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ACCESSION # D197182878

38795

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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635470

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Kevin E. Bell, Data Assessment and Interpretation, R2-12, 373-1629	[] Yes [X] No	05/06/97
	6. Project Title/No./Work Order No. Tank 241-AW-102	7. Bldg./Sys./Fac. No. 241-AW-102	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-363, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

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

13a. Description of Change

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

This ECN 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).

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

A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) ECN-635470

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	[]
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OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
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Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
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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. K.E. Bell	Kevin E. Bell	5/23/97	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	5/23/97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other R.J. Cash	R.J. Cash	5/28/97	Other		
N.W. Kirch			DEPARTMENT OF ENERGY Signature or a Control Number that tracks the Approval Signature		
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Tank Characterization Report for Double-Shell Tank 241-AW-102

Kevin E. Bell
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U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: ECN-635470 UC: 2070
Org Code: 74620 Charge Code: E61977
B&R Code: EW 3120074 Total Pages: 123

Key Words: Waste Characterization, Double-Shell Tank, DST, Tank 241-AW-102, Tank AW-102, AW-102, AW 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-AW-102. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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Release Approval 5/29/97 Date

DATE: HANFORD RELEASE STA: 4 ID: 3
MAY 30 1997
Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-363	Page 1

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

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 09/28/94 on EDT-608073.	B.C. Simpson	C.S. Haller
		K.E. Bell	Kathleen M. Hall
1 RS	Incorporate per ECN-635470.	K.E. Bell	K.M. Hall 5/23/97

A-7320-005 (08/91) WEF168

HNF-SD-WM-ER-363, Rev. 1
Formerly WHC-SD-WM-ER-363, Rev. 0

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

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Date Published
May 1997

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

Approved for public release; distribution is unlimited

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LIST OF TERMS

Ci	curies
Ci/L	curies per liter
CI	confidence interval
cm	centimeter
df	degrees of freedom
DQO	data quality objectives
DSC	differential scanning calorimetry
DST	double-shell tank
ft	feet
g	gram
g/L	grams per liter
g/mL	grams per milliliter
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
J/g	joules per gram
kg	kilogram
kg/L	kilograms per liter
kgal	kilogallon
kL	kiloliter
kW	kilowatt
L	liter
LANL	Los Alamos National Laboratory
LFL	lower flammability limit
LL	lower limit
m	meter
M	moles per liter
mm	millimeter
MT	metric ton
n/a	not applicable
NR	not reported
PHMC	Project Hanford Management Contractor
REML	restricted maximum likelihood estimation
RPD	relative percent difference
SAP	Sampling and Analysis Plan
TCP	tank characterization plan
TCR	tank characterization report
TGA	thermogravimetric analysis

LIST OF TERMS (Continued)

TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TRU	transuranic
TWRS	Tank Waste Remediation System
QC	quality control
UL	upper limit
WSTRS	waste status and transaction record summary
°C	degrees Centigrade
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μeq/mL	microequivalents per milliliter
μg	microgram
μg/g	micrograms per gram
μCi/L	microcuries per liter
μg/mL	microcuries per milliliter

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1.0 INTRODUCTION

One of the major functions of the Tank Waste Remediation System (TWRS) is to characterize waste 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-AW-102. This report has the following objectives:

- To use characterization data to respond to technical issues associated with 241-AW-102 waste
- To provide a standard characterization of this waste as 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 also 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 waste compatibility data quality objective (DQO) (Fowler 1995a), other information can be used to support or question conclusions derived from these results. Historical information for tank 241-AW-102 provided in Appendix A included 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 are summarized in Appendix B along with the sampling results. The results of the 1995 and 1996 grab sampling events were originally reported in Esch (1995 and 1996) and satisfied the data requirements specified in the respective revisions of the compatibility grab sampling and analysis plan (SAP) for this tank (Schreiber 1995 and Bell 1996). 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. Appendix E contains a bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-AW-102 and its respective waste types.

