1.4.1, and the data are presented in Section B2.8.1. The second sampling event occurred on November 14 through 17, 1994. This event is described in

Section B1.4.2, and the results are presented in Section B2.8.2. The tank contents have changed considerably since both of these samplings. The tank contents were essentially unchanged between these two sampling events, but most of the waste was removed after November 1994. The tank contents were as low as 106 kgal (401 kL) in November 1995, and have since been increased to approximately 246 kgal (931 kL). In other words, over half of the current contents of tank 241-AP-106 were not present when the two historical sampling events occurred.

B1.4.1 Description of 1993 Historical Sampling Event

Tank 241-AP-106 was grab sampled on March 16 and 17, 1993 using the "bottle-on-a-string" method. To provide an indication of waste homogeneity, the samples were required to be obtained from the entire volume of the tank (De Lorenzo et al. 1994b). Therefore, samples were taken from three equally spaced risers, situated 120° apart at a radius of 6 m (20 ft) from the tank's center. Each sampling location varied randomly in depth to include the vertical range of the tank. A duplicate sample was taken to demonstrate local homogeneity or lack thereof. Two sample bottles were drawn from each of five locations and four sample bottles were drawn from the sixth location. One bottle each was for inorganic analyses and one bottle each was for organic analyses. Each glass sample bottle was used to collect approximately 100 mL of liquid.

Seven of the samples (including a field blank) were transported to the 222-S Laboratory for analysis. These seven individual samples and a composite were analyzed for inorganic and radiological constituents (see Table B1-4). The remaining seven samples and field blank were shipped to Pacific Northwest National Laboratory (PNNL) where they were analyzed for organic constituents (see Table B1-5).

At the time of collection, all samples were described as clear, colorless liquids with no solids or multiple phases present. A descriptive photograph substantiated this description. No other information was provided regarding the description of the waste in each sample (De Lorenzo et al. 1994b).

Table B1-4. 222-S Laboratory Sample Numbers from the 1993 Historical Sampling Event for Tank 241-AP-106.[1]

Riser, Angle	Depth (from Tank Bottom)	Position	Tank Farm Sample Number	Laboratory Sample Number
1(NE),30°	671 cm (264 in.) 483 cm (190 in.)	1 2	G267 G269	G437 G438
1(SE),150°	953 cm (375 in.) 330 cm (130 in.)	5 6	G256 G258	G423 G427
1(W),270°	765 cm (301 in.) 765 cm (301 in.) 284 cm (112 in.)	3A 3B 4	G262 G264 G260	G432 G433 G428
--	--	--	Composite[2]	G386

Notes:

[1]De Lorenzo (1994b)

[2]Composite sample formed from subsamples from all samples.

Table B1-5. PNNL Sample Numbers from the 1993 Historical Sampling Event for Tank 241-AP-106.[1]

Riser, Angle	Depth (from Tank Bottom)	Position	Tank Farm Sample Number	PNNL Laboratory Sample Number
1(NE),30°	671 cm (264 in.) 483 cm (190 in.)	1 2	G266 G268	93-05398 93-05401
1(SE),150°	953 cm (375 in.) 330 cm (130 in.)	5 6	G257 G259	93-05395 93-05396
1(W),270°	765 cm (301 in.) 765 cm (301 in.) 284 cm (112 in.)	3A 3B 4	G263 G265 G261	93-05400 93-05399 93-05397
Field blank	--	--	G272	93-05402

Note:

[1]De Lorenzo (1994b)

B1.4.2 Description of 1994 Historical Sampling Event

Tank 241-AP-106 was characterized as a candidate feed tank for the 242-A Evaporator Campaign 95-1. As a result, the tank was grab sampled in November 1994 in accordance with the tank characterization plan (Valenzuela 1994). This document required visual observations for the presence of an organic layer, as well as analyses for DSC, weight percent water by TGA, pH, ammonia, hydroxide, and several radionuclides and organics. Sampling information is presented in Table B1-6.

The amount of waste collected for the samples depended on the size of the sampling jar, either 100 or 200 mL. All samples were described as clear, yellow, and essentially homogeneous, with no solids or organic layers present. These samples did not require heating or dilution to maintain solubility. However, the sample dose rates differed more than tenfold between the highest and lowest value, indicating that the samples were not homogeneous. The dose rates ranged from 105 mR to 7,800 mR. The highest dose rate observed was from the sample nearest the tank bottom (Miller 1995).

Table B1-6. Tank 241-AP-106 Sample Analysis Summary for the 1994 Historical Sampling Event.[1]

Customer Sample Number	Date Sampled	Date Sample Received at Lab	Sample Location[2]	Sample Depth[3]
106-AP-1a	11/14/94[4]	11/15/94[4]	Riser 1 (30°)	871 cm (343 in.)
106-AP-1b	11/14/94	11/15/94	Riser 1 (30°)	871 cm (343 in.)
106-AP-1c	11/14/94	11/15/94	Riser 1 (30°)	871 cm (343 in.)
106-AP-1d	11/14/94	11/17/94	Riser 1 (30°)	871 cm (343 in.)
106-AP-2a	11/15/94	11/17/94	Riser 1 (30°)	1,389 cm (547 in.)
106-AP-2b	11/15/94	11/17/94	Riser 1 (30°)	1,389 cm (547 in.)
106-AP-2c	11/15/94	11/17/94	Riser 1 (30°)	1,389 cm (547 in.)
106-AP-2d	11/15/94	11/16/94	Riser 1 (30°)	1,389 cm (547 in.)
106-AP-3a	11/17/94	11/18/94	Riser 1 (150°)	1,499 cm (590 in.)
106-AP-3b	11/17/94	11/18/94	Riser 1 (150°)	1,499 cm (590 in.)
106-AP-3c	11/17/94	11/18/94	Riser 1 (150°)	1,499 cm (590 in.)
106-AP-3d	11/17/94	11/18/94	Riser 1 (150°)	1,499 cm (590 in.)
106-AP-4	11/17/94	11/18/94	Riser 1 (150°)	605 cm (238 in.)

Notes:

[1]Miller (1995)

[2]Sampled riser location angular coordinate clockwise from North.

[3]Sample depth is the distance from the top of the bottle to the top of the riser flange.

[4]Dates are in mm/dd/yy format.

B2.0 ANALYTICAL RESULTS

B2.1 OVERVIEW

This section summarizes the sampling and analytical results associated with the September 1996 sampling and analysis of tank 241-AP-106. The locations of the analytical results for the inorganic, carbon, radionuclide, physical, thermodynamic, and vapor phase measurements, as well as the historical results associated with this tank, are presented in Table B2-1. These results are documented in the final report (Esch 1996).

In each data table, the "Mean" column is the average of the result and duplicate values. All values, including those below the detection level (denoted by the less-than symbol, "<"), were averaged. If both sample and duplicate values were non-detected, the mean is expressed as a non-detected value. If one value was detected while the other was not, the mean is also expressed as a non-detected value. If both values were detected, the mean is expressed as a detected value. The "Sample Elevation" column refers to the distance from the bottom of the tank to the mouth of the sample bottle.

Table B2-1. Analytical Presentation Tables.

Analysis	Table Number
Non-detected ICP results	B2-2
Detected ICP results	B2-3 through B2-18
Anions by IC	B2-19 through B2-26
Hydroxide	B2-27
Total inorganic carbon	B2-28
Total organic carbon	B2-29
^{241}Am	B2-30
$^{239/240}$Pu	B2-31
$^{89/90}$Sr	B2-32
^{137}Cs and ^{60}Co	B2-33 and B2-34
pH	B2-35
Specific gravity	B2-36
Thermogravimetric analysis	B2-37
Headspace measurements	B2-38
1993 historical sampling data	B2-39
1994 historical sampling data	B2-40

The four quality control (QC) parameters assessed in conjunction with the tank 241-AP-106 samples were standard recoveries, spike recoveries, duplicate analyses, and blanks. The QC criteria specified in the SAP were taken from the *Hanford Analytical Services Quality Assurance Plan* (DOE 1995). Sample and duplicate pairs in which any of the QC parameters were outside of these criteria are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, e, or f as follows:

- "a" indicates that the standard recovery was below the QC limit.
- "b" indicates that the standard recovery was above the QC limit.
- "c" indicates that the spike recovery was below the QC limit.
- "d" indicates that the spike recovery was above the QC limit.
- "e" indicates that the relative percent difference (RPD) was above the QC limit.
- "f" indicates blank contamination.

B2.2 INORGANIC ANALYSES

B2.2.1 Inductively Coupled Plasma

Analyses by ICP for the waste metallic constituents were performed in duplicate directly on the samples per procedure LA-505-161 following an acid dilution; a full suite of analytes were reported. Table B2-2 lists the ICP analytes for which all data results were nondetected along with their single highest nondetected value and the location from which the sample was obtained. The concentrations of ICP metals for which one or more data results were detected are presented in Tables B2-3 through B2-18. Note that all the highest nondetect values came from the sampling location nearest the bottom of the tank; this trend is also noticeable with the detected analytes, suggesting vertical heterogeneity. The material in the bottom sample is very different from the other samples, and the tank appears to be stratified.

Table B2-2. Tank 241-AP-106 Nondetected ICP Analytes.

Analyte	Highest Non-Detected Value (µg/mL)
Antimony	< 18.1
Arsenic	< 30.1
Barium	< 15.1
Beryllium	< 1.51
Bismuth	< 30.1
Calcium	< 30.1
Cerium	< 30.1
Cobalt	< 6.02
Iron	< 15.1
Lanthanum	< 15.1
Lead	< 30.1
Magnesium	< 30.1
Manganese	< 3.01
Neodymium	< 30.1
Samarium	< 30.1
Selenium	< 30.1
Strontium	< 3.01
Thallium	< 60.2
Titanium	< 3.01
Total uranium	< 150
Vanadium	< 15.1

Table B2-3. Tank 241-AP-106 Analytical Results: Aluminum.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	351	354	352.5
S96T005183		102 (40 in.)	952	947	949.5
S96T005182		25 (10 in.)	8,780	9,000	8,890

Table B2-4. Tank 241-AP-106 Analytical Results: Boron.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	1.47	1.49	1.48
S96T005183		102 (40 in.)	2.18	2.24	2.21
S96T005182		25 (10 in.)	< 15.1	< 15.1	< 15.1

Table B2-5. Tank 241-AP-106 Analytical Results: Cadmium.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	< 0.105	< 0.105	< 0.105
S96T005183		102 (40 in.)	< 0.205	< 0.205	< 0.205
S96T005182		25 (10 in.)	2.06	2.16	2.11

Table B2-6. Tank 241-AP-106 Analytical Results: Chromium.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	12.9	12.9	12.9
S96T005183		102 (40 in.)	24.3	24.3	24.3
S96T005182		25 (10 in.)	159	163	161

Table B2-7. Tank 241-AP-106 Analytical Results: Copper.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	0.245	0.221	0.233
S96T005183		102 (40 in.)	< 0.41	< 0.41	< 0.41
S96T005182		25 (10 in.)	< 3.01	< 3.01	< 3.01

Table B2-8. Tank 241-AP-106 Analytical Results: Lithium.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	0.326	0.313	0.3195
S96T005183		102 (40 in.)	< 0.41	< 0.41	< 0.41
S96T005182		25 (10 in.)	< 3.01	< 3.01	< 3.01

Table B2-9. Tank 241-AP-106 Analytical Results: Molybdenum.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	1.86	1.79	1.825
S96T005183		102 (40 in.)	2.08	2.13	2.105
S96T005182		25 (10 in.)	17.1	17.7	17.4

Table B2-10. Tank 241-AP-106 Analytical Results: Nickel.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	< 0.42	< 0.42	< 0.42
S96T005183		102 (40 in.)	< 0.82	< 0.82	< 0.82
S96T005182		25 (10 in.)	6.69	7.25	6.97

Table B2-11. Tank 241-AP-106 Analytical Results: Phosphorus.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	238	240	239[QC:d]
S96T005183		102 (40 in.)	326	323	324.5
S96T005182		25 (10 in.)	455	468	461.5

Table B2-12. Tank 241-AP-106 Analytical Results: Potassium.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	1,190	1,190	1,190[QC:e]
S96T005183		102 (40 in.)	3,470	3,450	3,460
S96T005182		25 (10 in.)	22,300	22,800	22,550

Table B2-13. Tank 241-AP-106 Analytical Results: Silicon.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	15	15	15
S96T005183		102 (40 in.)	18.9	19	18.95
S96T005182		25 (10 in.)	40.2	42.3	41.25

Table B2-14. Tank 241-AP-106 Analytical Results: Silver.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	0.612	0.6	0.606
S96T005183		102 (40 in.)	1.22	1.18	1.2
S96T005182		25 (10 in.)	7.8	8.34	8.07

Table B2-15. Tank 241-AP-106 Analytical Results: Sodium.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	8,420	8,490	8,455
S96T005183		102 (40 in.)	17,300	17,100	17,200
S96T005182		25 (10 in.)	1.100E+05	1.130E+05	1.115E+05

Table B2-16. Tank 241-AP-106 Analytical Results: Sulfur.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	88.4	88.6	88.5
S96T005183		102 (40 in.)	183	181	182
S96T005182		25 (10 in.)	1,150	1,190	1,170

Table B2-17. Tank 241-AP-106 Analytical Results: Zinc.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	0.541	0.538	0.5395
S96T005183		102 (40 in.)	0.6	0.592	0.596
S96T005182		25 (10 in.)	4.86	4.87	4.865

Table B2-18. Tank 241-AP-106 Analytical Results: Zirconium.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	< 0.21	< 0.21	< 0.21
S96T005183		102 (40 in.)	< 0.41	< 0.41	< 0.41
S96T005182		25 (10 in.)	< 3.01	3.17	< 3.09

B2.2.2 Ion Chromatography

The analyses by ion chromatography (IC) were performed in duplicate directly on the grab samples per procedure LA-533-105. The concentrations of anions by IC are shown in Tables B2-19 through B2-26.

Table B2-19. Tank 241-AP-106 Analytical Results: Bromide.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	< 25.12	< 25.1	< 25.1
S96T005183		102 (40 in.)	< 518	< 518	< 518
S96T005182		25 (10 in.)	< 518	< 518	< 518

Table B2-20. Tank 241-AP-106 Analytical Results: Chloride.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	173	180.0	176.6
S96T005183		102 (40 in.)	638	615.0	626.4
S96T005182		25 (10 in.)	1,620	1,610	1,610

Table B2-21. Tank 241-AP-106 Analytical Results: Fluoride.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	129	128.0	128.3
S96T005183		102 (40 in.)	656	606.0	631.2
S96T005182		25 (10 in.)	2,470	2,430	2,450

Table B2-22. Tank 241-AP-106 Analytical Results: Nitrate.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	5,950	5,920	5,940
S96T005183		102 (40 in.)	27,700	28,500	28,100
S96T005182		25 (10 in.)	1.29E+05	1.29E+05	1.29E+05

Table B2-23. Tank 241-AP-106 Analytical Results: Nitrite.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	1,860	1,890	1,870
S96T005183		102 (40 in.)	7,730	7,580	7,660
S96T005182		25 (10 in.)	30,600	31,000	30,800

Table B2-24. Tank 241-AP-106 Analytical Results: Oxalate.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	59.62	64.70	62.16
S96T005183		102 (40 in.)	< 435	< 435	< 435
S96T005182		25 (10 in.)	1,010	976	991

Table B2-25. Tank 241-AP-106 Analytical Results: Phosphate.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	670	675.0	672.5
S96T005183		102 (40 in.)	1,870	1,650	1,760
S96T005182		25 (10 in.)	821	699	760

Table B2-26. Tank 241-AP-106 Analytical Results: Sulfate.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µg/mL	µg/mL	µg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	279	291.0	285.1
S96T005183		102 (40 in.)	1,290	1,310	1,300
S96T005182		25 (10 in.)	3,600	3,640	3,620

B2.2.3 Potentiometric Titration

The titration analyses for hydroxide were performed in duplicate directly on the grab samples per procedure LA-211-102. The results are shown in Table B2-27.

Table B2-27. Tank 241-AP-106 Analytical Results: Hydroxide.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg/mL	μg/mL	μg/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	2,560	2,830	2,700
S96T005183		102 (40 in.)	6,070	6,410	6,240
S96T005182		25 (10 in.)	27,800	27,900	27,800

B2.3 CARBON ANALYSES

B2.3.1 Total Inorganic Carbon

The analyses for total inorganic carbon (TIC) were performed in duplicate by coulometry following an acid preparation per procedure LA-342-100. The results are presented in Table B2-28.

Table B2-28. Tank 241-AP-106 Analytical Results: Total Inorganic Carbon.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg C/mL	μg C/mL	μg C/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	561	560	560.5
S96T005183		102 (40 in.)	804	772	788
S96T005182		25 (10 in.)	4,060	4,090	4,075

B2.3.2 Total Organic Carbon

The analyses for TOC were performed in duplicate by furnace oxidation directly on the grab samples per procedure LA-344-105. The results are presented in Table B2-29.

Table B2-29. Tank 241-AP-106 Analytical Results: Total Organic Carbon.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μg C/mL	μg C/mL	μg C/mL
S96T005181	Riser 1 @ 150°	178 (70 in.)	734	685.0	709.5
S96T005183		102 (40 in.)	914	834	874
S96T005182		25 (10 in.)	3,400	3,100	3,250

B2.4 RADIONUCLIDE ANALYSES

B2.4.1 Alpha Proportional Counting

The analyses for ^{241}Am and $^{239/240}$Pu were performed in duplicate directly on the grab samples per procedures LA-953-103 and LA-943-128, respectively. The results are presented in Tables B2-30 and B2-31.

Table B2-30. Tank 241-AP-106 Analytical Results: Americium-241.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	μCi/mL	μCi/mL	μCi/mL
S96T005184	Riser 1 @ 150°	178 (70 in.)	< 6.15E-06	< 7.06E-06	< 6.61E-06
S96T005186		102 (40 in.)	< 6.72E-06	< 9.37E-06	< 8.05E-06
S96T005185		25 (10 in.)	8.760E-04	9.000E-04	8.880E-04

Table B2-31. Tank 241-AP-106 Analytical Results: Plutonium-239/40.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µCi/mL	µCi/mL	µCi/mL
S96T005184	Riser 1 @ 150°	178 (70 in.)	< 5.890E-06	< 5.390E-06	< 5.640E-06
S96T005186		102 (40 in.)	1.840E-05	2.000E-05	1.920E-05
S96T005185		25 (10 in.)	1.170E-04	1.170E-04	1.170E-04

B2.4.2 Beta Proportional Counting

The analyses for ^{90}Sr were performed in duplicate directly on the grab samples per procedure LA-220-101. The results are presented in Table B2-32.

Table B2-32. Tank 241-AP-106 Analytical Results: Strontium-89/90.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µCi/mL	µCi/mL	µCi/mL
S96T005184	Riser 1 @ 150°	178 (70 in.)	0.0277	0.0276	0.02765
S96T005186		102 (40 in.)	0.00451	0.00462	0.004565
S96T005185		25 (10 in.)	0.496	0.528	0.512

B2.4.3 Gamma Energy Analysis

The gamma energy analyses (GEA) for ^{137}Cs and ^{60}Co were performed in duplicate directly on the grab samples. Procedure LA-548-121 was used for both analyses, and the results are presented in Tables B2-33 and B2-34.

Table B2-33. Tank 241-AP-106 Analytical Results: Cesium-137.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µCi/mL	µCi/mL	µCi/mL
S96T005184	Riser 1 @ 150°	178 (70 in.)	10.20	9.360	9.780
S96T005186		102 (40 in.)	25.00	24.30	24.65
S96T005185		25 (10 in.)	139	139	139

Table B2-34. Tank 241-AP-106 Analytical Results: Cobalt-60.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	µCi/mL	µCi/mL	µCi/mL
S96T005184	Riser 1 @ 150°	178 (70 in.)	< 3.71E-04	< 3.87E-04	< 3.79E-04
S96T005186		102 (40 in.)	< 7.58E-04	< 7.59E-04	< 7.59E-04
S96T005185		25 (10 in.)	< 0.0306	< 0.0260	< 0.0283

B2.5 PHYSICAL ANALYSES

B2.5.1 pH

The pH of the waste material was analyzed directly in duplicate using procedure LA-212-106, and the results ranged from 13.21 to 13.72. Results for pH that are greater than 12.5 are suspect and should be considered estimates. This is because the highest calibration buffer available is 12.5 and pH electrode performance degrades at high pH (Esch 1996). The results are presented in Table B2-35.

Table B2-35. Tank 241-AP-106 Analytical Results: pH.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	unitless	unitless	unitless
S96T005181	Riser 1	178 (70 in.)	13.21	13.27	13.24
S96T005183		102 (40 in.)	13.59	13.56	13.57
S96T005182		25 (10 in.)	13.70	13.72	13.71

B2.5.2 Specific Gravity

Specific gravity was measured directly on duplicate samples following procedure LA-510-112, and the results are presented in Table B2-36.

Table B2-36. Tank 241-AP-106 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	unitless	unitless	unitless
S96T005181	Riser 1 @ 150°	178 (70 in.)	0.987	0.994	0.990
S96T005183		102 (40 in.)	1.009	1.016	1.012
S96T005182		25 (10 in.)	1.205	1.207	1.206

B2.6 THERMODYNAMIC ANALYSES

As required by the waste compatibility DQO, TGA and DSC were performed in duplicate directly on the samples.