Tank 241-AW-102 is the designated feed tank for the 242-A Evaporator; consequently, its level and waste composition are constantly changing. Definitive characterization is difficult under dynamic conditions; the waste inventory values change with time. Because the most recent waste transfers involved liquids, the tank inventory and data assessment was limited to the tank solids.

Table 1-1. Summary of Recent Sampling.

Sample/date	Phase	Location	Segmentation	% Recovery
Grab samples 2AW-95-1, 2AW-95-2, 2AW-95-3 (8/25/95)	Supernate and solids	Riser 16A	n/a	100
Grab samples 2AW961, 2AW962 (8/13/96)	Solids[1]	Riser 22A	n/a	100
Vapor sample (8/25/96	Gas	6.1 m (20 ft.) below top of riser 22A	n/a	n/a

Notes:

n/a = not applicable

1.2 TANK BACKGROUND AND STATUS

Tank 241-AW-102, located in the 200 East Area AW Tank Farm, was constructed and went into service in 1980. The tank has received extensive use throughout its history and is presently used as the feed tank for the 242-A Evaporator. It was used during the recently completed 242-A Evaporator Campaign 96-1 (Guthrie 1996). Although that campaign was completed, tank 241-AW-102 is in continual use.

Transfers to and from the 242-A Evaporator were made during much of the operating life of tank 241-AW-102. Appendix A contains a more detailed review of the tank 241-AW-102 transfer history.

From the fourth quarter of 1981 to the third quarter of 1982, the tank received dilute non-complexed waste from various tanks. Also during this time, supernatant waste and dilute non-complexed waste were transferred from this tank to various double-shell tanks. The tank received supernatant waste from single- and double-shell tanks, dilute non-complexed sulfate waste, and a small amount of B Plant low-level waste in 1982. In 1983, the tank received dilute non-complexed phosphate waste and waste water from the 300 and 400 Area laboratories, and sent concentrated phosphate waste to tank 241-AN-106.

Transfers to and from tank 241-AW-102 from the second quarter of 1983 to the first quarter of 1989 were in support of the 242-A Evaporator. During this time, dilute non-complexed waste and supernatant waste were transferred to tank 241-AW-102 from various tanks. During the same period, dilute non-complexed waste was transferred from tank 241-AW-102 to various double-shell tanks.

Flush water from miscellaneous sources was added from 1984 to 1989. The tank received dilute non-complexed waste from PUREX and salt well liquor in 1985 and 1986. Tank 241-AW-102 received laboratory waste during the fourth quarter of 1986 and the second quarter of 1987. From 1987 through 1989, the tank received laboratory, supernatant, and dilute non-complexed sulfate waste. Dilute complexed hot semi-works transuranic (TRU) solids and supernatant were transferred from the tank in 1988 and 1989. Flush water from miscellaneous sources and supernatant waste were added to the tank in 1989 and 1990. Supernatant waste also was transferred out during this time.

Supernatant waste was transferred to and from tank 241-AW-102 during 1992. Salt well liquor from the 242-A Evaporator was transferred to the tank from late 1992 to 1996. From 1994 to 1997, dilute non-complexed waste and flush water were transferred to the tank. Dilute non-complexed waste was sent to tank 241-AW-106 and the 242-A Evaporator from 1994 to 1996. In the first quarter of 1997, waste was transferred to tank 241-AW-102 from tank 241-AP-105.

The final disposal of the waste in tank 241-AW-102 will be as high- and low-level glass fractions. Following processing through the 242-A Evaporator, the waste will be pretreated to separate the high- and low-level fractions before vitrification. The tank has an operational capacity of 3,960,000 L (1,050,000 gal) and as of October 31, 1996, it contained an estimated 375 kL (99 kgal) of waste classified as dilute non-complexed (Hanlon 1997). The volume of the waste phases found in the tank are shown in Table A1-1. Tank 241-AW-102 is still in service. It is categorized as sound and is actively ventilated. It is not on any Watch List (Public Law 101-510) and all monitoring systems were in compliance with documented standards as of October 31, 1996 (Hanlon 1997)..