B2.6.1 Thermogravimetric Analysis

Thermogravimetric analysis measures the mass of a sample while its temperature is increased at a constant rate. Nitrogen is passed over the sample during heating to remove any released gases. Any decrease in the weight of a sample during TGA represents a loss of gaseous matter from the sample, either through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 to 200 °C) is due to water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well.

Tank 241-AP-106 samples were analyzed by TGA using either procedure LA-514-114 on a Perkin-Elmer TGA 7[1] instrument, or procedure LA-560-112 on a Mettler TG 50[2] instrument. Grab sample 6AP-96-3 measured considerably less weight percent water than the other two samples, consistent with its higher specific gravity. The TGA results are presented in Table B2-37.

Table B2-37. Tank 241-AP-106 Analytical Results: Percent Water.

Sample Number	Sample Location	Sample Elevation	Result	Duplicate	Mean
Liquids		cm	%	%	%
S96T005181	Riser 1 @ 150°	178 (70 in.)	96.05	95.24	95.64
S96T005183		102 (40 in.)	94.31	94.33	94.32
S96T005182		25 (10 in.)	70.14	69.67	69.91

B2.6.2 Differential Scanning Calorimetry

In a DSC analysis, heat absorbed or emitted by a substance is measured while the temperature of the sample is increased at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically.

The DSC analyses for tank 241-AP-106 were performed using either procedure LA-514-113 on a Mettler DSC 20™ instrument or procedure LA-514-114 on a Perkin-Elmer DSC 7™ instrument. No exothermic reactions were noted, which is consistent with the historical results presented in Section B2.8.2.

[1]Trademark of Perkins Research and Manufacturing Company, Inc., Canoga Park, California.

[2]Trademark of Mettler Electronics, Anaheim, California.

B2.7 VAPOR PHASE MEASUREMENT

On September 9, 1996, just prior to the September 12, 1996 grab sampling event of tank 241-AP-106, vapor phase measurements were conducted per procedure WHC-IP-0030 (WHC 1992), IH 1.4 and IH 2.1. These measurements supported the safety screening DQO (Dukelow et al. 1995), and were taken to resolve flammable gas issues. The vapor phase measurements were taken at three different locations from each of two different risers. The results of these measurements are provided in Table B2-38. All the flammability measurements indicated that the gases in the tank headspace were 0 percent of the LFL.

B2.8 HISTORICAL SAMPLE RESULTS

B2.8.1 Results of the 1993 Historical Sampling Event

Seven samples were delivered to the 222-S Laboratory on March 19, 1993 and tested for inorganic and radiochemical analyses. The seven samples consisted of two samples from each riser and one duplicate. From each of the seven samples, duplicates were produced for a total of fourteen samples analyzed. A composite sample and its duplicate were analyzed for chemical and radionuclide composition. The weight percent water and specific gravity analyses were performed on the individual samples and the composite sample in duplicate. Because of the high water content of the tank waste, DSC analyses were not conducted.

The chemical, radiochemical, physical, and organic results (not including volatile and semivolatile results) associated with tank 241-AP-106 are presented in Table B2-39. For further details, see De Lorenzo et al. (1994b).

Table B2-38. Results of Vapor Phase Measurements of Tank 241-AP-106.

Measurement	Breather/Vent	Sample Riser	Headspace (measured 91 cm [3 ft] inside tank)
Riser 1 at 30°, rep. 1			
LFL	0 percent	0 percent	0 percent
Ammonia	0 ppm	0 ppm	6 ppm
TOC	0 ppm	0 ppm	1 ppm
Oxygen	21.0 percent	20.9 percent	20.9 percent
Riser 1 at 30°, rep. 2			
LFL	---	---	0 percent
Ammonia	---	---	0 ppm
TOC	---	---	2 ppm
Oxygen	---	---	21.0 percent
Riser 1 at 150°, rep. 1			
LFL	0 percent	0 percent	0 percent
Ammonia	0 ppm	0 ppm	5 ppm
TOC	0 ppm	0 ppm	1 ppm
Oxygen	20.9 percent	20.9 percent	20.9 percent
Riser 1 at 150°, rep. 2			
LFL	0 percent	0 percent	0 percent
Ammonia	5 ppm	5 ppm	5 ppm
TOC	1 ppm	1 ppm	1 ppm
Oxygen	21 percent	21 percent	21 percent

Table B2-39. Results from the 1993 Historical Sampling Event for Tank 241-AP-106.[1] (2 sheets)

Analyte	Tank Characterization Report Result
Metals	**(μg/L)**
Aluminum (Al)	2.11E+05
Antimony (Sb)	< 5,250
Arsenic (As)	< 250
Barium (Ba)	161
Beryllium (Be)	< 3,830
Cadmium (Cd)	5,920
Chromium (Cr)	4,740
Iron (Fe)	6,890
Lead (Pb)	< 1,550
Mercury (Hg)	< 2.50
Nickel (Ni)	408
Phosphorus (P)	85,200
Potassium (K)	8.18E+05
Selenium (Se)	< 250
Silver (Ag)	< 6,380
Sodium (Na)	5.53E+06
Uranium (U)	3,710
Ions	**(μg/L)**
Ammonia (NH_3)	< 1.60E+05
Carbonate (CO_3^{2-})	2.58E+06
Chloride (Cl^-)	56,300
Cyanide (CN^-)	503
Fluoride (F^-)	1.73E+05
Hydroxide (OH^-)	1.43E+06
Nitrate (NO_3^-)	4.23E+06
Nitrite (NO_2^-)	1.16E+06
Phosphate (PO_4^{-3})	2.11E+05
Sulfate (SO_4^{-2})	1.40E+05
Radionuclides	**(μCi/L)**
^{241}Am	9.54E-05
^{125}Sb	< 18.8

Table B2-39. Results from the 1993 Historical Sampling Event for Tank 241-AP-106.[1] (2 sheets)

Analyte	Tank Characterization Report Result
Radionuclides (Cont'd)	**(μCi/L)**
^{14}C	0.00774
$^{144}Ce/Pr$	< 46.1
^{134}Cs	12.6
^{137}Cs	4,570
^{60}Co	< 1.92
$^{243/244}Cm$	< 6.37E-04
^{129}I	< 0.0907
^{237}Np	0.418
^{94}Nb	< 1.10
^{238}Pu	< 0.232
$^{239/240}Pu$	< 0.136
$^{106}Ru/Rh$	< 63.6
^{90}Sr	0.689
^{99}Tc	1.34
^{3}H	4.90
Physical Properties	
Percent water	100.2%
Specific gravity	0.996
pH	12.9
Viscosity	1 centipoise
Total inorganic carbon	4.86E+05 (μg C/L)
Total organic carbon	4.97E+05 (μg C/L)
Organic Complexants	**(μg/L)**
EDTA	< 20,000
HEDTA	< 20,000
Citrate	< 44,000
Glycolate	64,300
Oxalate	75,700

Note:

[1]De Lorenzo et al. (1994b)

The other seven samples and a field blank were delivered to the PNNL Analytical Chemistry Laboratory between March 19 and March 31, 1993 for volatile organic, semivolatile organic, and bulk organics analyses. None of the target analytes were detected above 500 ppb. Because of these analytes' volatile nature and relatively small contribution to the waste as indicated by the historical records, these results were not unexpected. For further detail, see De Lorenzo et al. (1994b).

B2.8.2 Results of the 1994 Historical Sampling Event

The analytical results from the November 1994 sampling event are given in Table B2-40. All analyses were performed on the direct samples with the following exceptions, which were analyzed following an acid digestion: total alpha and total beta activity, ^{241}Am, $^{243/244}$Cm, ^{154}Eu, ^{155}Eu, ^{226}Ra, and ^{79}Se. When the analytical results were compared to the notification limits listed in Valenzuela (1994), only TOC exceeded the limit. Three out of the four samples contained TOC results above the 87 μg/mL notification limit.

For informational purposes, the results from the 1994 grab sampling were also compared to the current safety screening DQO (Dukelow et al. 1995). The results of this evaluation indicated that none of the primary analytes exceeded the limits: No exotherms were noted during the DSC analyses; there was no organic layer present in any of the samples; and the total alpha activity ranged from < 5.23E-04 μCi/mL to < 0.00528 μCi/mL, orders of magnitude below the 61.5 μCi/mL DQO threshold.

Further details regarding the results from the 1994 sampling event can be found in Miller (1995).

Table B2-40. Results from November 1994 Grab Sampling.[1] (2 sheets)

Analyte	Result	Unit
Differential scanning calorimetry	No exotherms found	---
Water content	91.56	Weight percent
pH	12.8	---
Ammonia	17.7	μg/mL
Hydroxide	6,620	μg/mL
Total carbon	1,170	μg C/mL
Total inorganic carbon	898	μg C/mL
Total organic carbon	293	μg C/mL
Gross uranium	0.444	μg/mL
Total alpha	< 0.00528[2]	μCi/mL
Total beta	40.4	μCi/mL
^{154}Eu	< 0.0148[2]	μCi/mL
^{155}Eu	< 0.0676[2]	μCi/mL
^{226}Ra	< 0.617[2]	μCi/mL
Tritium	0.0101	μCi/mL
^{79}Se	8.62E-06[3]	μCi/mL
^{129}I	1.02E-04[3]	μCi/mL
^{237}Np	3.03E-05[3]	μCi/mL
^{241}Am	< 2.79E-04[2]	μCi/mL
$^{243/244}$Cm	< 2.79E-04[2]	μCi/mL
Acetone (VOA)	3,860[4]	μg/L
1-Butanol (VOA)	1,500[5]	μg/L
2-Butanone (VOA)	49.0[5]	μg/L
2-Hexanone (VOA)	< 500[6]	μg/L
4-Methyl-2-Pentanone (VOA)	< 500[6]	μg/L
2-Pentanone (VOA)	< 500	μg/L

Table B2-40. Results from November 1994 Grab Sampling.[1] (2 sheets)

Analyte	Result	Unit
Tetrahydrofuran (VOA)	680[7]	µg/L
2-Butoxyethanol (SVOA)	173	µg/L
n-Tributylphosphate (SVOA)	507[8]	µg/L

Notes:

VOA = Volatile organic analysis
SVOA = Semivolatile organic analysis

[1]Miller (1995)

[2]For analytes with all non-detect values, the highest non-detect number is listed.

[3]Only one out of the three sample results was detected; the lone detected value is presented.

[4]The lone non-detected result was excluded from the mean calculation.

[5]Based on the lone estimated value; all other values were non-detected.

[6]Value listed is the quantitation limit.

[7]Based on the lone detected result; all other values were non-detected.

[8]Average of detected and estimated results.

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The purpose of this chapter is to assess the overall quality and consistency of the current sampling results for tank 241-AP-106, and to present the results of the calculation of an analytical-based inventory.

The sampling and analysis factors that may impact interpretation of the data were evaluated and are reported in this section. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data.

B3.1 FIELD OBSERVATIONS

Waste recovery from the three grab samples obtained in September 1996 was 100 percent in all cases. The SAP (Sasaki 1996) specified that the sampling take place through riser 1 at 30°, whereas the actual sampling occurred through riser 1 at 150°. Sampler recovery difficulty was the basis for this change. Changes were made to the chain of custody forms after the samples were received and subsampled at the 222-S Laboratory. The sample dose rates and numbers on the original sample bottles did not match the information provided on the chain of custody forms for samples 6AP-96-2 and 6AP-96-3. After reviewing the dose rate and appearance information from the laboratory and the field work package, the chain of custody forms were changed by a tank farm representative. No other anomalies were noted.

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All pertinent QC tests were conducted on the 1996 grab samples, allowing a full assessment regarding the accuracy and precision of the data. Specific criteria for all analytes were given in DOE (1995). Sample and duplicate pairs that had one or more QC results outside the specified criteria were identified by footnotes in the data summary tables (see Section B.2).

The standard and spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low. The precision is estimated by the RPD, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred. Only two analytes had results outside any of the QC parameter limits. Potassium had one spike recovery slightly below the limit, and phosphorus had one spike recovery slightly above the limit. All analytes met the criteria for standard recoveries, precision, and blanks. Thus, the QC results were excellent, and the two minor discrepancies mentioned here and footnoted in the data summary tables should not impact either the validity or the use of the data.

B3.3 DATA CONSISTENCY CHECKS

Comparisons of different analytical methods can help to assess the consistency and quality of the data. Two comparisons were possible with the data set provided by the three grab samples: the comparisons of phosphorus and sulfur as analyzed by ICP with phosphate and sulfate as analyzed by IC, respectively. In addition, mass and charge balances were calculated to help assess the overall data consistency.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two different analytical methods. A close comparison between the two methods strengthens the credibility of both results, whereas a poor comparison brings the reliability of the data into question. All analytical mean results were taken from Table B3.4.1.

The analytical phosphorus mean result as determined by ICP was 342 μg/mL, equivalent to 1,050 μg/mL of phosphate. This is nearly identical with the IC phosphate mean result of 1,060 μg/mL. The ratio between these two phosphate results was 0.99.

The analytical sulfur mean result as determined by ICP was 480 μg/mL, equivalent to 1,440 μg/mL of sulfate. The IC sulfate mean result was 1,740 μg/mL. The ratio of sulfate by ICP to sulfate by IC was 0.83.

B3.3.2 Mass and Charge Balances

The principal objective of performing mass and charge balances is to determine if the measurements are self-consistent. In calculating the balances, only those analytes listed in Table B3-4 detected at a concentration of 1,000 μg/mL or greater were considered. All analytical results presented in this section were first converted from μg/mL to μg/g (using the specific gravity mean of 1.07 g/mL) before they were used in the tables.

A trace amount of settled solids was noticed in two of the grab samples, but no attempt was made to centrifuge and analyze them separately. Because the tank was predicted to contain only supernatant, all samples were analyzed as liquids. Thus, all of the cations listed in Table B3-1 and all of the anions listed in Table B3-2 were assumed to be present as ions. The positive charges attributed to sodium and potassium were expected to balance the negative charges exhibited by the anions. Aluminum was expected to be present as the aluminate ion. Phosphorus and sulfur were assumed to be present as phosphate and sulfate. The carbonate and acetate data were derived from the TIC and TOC analyses, respectively. The concentrations of cationic species in Table B3-1, the anionic species in Table B3-2, and the percent water were ultimately used to calculate the mass balance.

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

Mass balance = % water + 0.0001 x {total analyte concentration}

= % water + 0.0001 x $\{K^+ + Na^+ + AlO_2^- + CO_3^{2-} + C_2H_3O_2^- + F^- + OH^- + NO_3^- + NO_2^- + PO_4^{3-} + SO_4^{2-}\}$

The total analyte concentration calculated from the above equation is 148,600 $\mu g/g$. The mean weight percent water (obtained from the gravimetric analyses reported in Table B2-3) is 86.6 percent, or 866,000 $\mu g/g$. The mass balance resulting from adding the percent water to the total analyte concentration is 101 percent (Table B3-3).

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

Total cations (μeq/g) = $[K^+]/39.1 + [Na^+]/23.0 = 2{,}080\ \mu eq/g$

Total anions (μeq/g) = $[AlO_2^-]/59.0 + [CO_3^{2-}]/30.0 + [C_2H_3O_2^-]/59.0 + [F^-]/19.0 + [OH^-]/17.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 + [PO_4^{3-}]/31.7 + [SO_4^{2-}]/48.1 = 2{,}350\ \mu eq/g$

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.89, with a net negative charge of 270 μeq/g.

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

Table B3-1. Cation Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	Charge (μeq/g)
Potassium	8,480	K^+	8,480	217
Sodium	42,700	Na^+	42,700	1,860
Total			51,200	2,080

Table B3-2. Anion Mass and Charge Data.

Analyte	Concentration ($\mu g/g$)	Assumed Species	Concentration of Assumed Species ($\mu g/g$)	Charge ($\mu eq/g$)
Aluminum	3,180	AlO_2^-	6,950	118
TIC	1,690	CO_3^{2-}	8,450	282
TOC	1,500	$C_2H_3O_2^-$	3,690	63
Fluoride	1,000	F^-	1,000	53
Hydroxide	11,500	OH^-	11,500	676
Nitrate	50,700	NO_3^-	50,700	818
Nitrite	12,500	NO_2^-	12,500	272
Phosphate	991	PO_4^{3-}	991	31
Sulfate	1,630	SO_4^{2-}	1,630	34
Total			97,400	2,350

Table B3-3. Mass Balance Totals.

Totals	Concentrations ($\mu g/g$)	Charge $\mu eq/g$.
Cation total from Table B3-1	51,200	2,080
Anion total from Table B3-2	97,400	2,350
Weight percent water	866,000	0
Grand total	1,010,000	(270) Net

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The following statistical evaluation was performed using analytical data generated from the tank 241-AP-106 grab samples (Esch 1996). The grab samples were obtained in September 1996 from riser number one at 150° at three different depths. If it is assumed that riser-to-riser variability is not significant, then inferences about the tank can be made based on the statistics from these three grab samples.

A mean concentration and the associated variability were calculated for each analyte. A two-sided 95 percent confidence interval for the mean concentration was also calculated for each analyte. The confidence interval takes into account the spatial (sample to sample differences) and the analytical uncertainties. The upper and lower limits of a two-sided 95 percent confidence interval for the mean are

$$\hat{\mu} \pm t_{(df,0.025)} \times \hat{\sigma}_{\hat{\mu}}.$$

In these equations, $\hat{\mu}$ is the estimate of the mean concentration, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean concentration, and $t_{(df,0.025)}$ is the quantile from Student's t distribution with *df* degrees of freedom for a two-sided 95 percent confidence interval.

The mean, $\hat{\mu}$, and the standard deviation of the mean, $\hat{\sigma}_{\hat{\mu}}$, were estimated using restricted maximum likelihood estimation (REML) methods. For tank 241-AP-106, the degrees of freedom (*df*) is the number of grab samples minus one.

B3.4.1 Mean Concentrations

The statistics in this section were based on analytical data from the 1996 sampling event of tank 241-AP-106. The data were statistically evaluated using one-way analysis of variance (ANOVA); i.e., the data are identified by one variable (the grab sample). Analysis of variance techniques were used to estimate the mean and its associated variability for all analytes that had at least 50 percent of the reported data as quantitative values.

No ANOVA estimates were computed for analytes that had less than 50 percent of the reported data as quantitative values. For those analytes that had a mixture of both quantitative values and "less than" values, the ANOVA was computed using two different methodologies.

> The upper value of the "less than" (e.g., 3.5 for < 3.5) was used to represent all "less than" analytical values in the first computation. This produces a bias of unknown magnitude in both the mean analyte concentration and the variance associated with the mean; the mean analyte concentration is biased high. The extension ".w" was added to the analyte name in the tables to distinguish which analyte was statistically analyzed using "less than" values.
>
> The "less than" values were deleted in the second computation. Deleting data produces unbalanced data sets, which complicates the statistical analysis. Deleting data decreases the number of degrees of freedom. Deleting data also produces a bias of unknown magnitude in both the mean analyte concentration and the variance associated with the mean. The extension ".wo" was added to the analyte name in the tables to distinguish which analyte was statistically analyzed with the "less than" values deleted.

The mean concentration estimates, along with the two-sided 95 percent confidence interval for the mean concentration, are given in Table B3-4 for those analytes with at least 50 percent of the reported data as quantitative values. For some of the analytes, the lower limit of the 95 percent confidence interval was a negative value. Because the actual concentration of an analyte cannot be less than zero, the lower limit is reported as zero in these cases. The analytes that had less than 50 percent of the reported data as quantitative values are listed in Table B3-5. Table B3-5 cites the largest value observed from the six analytical results.

Table B3-4. Summary Statistics - Mean Concentrations. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	*df*	Lower Limit	Upper Limit
Ag.icp.a	µg/mL	3.29	2.40	2	0.00	13.6
Al.icp.a	µg/mL	3,400	2,750	2	0.00	15,200
B.icp.a.w	µg/mL	6.26	4.42	2	0.00	25.3
B.icp.a.wo	µg/mL	1.85	0.365	1	0.00	6.48
Cl^-.ic	µg/mL	806	425	2	0.00	2,630
Cr.icp.a	µg/mL	66.1	47.6	2	0.00	271
^{137}Cs.gea	µCi/mL	57.8	40.8	2	0.00	233
DSC.dry wt	J/g dry	0.00	0.00	2	0.00	0.00
F^-.ic	µg/mL	1,070	705	2	0.00	4,100
%Water.tga	wt%	86.6	8.37	2	50.6	123
K.icp.a	µg/mL	9,070	6,770	2	0.00	38,200
Mo.icp.a	µg/mL	7.11	5.15	2	0.00	29.2
NO_2^-.ic	µg/mL	13,400	8,840	2	0.00	51,500
NO_3^-.ic	µg/mL	54,300	37,900	2	0.00	2.17E+05
Na.icp.a	µg/mL	45,700	33,000	2	0.00	1.88E+05
OH^-	µg/mL	12,300	7,860	2	0.00	46,100
Oxalate.ic.w	µg/mL	497	270	2	0.00	1,660
Oxalate.ic.wo	µg/mL	528	465	1	0.00	6,440
P.icp.a	µg/mL	342	64.8	2	62.8	620

Table B3-4. Summary Statistics - Mean Concentrations. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	Lower Limit	Upper Limit
PO_4^{3-}.ic	µg/mL	1,060	349	2	0.00	2,570
$^{239/240}$Pu.w	µCi/mL	4.73E-05	3.51E-05	2	0.00	1.98E-04
$^{239/240}$Pu.wo	µCi/mL	6.81E-05	4.89E-05	1	0.00	6.89E-04
S.icp.a	µg/mL	480	346	2	0.00	1,970
SO_4^{2-}.ic	µg/mL	1,740	987	2	0.00	5,980
Si.icp.a	µg/mL	25.1	8.17	2	0.00	60.2
Specific gravity	g/mL	1.07	0.0685	2	0.775	1.36
^{90}Sr	µCi/mL	0.169	0.153	2	0.00	0.825
TIC	µg/mL	1,810	1,140	2	0.00	6,690
TOC	µg/mL	1,610	821	2	0.00	5,140
Zn.icp.a	µg/mL	2.00	1.43	2	0.00	8.16
pH	pH units	13.5	0.140	2	12.9	14.1

Table B3-5. Analytes with > 50 Percent "Less Than" Values. (2 sheets)

Analyte	Unit	Result
^{241}Am.aea	µCi/mL	9.00E-04
As.icp.a	µg/mL	< 30.1
Ba.icp.a	µg/mL	< 15.1
Be.icp.a	µg/mL	< 1.51
Bi.icp.a	µg/mL	< 30.1
Br^-.ic	µg/mL	< 518
Ca.icp.a	µg/mL	< 30.1
Cd.icp.a	µg/mL	2.16
Ce.icp.a	µg/mL	< 30.1
Co.icp.a	µg/mL	< 6.02

Table B3-5. Analytes with > 50 Percent "Less Than" Values. (2 sheets)

Analyte	Unit	Result
^{60}Co.gea	µCi/mL	< 0.0306
Cu.icp.a	µg/mL	< 3.01
Fe.icp.a	µg/mL	< 15.1
La.icp.a	µg/mL	< 15.1
Li.icp.a	µg/mL	< 3.01
Mg.icp.a	µg/mL	< 30.1
Mn.icp.a	µg/mL	< 3.01
Nd.icp.a	µg/mL	< 30.1
Ni.icp.a	µg/mL	7.25
Pb.icp.a	µg/mL	< 30.1
Sb.icp.a	µg/mL	< 18.1
Se.icp.a	µg/mL	< 30.1
Sm.icp.a	µg/mL	< 30.1
Sr.icp.a	µg/mL	< 3.01
Ti.icp.a	µg/mL	< 3.01
Tl.icp.a	µg/mL	< 60.2
U.icp.a	µg/mL	< 150
V.icp.a	µg/mL	< 15.1
Zr.icp.a	µg/mL	3.17

B3.4.2 Analysis of Variance Model

A statistical model is needed to account for the spatial and measurement variability in $\hat{\sigma}_{\hat{\mu}}$. This cannot be done using an ordinary standard deviation of the data (Snedecor and Cochran 1980).

The data were statistically evaluated using one-way analysis of variance. The one-way analysis of variance statistical model used to describe the structure of the data is

$$Y_{ij} = \mu + S_i + A_{ij},$$

$$i=1,2,\ldots,a,\ j=1,2,\ldots,n_i,$$

where

Y_{ij}	=	concentration from the j^{th} analytical result from the i^{th} grab sample
μ	=	the grand mean
S_i	=	the effect of the i^{th} grab sample
A_{ij}	=	the effect of the j^{th} analytical result from the i^{th} grab sample
a	=	the number of grab samples
n_i	=	the number of analytical results from the i^{th} grab sample.

The variable S_i is assumed to be a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(S)$ and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(S)$ and $\sigma^2(A)$ were obtained using REML techniques. This method applied to variance component estimation is described in Harville (1977). The results using the REML techniques were obtained using the statistical analysis package S-PLUS[3] (Statistical Sciences 1993).

B3.4.3 Sampling-Based Tank Inventory

The sampling-based tank inventory for each analyte is calculated by multiplying the tank volume for liquids by the mean concentration. The tank volume for liquids is 931 kL (246 kgal) (Hanlon 1996). The tank inventory for each analyte, along with the upper and lower limits, is presented in Appendix D.

[3]Registered trademark of Statistical Sciences, Seattle, Washington.

B4.0 APPENDIX B REFERENCES

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

De Lorenzo, D. S., A. T. DiCenso, L. C. Amato, R. H. Stephens, B. C. Simpson and D. B. Hiller, 1994b, *Tank Characterization Report for Double-Shell Tank 241-AP-106*, WHC-SD-WM-ER-361, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1995, *Hanford Analytical Services Quality Assurance Plan*, DOE/RL-94-55, Rev. 2, U.S. Department of Energy, Richland, Washington.

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Esch, R. A., 1996, *Tank 241-AP-106 Grab Samples 6AP-96-1, 6AP-96-2, and 6AP-96-3 Analytical Results for the Final Report*, WHC-SD-WM-DP-217, Rev. 0, Rust Federal Services of Hanford, Richland, Washington.

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

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

Harville, D. A., 1977, "Maximum Likelihood Approaches to Variance Component Estimation and to Related Problems," *Journal of the American Statistical Association*, vol. 72, pp. 320-340.

Kristofzski, J. G., 1996, *Directions for Opportunistic Analyses*, (internal memorandum 79400-96-168 to J. H. Baldwin and Distribution, September 11), Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1995, *Analysis and Characterization of Double Shell Tank 241-AP-106, Liquid Grab Samples, Riser 1, 30° and 150° in Conjunction with Evaporator Campaign 95-1*, WHC-SD-WM-DP-078, Rev. 0B, Westinghouse Hanford Company, Richland, Washington.

Sasaki, L. M., 1996, *Compatibility Grab Sampling and Analysis Plan*, WHC-SD-WM-TSAP-037, Rev. 2D, Westinghouse Hanford Company, Richland, Washington.

Snedecor, G. W., and W. G. Cochran, 1980, *Statistical Methods*, 7th Edition, Iowa State University Press, Ames, Iowa.

Statistical Sciences, 1993, *S-PLUS® Reference Manual, Version 3.2*, StatSci, a division of MathSoft, Inc., Seattle, Washington.

Valenzuela, B. D., 1994, *Tank 241-AP-106 Tank Characterization Plan*, WHC-SD-WM-TP-277, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Fire Protection Engineering Surveys Instructions*, WHC-IP-0030, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

This page intentionally left blank.

APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

The statistical analysis required for tank 241-AP-106 by the safety screening DQO was performed and is reported in Appendix C. The safety screening DQO (Dukelow et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. In this appendix, results from calculating one-sided confidence limits supporting the safety screening DQO for tank 241-AP-106 are reported. All data in this section are from the 1996 sampling event for tank 241-AP-106 (Esch 1996).

Confidence intervals were computed for each sample number from tank 241-AP-106 analytical data. The upper limit of a one-sided 95 percent confidence interval for the mean is

$$\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}.$$

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with *df* degrees of freedom for a one-sided 95 percent confidence interval. For the tank 241-AP-106 data, *df* equals the number of observations minus one; i.e., $df = 1$.

The upper limit of the 95 percent confidence interval for each sample number based on DSC is listed in Table C1-1. Each confidence interval can be used to make the following statement: "If the upper limit is less than 480 J/g dry, then one would reject the null hypothesis that DSC is greater than or equal to 480 J/g dry at the 0.05 level of significance." All three grab samples had results of 0.0 J/g dry. The upper limit is less than 480 J/g dry for each grab sample. Thus, the hypothesis that the DSC results are greater than 480 J/g dry is rejected for all three grab samples.

If the plutonium is ^{239}Pu, the limit for plutonium is 1 g/L. Because total alpha analyses were not performed, the one-sided confidence interval was calculated for the $^{239/240}$Pu data. The $^{239/240}$Pu data were transformed to g/L using the specific activity for ^{239}Pu (0.0615 Ci/g) and assuming that all the plutonium is ^{239}Pu. The upper limit of the 95 percent confidence interval for each sample number based on $^{239/240}$Pu data is listed in Table C1-2. Each confidence interval can be used to make the following statement: "If the upper limit is less than 1 g/L, then one would reject the null hypothesis that the $^{239/240}$Pu is greater than or equal to 1 g/L at the 0.05 level of significance." The upper limit was less then 1 g/L for each grab sample. Thus, the hypothesis that the plutonium results are greater than 1 g/L is rejected for all three grab samples.

Table C1-1. Summary Statistics - DSC - Tank 241-AP-106.

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	Upper Limit
S96T005181	6AP-96-1	0.00 J/g dry	0.00	0.00
S96T005182	6AP-96-3	0.00 J/g dry	0.00	0.00
S96T005183	6AP-96-2	0.00 J/g dry	0.00	0.00

Table C1-2. Summary Statistics - $^{239/240}Pu$ - Tank 241-AP-106.

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	Upper Limit
		g/L	g/L	g/L
S96T005184	6AP-96-1	9.10E-08[1]	4.03E-09[1]	1.16E-07[1]
S96T005185	6AP-96-3	1.89E-06	0.00E+00	1.89E-06
S96T005186	6AP-96-2	3.10E-07	1.29E-08	3.91E-07

Note:

[1]Both measurements were "less than" values. Statistics were calculated using the data at the detection limit.

C1.0 APPENDIX C REFERENCES

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Esch, R. A., 1996, *Tank 241-AP-106 Grab Samples 6AP-96-1, 6AP-96-2, and 6AP-96-3 Analytical Results for the Final Report*, WHC-SD-WM-DP-217, Rev. 0, Rust Federal Services of Hanford, Richland, Washington.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-106

This page intentionally left blank.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-106

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Kupfer et al. 1995). As part of this effort, an evaluation of available chemical and radionuclide components in tank 241-AP-106 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task. The expected waste type is dilute non-complexed (DN).

D1.0 CHEMICAL INFORMATION SOURCES

Available composition information for the waste in tank 241-AP-106 is as follows.

- Characterization results from the March 1993 "bottle-on-a-string" sampling event (Welsh 1994).
- Characterization results for the 3,535 kL (934 kgal) of waste transferred from tank 241-AP-106 to tank 241-AP-108 in May 1995 (Baldwin and Stephens 1996).
- The waste compatibility results for the September 1996 sampling event provided the most recent data on the contents of tank 241-AP-106 (Esch 1996).
- The HDW model document (Agnew et al. 1996) provides tank content estimates derived from the LANL model, in terms of component concentrations and inventories. A complete list of data sources used in this evaluation is provided at the end of this section.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The HDW model provides composition estimates for the waste in tank 241-AP-106 on January 1, 1994. Sample-based inventories derived from analyses of samples taken from the same time period (De Lorenzo et al. 1994), and HDW model inventories generated by the HDW model (Agnew et al. 1996), are compared in Tables D2-1 and D2-2. A tank volume of 3,891 kL (1,028 kgal) was used by generating the sample-based inventory, and the HDW model used a slightly higher volume of 3,899 kL (1,030 kgal). The density used to calculate the sample-based inventory is 0.996 g/mL. The density used in the HDW model was 1.15 g/mL. No solids are expected to be in tank 241-AP-106.

The HDW model estimates are generally higher for all major components. The beginning of 1994 is the reference point for the HDW model. Most of this waste was removed in 1995, and multiple transfers of dilute facility wastes into tank 241-AP-106 have changed the waste composition.

In January 1994, tank 241-AP-106 contained DN waste. Analytical data from DN samples are generally reliable, and comparisons of HDW predictions with analytical results usually serve as a way to assess the validity of the model predictions. However, samples taken around January 1994 did not reach a more dense, stratified layer at the bottom of the tank. Conclusions based on analyses of these samples alone would be incorrect.

Table D2-1. Sampling and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Double-Shell Tank 241-AP-106.

Analyte	Sampling Inventory Estimate[1] (kg)	HDW Inventory Estimate[2] (kg)	Analyte	Sampling Inventory Estimate[1] (kg)	HDW Inventory Estimate[2] (kg)
Al	901	46,000	NO_3	18,100	4.21E+05
As	< 22.4	n/r	Ni	1.74	643
Ba	0.687	n/r	Pb	< 6.62	134
Be	n/r	n/r	Se	< 1.07	n/r
B	n/r	n/r	Si	n/r	2,630
Cd	25.3	n/r	Ti	n/r	n/r
Ca	n/r	n/r	U	15.8	3,920
Ce	n/r	n/r	Zn	n/r	n/r
Cr	20.2	2,230	Zr	n/r	323
Cu	n/r	n/r	NH_3	< 683	n/r
Fe	29.4	930	CO_3	11,000	59,500
K	3,490	12,100	Cl	240	8,690
Mg	n/r	n/r	NO_2	4,970	55,300
Mn	n/r	782	PO_4	901	19,600
Na	23,600	3.25E+05	SO_4	598	19,900
CN	2.15	n/r	TOC	2,120	19,100
F	739	5,520	H_2O (wt %)	100.2%	76.2
OH	6,110	1.31E+05	SpG	0.996	1.15

Notes:

[1]De Lorenzo et al. (1994)

[2]Agnew et al. (1996) Estimates as of January 1, 1994.

Table D2-2. Sampling and Hanford Defined Waste Model Inventory Estimates for Radioactive Components in Double-Shell Tank 241-AP-106. (Decayed to January 1, 1994)

Analyte	Sampling Inventory Estimate[1] (Ci)	HDW Inventory Estimate[2] (Ci)	Analyte	Sampling Inventory Estimate[1] (Ci)	HDW Inventory Estimate[2] (Ci)
^{241}Am	0.407	n/r	$^{239/240}$Pu	< 0.581	136
^{14}C	0.0330	n/r	^{79}Se	n/r	n/r
^{137}Cs	19,500	1.92E+05	$^{89/90}$Sr	2.98	1.64E+05
^{60}Co	< 8.20	n/r	^{99}Tc	5.72	n/r
^{242}Cm	n/r	n/r	^{3}H	20.9	n/r
$^{243/244}$Cm	< 2.72	n/r			

Notes:

[1]De Lorenzo et al. (1994)

[2]Agnew et al. (1996)

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed in order to identify potential errors and/or missing information that would influence the sampling-based inventories. The evaluation also provides an estimate of the current inventory in tank 241-AP-106 from sample data, contributing wastes, and transfer records.

D3.1 CONTRIBUTING WASTE TYPES

By the middle of 1989, tank 241-AP-106 contained 1,850 kL (490 kgal) of partially concentrated non-complexed waste (PCN) with a specific gravity of about 1.2. All but 825 kL (218 kgal) of this waste was moved out of the tank in July 1989. Dilute waste, totalling 3,490 kL (923 kgal) with a specific gravity very close to 1.0, was transferred from tank 241-AY-102 in October 1989. During May 1995, all but 409 kL (108 kgal) of the waste in tank 241-AP-106 was transferred to tank 241-AP-108. Since that time, tank 241-AP-106 has been a receiver for dilute wastes from the 222-S Laboratory, the 300 and 400 areas, B Plant, and T Plant. As of September 30, 1996, tank 241-AP-106 contained 931 kL (246 kgal) of DN waste (Hanlon 1996).

D3.2 EVALUATION OF HISTORICAL DATA

Of the three major sampling events for tank 241-AP-106, two provide concentration data on waste constituents of concern. The first of these two sampling events occurred in March 1993. For this sampling event, the lowest depth from which samples were taken was 284 cm (112 in.) from the bottom of the tank. This means that 1,170 kL (308 kgal) of waste was not sampled directly. All of the samples taken had density values less than 1.000 g/mL. In July 1989, tank 241-AP-106 contained 825 kL (218 kgal) of waste with a density of 1.2 g/mL before being filled with the more dilute waste from tank 241-AY-102. Denser material is at the bottom of the tank and was not accounted for by the March 1993 sampling event.

Further evidence for this is provided by the TCR for tank 241-AP-108 (Baldwin and Stephens 1996). When this tank was sampled in January 1996, 97 volume percent of the waste in that tank had come from 241-AP-106. However, as Baldwin and Stephens (1996) point out, a comparison between the tank 241-AP-108 data and data from the March 1993 sampling of tank 241-AP-106 did not reveal similar analyte concentrations; in fact, concentrations in tank 241-AP-108 were 3 to 5 times higher than the concentrations found in tank 241-AP-106. Baldwin and Stephens (1996) indicated that these differences may be due to settling and evaporation.

Another explanation is that when waste from tank 241-AP-106 was transferred to tank 241-AP-108, a portion of the uncharacterized waste at the bottom of the tank, waste with higher analyte concentrations, was moved to tank 241-AP-108. When tank 241-AP-108 was characterized in 1996, samples included a mixture of the dense waste from the bottom of tank 241-AP-106 and the lighter material above.

Data from the second sampling event for tank 241-AP-106 that provided concentration data on waste constituents of concern, which occurred in September 1996, offer more evidence in support of this argument. These samples were taken after waste was transferred from tank 241-AP-106 to tank 241-AP-108 and after approximately 520 kL (138 kgal) of new waste was added. However, one sample, Sample 96-3 was taken 25 cm (10 in.) from the bottom of the tank and, as Table D3-1 demonstrates, concentrations from that sample are higher than the others. Notice that the density for sample 96-3 is 1.21 g/mL, essentially the same as the PCN waste resident in tank 241-AP-106 in 1989. No other wastes with this density were added to the tank after 1989, so Sample 96-3 must be the PCN heel that was not characterized by the March 1993 sampling event.

Table D3-1. Analytical Results from September 1996 Sampling of Tank 241-AP-106.[1] (3 sheets)

Sample Identification	96-1	96-2	96-3
	µg/mL	µg/mL	µg/mL
DFB[2] (in.)	70	40	10
Ag^{+}	0.606	1.20	8.07
Al^{+3}	353	950	8,890
As^{+5}	< 2.10	<4.10	<30.1
B^{+3}	1.48	2.21	<15.1
Ba^{+2}	<1.05	<2.05	<15.1
Be^{+2}	<0.105	<0.205	<1.51
Bi^{+3}	<2.10	<4.10	<30.1
Ca^{+2}	<2.10	<4.10	<30.1
Cd^{+2}	<0.105	<0.205	<2.16
Ce^{+3}	<2.10	<4.10	<30.1
Co^{+3}	<0.420	<0.820	<6.02
Cr^{+3}	12.9	24.3	163
Cu^{+2}	0.233	<0.410	<3.01
Fe^{+3}	<1.05	<2.05	<15.1
K^{+}	1,190	3,460	22,600
La^{+3}	<1.05	<2.05	<15.1
Li^{+}	0.320	0.410	3.01
Mg^{+2}	<0.210	<4.10	<30.1
Mn^{+4}	<0.210	<0.410	<3.01
Mo^{+6}	1.83	2.11	17.4
Na^{+}	8,460	17,200	112,000
Nd^{+3}	<2.10	<4.10	<30.1
Ni^{+3}	<0.420	<0.820	6.97
P	239	325	462
Pb^{+4}	<2.10	<4.10	<30.1
S	88.5	182	1,170
Sb^{+5}	<1.26	<2.46	<18.1
Se^{+6}	<2.10	<4.10	<30.1
Si^{+4}	15.0	19.0	41.3
Sm^{+3}	<2.10	<4.10	<30.1
Sr^{+2}	<0.210	<0.410	<3.01
Ti^{+4}	<0.210	<0.410	<3.01
Tl^{+3}	<4.20	<8.20	<60.2

Table D3-1. Analytical Results from September 1996 Sampling of Tank 241-AP-106.[1] (3 sheets)

Sample Identification	96-1	96-2	96-3
	μg/mL	μg/mL	μg/mL
DFB[2] (in.)	70	40	10
U g/L	<10.5	<20.5	<150
V^{+5}	<1.05	<2.05	<15.1
Zn^{+2}	0.540	0.596	4.87
Zr^{+4}	<0.210	<0.410	<3.01
F-	128	631	2,450
Cl	177	626	1,610
NO_2	1,870	7,660	30,800
NO_3	5,940	28,100	129,000
PO_4	673	1,760	760
SO_4	285	1,300	3,620
OH-	2,700	6,240	27,800
CO_3	2,800	3,940	20,400
TOC	710	874	3,250
	μCi/mL	μCi/mL	μCi/mL
^{14}C	n/r	n/r	n/r
^{60}Co	<3.87E-04	<7.59E-04	<0.0260
^{90}Sr	0.0277	0.00456	0.512
^{99}Tc	n/r	n/r	n/r
^{137}Cs	9.78	24.7	139
^{154}Eu	n/r	n/r	n/r
^{235}U	n/r	n/r	n/r
^{238}U	n/r	n/r	n/r
^{237}Np	n/r	n/r	n/r
^{238}Pu	n/r	n/r	n/r
$^{239/240}Pu$	<5.89E-06	1.92E-05	1.17E-04
^{241}Pu	n/r	n/r	n/r
^{241}Am	<6.15E-06	<9.37E-06	8.88E-04

Table D3-1. Analytical Results from September 1996 Sampling of Tank 241-AP-106.[1] (3 sheets)

Sample Identification	96-1	96-2	96-3
	μg/mL	μg/mL	μg/mL
DFB[2] (in.)	70	40	10
Density	0.999 g/mL	1.01 g/mL	1.21 g/mL
% Water	95.64 %	94.32 %	69.91 %

Notes:

[1]Esch (1996)

[2]DFB = Depth from bottom of tank.

How much of this PCN waste remained in tank 241-AP-106 after the transfer of waste to tank 241-AP-108? Originally, tank 241-AP-106 contained 825 kL (218 kgal) of PCN. During the transfer to tank 241-AP-108, the volume in tank 241-AP-106 was reduced from 3,890 kL (1,028 kgal) to 409 kL (108 kgal). A float and suction pump was used to pump the waste from tank 241-AP-106. This type of pump is attached to a 444-cm (175-in.) hose with a float near the suction end at the waste surface. As the tank level decreases, the pump suction hose descends and the waste near the surface is drawn into the pump. If the volume in tank 241-AP-106 upon completion of the transfer was 409 kL (108 kgal), then approximately 416 kL (110 kgal) of the PCN heel was pumped to tank 241-AP-108.

To check this assumption, the Sample 96-3 data in Table D3-1 were combined with the March 1993 data for tank 241-AP-106 to establish a new waste profile for the tank before the transfer to tank 241-AP-108 occurred. Average concentrations from the March 1993 data were assumed to represent 3,119 kL (824 kgal) of the 3,535 kL (934 kgal) sent to tank 241-AP-108, and the Sample 96-3 data was assumed to represent the remaining 409 kL (108 kgal). A new composition was derived by multiplying March 1993 concentrations by 3,119 kL (824 kgal), adding to it the product of the Sample 96-3 concentrations and a volume of 409 kL (108 kgal), and then dividing the sum by 3,535 kL (934 kgal). The resulting composition is compared in Table D3-2 to data from the January 1996 sampling of tank 241-AP-108.

The ratios between the two tanks (shown in Table D3-2) are much closer than the comparison done by Baldwin and Stephens (1996). The reconciled concentrations for tank 241-AP-106 are generally higher than those reported for tank 241-AP-108. This suggests that the assumed amount of PCN transferred is too high. Yet, the transfer records for tank 241-AP-106 show that at least 416 kL (110 kgal) of the 825 kL (218 kgal) of PCN waste was transferred since only 409 kL (108 kgal) of waste were left in the tank.

Other factors contribute to the differences. Of the waste in tank 241-AP-108, 3 volume percent did not come from tank 241-AP-106. The 96-3 sample was taken nearly one year after the transfer occurred. During the interim period, tank 241-AP-106 received over 378 kL (100 kgal) of new waste which may have influenced the waste composition at the bottom of the tank.

Based on the comparisons in Table D3-2 and this evaluation, it is concluded that the 409 kL (108 kgal) remaining in tank 241-AP-106 after the transfer in May 1995 consisted of PCN waste. Sample 96-3 from the September 1996 sampling event for tank 241-AP-106 has a composition consistent with PCN waste.

Table D3-2. Comparison of Analytical Results for Tank 241-AP-106 to Tank 241-AP-108 as of May 1995.

Analyte	241-AP-106[1] μg/mL	241-AP-108[2] μg/mL	Ratios 241-AP-106/ 241-AP-108
Al	1,233	1,070	1.15
Na	18,069	17,400	1.04
CO_3^{-2}	4,546	8,650	0.53
CL^-	239	190	1.26
F^-	441	575	0.77
SO_4^{-2}	550	515	1.07
NO_3^-	18,925	14,800	1.28
NO_2^-	4,651	3,730	1.25
PO_4^{-3}	276	299	0.92
OH^-	4,536	2,770	1.64
TOC (g/L)	821	398	2.06
Units	μCi/L	μCi/L	
^{90}Sr	0.0609	0.0311	1.96
^{137}Cs	16.4	19.5	0.84

Notes:

[1]Esch (1996)

[2]Baldwin and Stephens (1996)

The data obtained from the September 1996 sampling event are used to define the best-basis estimate for tank 241-AP-106 using the assumptions that Sample 96-3 is a sample of the 409-kL (108-kgal) heel, and that the means of the 96-1 and 96-2 sample concentrations are representative of the remaining volume, 521 kL (138 kgal), of waste in the tank. There are few data from other sources to verify the accuracy of the September 1996 data; most of the waste added since 1993 has been facility wastes. Facility waste compositions used to estimate the composition of transferred waste are typically general descriptions based on averages of historical data.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Inventories based on the September 1996 sampling event and waste layer volumes derived in this engineering assessment should serve as the basis for the best estimate inventory of tank 241-AP-106 on September 30, 1996 for the following reasons.

1. The HDW model estimate is outdated because of subsequent waste transfers.

2. The September 1996 sampling event provides the most recent data for the waste.

3. The assumed waste layer volumes produce inventories consistent with available data from other sources.

Best-basis inventory estimates for tank 241-AP-106 are presented in Tables D4-1 and D4-2. Radionuclide values are decayed to January 1, 1994. The tank is active. Waste has been added since grab samples were taken in September 1996. Transfers into and out of the tank since September 30, 1996 need to be considered for future inventory determinations and waste composition estimates.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-106 as of September 30, 1996.[1]

Analyte	Total inventory (kg)	Basis (S, M, or E)
Al	2,610	S/E
Bi	< 9.44	S/E
Ca	< 9.44	S/E
Cl	634	S/E
TIC as CO_3	7,280	S/E
Cr	52.3	S/E
F	824	S/E
Fe	< 4.73	S/E
Hg	n/r	
K	7,010	S/E
La	< 4.73	S/E
Mn	< 0.944	S/E
Na	35,900	S/E
Ni	2.12	S/E
NO_2	10,400	S/E
NO_3	41,750	S/E
OH	9,657	S/E
Pb	< 9.44	S/E
P as PO_4	919	S/E
Si	21.5	S/E
S as SO_4	1,350	S/E
Sr	< 0.944	S/E
TOC	1,340	S/E
U_{TOTAL}	< 47.1	S/E
Zr	< 0.944	S/E

Notes:

S = Sample-based
M = HDW model-based
E = Engineering assessment-based

[1]This is an active tank. Transfers to and from the tank will change inventory and waste composition.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-106 as of September 30, 1996. (Decayed to January 1, 1994) (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)
^{3}H	n/r	
^{14}C	n/r	
^{59}Ni	n/r	
^{60}Co	< 6.84	S
^{63}Ni	n/r	
^{79}Se	n/r	S
^{90}Sr	149	S
^{90}Y	149	S
^{93}Zr	n/r	
^{93m}Nb	n/r	
^{99}Tc	n/r	
^{106}Ru	n/r	
^{113m}Cd	n/r	
^{125}Sb	n/r	
^{126}Sn	n/r	
^{129}I	n/r	
^{134}Cs	n/r	
^{137}Cs	45,740	S
^{137m}Ba	43,500	S
^{151}Sm	n/r	
^{152}Eu	n/r	
^{154}Eu	n/r	
^{155}Eu	n/r	
^{226}Ra	n/r	
^{227}Ac	n/r	
^{228}Ra	n/r	
^{229}Th	n/r	
^{231}Pa	n/r	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-106 as of September 30, 1996. (Decayed to January 1, 1994) (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)
^{232}Th	n/r	
^{232}U	n/r	
^{233}U	n/r	
^{234}U	n/r	
^{235}U	n/r	
^{236}U	n/r	
^{237}Np	n/r	
^{238}Pu	n/r	
^{238}U	n/r	
$^{239/240}$Pu	< 0.0365	S
^{241}Am	< 0.226	S
^{241}Pu	n/r	
^{242}Cm	n/r	
^{242}Pu	n/r	
^{243}Am	n/r	
^{243}Cm	n/r	
^{244}Cm	n/r	

Notes:

S = Sample-based
M = HDW model-based
E = Engineering assessment-based

D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. Corbin, T. Duran, J. FitzPatrick, K. Jurgensen, T. Ortiz, and B. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, Los Alamos National Laboratory, Los Alamos, New Mexico.

De Lorenzo, D. S., L. Amato, A. DiCenso, D. Hiller, and R. Stephens, 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-106*, WHC-SD-WM-ER-361, Rev. 0, Los Alamos Technical Associates, Richland, Washington.

Baldwin, J. H., and R. Stephens, 1996, *Tank Characterization Report for Double-Shell Tank 241-AP-108*, WHC-SD-WM-ER-593, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Esch, R. A., 1996, *Tank 241-AP-106 Grab Samples 6AP-96-1, 6AP-96-2, and 6AP-96-3 Analytical Results for the Final Report*, WHC-SD-WM-DP-217, Rev. 0, Rust Federal Services of Hanford, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending September 30, 1996*, WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., M. D. LeClair, W. W. Schulz, and L. W. Shelton, 1995, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Welsh, T. L., 1994, *Tank 241-AP-106 Characterization Results*, WHC-SD-WM-TRP-170, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AP-106

This page intentionally left blank.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AP-106

Appendix E provides a bibliography of information that supports the characterization of tank 241-AP-106. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-AP-106 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references broken down into subgroups. These categories and their subgroups are listed below.

I. NON-ANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives and Customers of Characterization Data

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

- IIa. Sampling of Tank 241-AP-106 Waste and Waste Types

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories using both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

IV. OTHER DOCUMENTED RESOURCES

This bibliography is divided into the appropriate sections of material to use, with an annotation after each reference describing the information source. Where possible, information source references are provided. A majority of the information listed may be found in the Lockheed Martin Hanford Corporation Tank Characterization Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Jungfleisch, F. M. and B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980,* WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- A model based on process knowledge and radioactive decay estimations for different compositions of process waste streams assembled for total, solution, and solids compositions per tank. Assumptions about waste/waste types and solubility parameters/constraints are also given.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 3*, LA-UR-96-858, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains waste type summaries and primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids.

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

- Contains spreadsheets depicting all available data on tank additions/transfers.

Koreski, G. M., 1991, *Operational Waste Volume Projection*, WHC-SD-WM-ER-029, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains spreadsheets depicting transfer activity for double-shell tanks.

Ic. Surveillance/Tank Configuration

Braun Hanford Company, 1985, *Plan Tank Penetrations 241-AP-106 & 108*, Drawing H-2-90536, Rev. 2, Braun Hanford Company, Richland, Washington.

- Document gives an assessment of riser locations for each tank; however, not all tanks are included/completed.

Leach, C. E., and S. M. Stahl, 1996, *Hanford Site Tank Farm Facilities Interim Safety Basis Volumes I and II*, WHC-SD-WM-ISB-001, Rev. 0L, Westinghouse Hanford Company, Richland, Washington.

- Provides a ready reference to the tank farms safety envelope.

Lipnicki, J., 1996, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Gives an assessment of riser locations for each tank; however, not all tanks are included/completed. Also includes an estimate of which risers are available for sampling.

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

- Document shows riser locations in relation to tank aerial view and contains a description of each riser and its contents.

Tran, T. T., 1993, *Thermocouple Status Single-Shell and Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Compilation information on thermocouple trees installed in the Hanford Site underground waste tanks.

WHC, 1994, *Piping Plan Tank 106*, Drawing H-2-90558, Westinghouse Hanford Company, Richland, Washington.

- Drawing shows a top-down view of the riser locations and piping.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria, Volumes I and II,* WHC-SD-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Describes the nature, scope, and frequency of surveillance employed for waste storage tanks, states action criteria for response to data deviation, and presents tank data reviews for the period between June 15, 1973 and June 15, 1988.

Id. Sample Planning/Tank Prioritization

Brown, T. M., S. J. Eberlein, J. W. Hunt and T. J. Kunthara, 1996, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Document summarizes the technical basis for characterizing the waste in the tanks and assigns a priority number to each tank.

Ecology, EPA and DOE, 1993, *Hanford Federal Facility Agreement and Consent Order,* as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

- Document contains agreement between U.S. Environmental Protection Agency, DOE, and Washington State Department of Ecology that sets milestones for completing work on the Hanford Site tank farms.

EPA, 1990, "Identification and Listing of Hazardous Wastes," *40 CFR 261*, U.S. Environmental Protection Agency, Washington, D.C.

- Document identifies and lists hazardous wastes, and defines procedures for determining if a waste should be classified as hazardous.

Hendrickson, D. W., and T. L. Welsh, 1992, *Tank 241-AP-106 Sampling and Characterization Plan,* WHC-SD-WM-TP-117, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Plan for sampling the tank for the Hanford Grout Treatment Facility. The project was cancelled.

Sasaki, L. M., 1996, *Compatibility Grab Sampling and Analysis Plan*, WHC-SD-WM-TSAP-037, Rev. 2D, Westinghouse Hanford Company, Richland, Washington.

- Specifies the goals of the September 1996 sampling event and details the sampling and analysis procedures.

Valenzuela, B. D., 1994, *Tank 241-AP-106 Tank Characterization Plan,* WHC-SD-WM-TP-277, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Specifies the goals of the November 1994 sampling event and details the sampling and analysis procedures.

Ie. Data Quality Objectives and Customers of Characterization Data

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tanks are under safe operating conditions.

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

- DQO containing outline of the essential data needed to make decisions concerning operation of the 242-A Evaporator and the Liquid Effluent Retention Facility.

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

- DQO used to determine whether the waste in the tank is safely compatible with the waste in other tanks.

St. Denis, R., 1993, *Analysis and Characterization of Grout Tanks 241-AP-105 and 241-AP-106*, WHC-SD-WM-DP-049, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Reports analytical results for grout feed characterization of tank contents.

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

IIa. Sampling of Tank Waste and Waste Types

De Lorenzo, D. S., L. C. Amato, A. T. DiCenso, D. B. Hiller, and R. H. Stephens, 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-106*, WHC-SD-WM-ER-361, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document is the original TCR for Tank 241-AP-106, and contains sampling results from the March 1993 sampling event.

Esch, R. A., 1996, *Tank 241-AP-106 Grab Samples 6AP-96-1, 6AP-96-2, and 6AP-96-3 Analytical Results for the Final Report*, WHC-SD-WM-DP-217, Rev. 0, Rust Federal Services of Hanford, Richland, Washington.

- Document contains sample analyses results from the 1996 grab sampling event.

Hendrickson, D. W., and T. L. Welsh, 1993, *Tank 241-AP-106 Sampling and Characterization Plan,* WHC-SD-WM-TP-117, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Plan for sampling the tank for the Hanford Grout Treatment Facility. Estimates of the tank contents were provided based on process history and waste stream analyses.

Miller, G. L., 1995, *Analysis and Characterization of Double Shell Tank 241-AP-106, Liquid Grab Samples, Riser 1, 30° and 150° in Conjunction with Evaporator Campaign 95-1,* WHC-SD-WM-DP-078, Rev. 0C, Westinghouse Hanford Company, Richland, Washington.

- Document contains sample analyses results from the November 1994 grab sampling event.

Welsh, T. L., 1994, *Tank 241-AP-106 Characterization Results,* WHC-SD-WM-TRP-170, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains sample analyses results from the March 1993 grab sampling event.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories using both Campaign and Analytical Information

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 3*, LA-UR-96-858, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains waste type summaries and primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids.

Agnew, S. F., 1995, *Letter Report: Strategy for Analytical Data Comparisons to HDW Model*, (letter CST-4:95-sfa272 to S. J. Eberlein, September 28), Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains proposed tank groups based on TLM, and statistical method for comparing analytical information to HDW predictions.

Kupfer, M. J., 1996, *Interim Report: Best Basis Total Chemical and Radionuclide Inventories in Hanford Site Tank Waste*, WHC-SD-WM-TI-740, Rev. D-Draft, Westinghouse Hanford Company, Richland, Washington.

- Contains a global component inventory for 200 Area waste tanks. Currently, 14 chemical and 2 radionuclide components are inventoried.

Schmittroth, F. A., 1995, *Inventories for Low-Level Tank Waste*, WHC-SD-WM-RPT-164, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains a global inventory based on process knowledge and radioactive decay estimations using ORIGEN2. Pu and U waste contributions are taken at 1 percent of the amount used in processes. Also compares information on Tc-99 from both ORIGEN2 and analytical data.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernates*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document gives solubility ranges used for key chemical and radionuclide components based on supernatant sample analyses.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1995, *Tank Waste Source Term Inventory Validation, Vol I & II*, WHC-SD-WM-ER-400, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains summary tank farm and tank write-ups on historical data. Appendices contain the following information: Appendix C - Level History AutoCAD sketch; Appendix D - Temperature Graphs; Appendix E - Surface Level Graph; Appendix F, Tank Evaporator Rate Graph; Appendix G - Riser Configuration Drawing and Table; Appendix I - In-Tank Photos; and Appendix K - Tank Layer Model Bar Spreadsheet.

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

- Summarizes issues surrounding characterization of nuclear wastes stored in Hanford Site waste tanks.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending September 30, 1996,* WHC-EP-0182-102, Westinghouse Hanford Company, Richland, Washington.

- Most recent release of a series of summaries including fill volumes, Watch List tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information. The series includes monthly summaries from December 1947 to the present; however, Hanlon has only authored the monthly summaries from November 1989 to the present.

Husa, E. I., R. E. Raymond, R. K. Welty, S. M. Griffith, B. M. Hanlon, R. R. Rios, N. J. Vermeulen, 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains in-tank photos and summaries on the tank description, leak detection system, and tank status.

Remund, K. M., G. Chen, S. A. Hartley, J. York, and B. C. Simpson, 1995, *Historical Tank Content Estimate (HTCE) and Sampling Estimate Comparisons*, PNL-10840, Pacific Northwest Laboratory, Richland, Washington.

- Document contains a statistical evaluation of the HDW inventory estimate against analytical values from 12 existing TCR reports using a select component data set.

Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single and Double Shell Tanks*, (internal memorandum #74A20-96-30 to D. J. Washenfelder, February 28) Westinghouse Hanford Company, Richland, Washington.

- Memo contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Chemical and Radionuclide Inventory for Single and Double Shell Tanks*, (internal memorandum #75520-95-007, to R. M. Orme, August 8) Westinghouse Hanford Company, Richland, Washington.

- Memo contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Radionuclide Inventories for Single and Double Shell Tanks*, (internal memorandum #71320-95-002 to F. M. Cooney, February 14), Westinghouse Hanford Company, Richland, Washington.

- Memo contains a tank inventory estimate based on analytical information.

WHC, 1993, Process Aids: A Compilation of Technical Letters By Process Laboratories and Technology, WHC-IP-0711-25, Westinghouse Hanford Company, Richland, Washington.

- These documents contain a collection of internal memos and letters concerning tank or process sampling. Grouped here are all of the Process Aids documents from 1969 to 1993.

DISTRIBUTION SHEET

To	From	Page 1 of 3
Distribution	Data Assessment and Interpretation	Date 03/10/97
Project Title/Work Order: Tank Characterization Report for Double-Shell Tank 241-AP-106, HNF-SD-WM-ER-361, Rev. 1		EDT No. N/A
		ECN No. ECN-635444

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
<u>OFFSITE</u>					
<u>Sandia National Laboratory</u> P.O. Box 5800 MS-0744, Dept. 6404 Albuquerque, NM 87815					
D. Powers		X			
<u>Nuclear Consulting Services Inc.</u> P. O. Box 29151 Columbus, OH 43229-01051					
J. L. Kovach		X			
<u>Chemical Reaction Sub-TAP</u> P.O. Box 271 Lindsborg, KS 67456					
B. C. Hudson		X			
<u>Tank Characterization Panel</u> Senior Technical Consultant Contech 7309 Indian School Road Albuquerque, NM 87110					
J. Arvisu		X			
<u>SAIC</u> 20300 Century Boulevard, Suite 200-B Germantown, MD 20874					
H. Sutter		X			
<u>Los Alamos Laboratory</u> CST-14 MS-J586 P. O. Box 1663 Los Alamos, NM 87545					
S. F. Agnew		X			

DISTRIBUTION SHEET

To	From	Page 2 of 3
Distribution	Data Assessment and Interpretation	Date 03/10/97
Project Title/Work Order		EDT No. N/A
Tank Characterization Report for Double-Shell Tank 241-AP-106, HNF-SD-WM-ER-361, Rev. 1		ECN No. ECN-635444

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
<u>Los Alamos Technical Associates</u>					
T. T. Tran	B1-44	X			
<u>Tank Advisory Panel</u> 102 Windham Road Oak Ridge, TN 37830					
D. O. Campbell		X			
<u>ONSITE</u>					
<u>Department of Energy - Richland Operations</u>					
J. F. Thompson	S7-54	X			
W. S. Liou	S7-54	X			
J. A. Poppiti	S7-54	X			
N. W. Willis	S7-54	X			
<u>DE&S Hanford, Inc.</u>					
R. J. Cash	S7-14	X			
W. L. Cowley	R2-54	X			
G. L. Dunford	A2-34	X			
G. D. Johnson	S7-14	X			
J. E. Meacham	S7-14	X			
<u>Fluor Daniel Northwest</u>					
J. L. Stroup	S3-09	X			
<u>Lockheed Martin Hanford, Corp.</u>					
K. M. Hodgson	H0-34	X			
T. J. Kelley	S7-21	X			
L. M. Sasaki	R2-12	X			
B. C. Simpson	R2-12	X			
R. R. Thompson	R2-12	X			
L. R. Webb	R2-12	X			
ERC (Environmental Resource Center)	R1-51	X			
Tank Characterization Resource Center	R2-12	5			
<u>Lockheed Martin Services, Inc.</u>					
B. G. Lauzon	R1-08	X			
Central Files	A3-88	X			
EDMC	H6-08	X			

DISTRIBUTION SHEET

To	From	Page 3 of 3
Distribution	Data Assessment and Interpretation	Date 03/10/97
Project Title/Work Order		EDT No. N/A
Tank Characterization Report for Double-Shell Tank 241-AP-106, HNF-SD-WM-ER-361, Rev. 1		ECN No. ECN-635444

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
<u>Numatec Hanford Corporation</u>					
J. S. Garfield	H5-49	X			
J. S. Hertzel	H5-61	X			
D. L. Lamberd	H5-61	X			
<u>Pacific Northwest National Laboratory</u>					
A. F. Noonan	K9-91	X			
<u>Rust Federal Services of Hanford, Inc.</u>					
C. T. Narquis	T6-16	X			
<u>SGN Eurisys Services Corp.</u>					
D. B. Engelman	L6-37	X			