Table 1-2. Description of Tank 241-AW-102.

TANK DESCRIPTION	
Type	Double-Shell
Constructed	1980
In service	1980
Diameter	22.9 m (75.0 ft)
Operating depth	10.5 m (34.5 ft)
Capacity	4,390 kL (1,160 kgal)
Bottom Shape	Flat
Ventilation	Active
TANK STATUS	
Waste classification	Dilute non-complexed
Total waste volume[1]	375 kL (99 kgal)
Supernatant volume	238 kL (63 kgal)
Saltcake volume	0 kL
Sludge volume[2]	136 kL (36 kgal)
Drainable interstitial liquid volume	0 kL
Waste surface level (1/26/97)	96.0[3] and 90.8[4] cm (36.2[3] and 35.8[4] in.)
Temperature (7/89 to 1/97)	11.7 °C (53.1 °F) to 40.6 °C (105 °F)
Integrity	Sound
Watch List	None
SAMPLING DATE	
Grab samples	August 1995
Grab samples	August 1996
Vapor samples	August 1996
SERVICE STATUS	
Active as a 242-A Evaporator feed tank	n/a
Interim stabilization	n/a
Intrusion prevention	n/a

Note:

[1]Waste volume is estimated from surface level measurements as of 1/26/97. This tank is very active, thus the waste volume may have changed.

[2]Sludge volume was last updated on 4/30/96 (Hanlon 1997). This tank is very active, thus the waste volume may have changed.

[3]From the ENRAF gauge.

[4]From the manual tape reading.

2.0 RESPONSE TO TECHNICAL ISSUES

The following four technical issues have been identified for tank 241-AW-102 (Brown et al. 1996).

- **Safety screening**. Does the waste pose or contribute to any recognized potential safety problems?
- **Vapor screening**. Does the tank headspace exceed 25 percent of the lower flammability limit, and if so, what are the principal fuel components?
- **Compatibility**. Is there assurance that commingling waste types during interim storage creates no safety problems? Is there assurance of continued operability during waste transfer and waste concentration/minimization?
- **Pretreatment**. Will providing tank waste samples to the Pretreatment program result in information necessary to satisfactorily support the TWRS disposal mission?

The 1995 and 1996 grab sampling events took place to satisfy the compatibility issue. The 1996 vapor sampling satisfied the tank headspace flammability issue of the safety screening DQO. Data from the recent analysis of two grab sampling events provided the means to respond to the compatibility issue. The organic solvent screening requirements described in Cash (1996) do not apply to tank 241-AW-102 because the tank is actively ventilated. The safety and pretreatment issues cannot be assessed at this time and will require more extensive sampling. See Appendix B for sample and analysis data for tank 241-AW-102.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-AW-102 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1996). The safety issues are exothermic conditions in the waste; flammable gases in the waste and/or tank headspace; and criticality conditions in the waste. Neither the 1995 nor 1996 grab sampling event was intended to address the issues of the safety screening DQO, and neither sampling event provided a vertical profile of the waste. The safety of the tank is ensured by adhering to the operating and specifications document for the double-shell tanks (WHC 1996). The safety screening issues will be fully assessed following more extensive sampling, however tank headspace vapor sample data were gathered during the 1996 grab sampling event and are available. In addition, energetics and $^{239/240}Pu$ activity were determined on selected 1995 and 1996 grab samples to evaluate waste compatibility.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO is to ensure that tank 241-AW-102 does not contain enough fuel to cause a safety hazard. Energetic measurements using differential scanning calorimetry (DSC) were performed on supernatant from the 1995 grab samples and solids from the 1996 grab samples. No exotherms were observed.

2.1.2 Flammable Gas

Vapor phase measurements taken in the tank headspace before the 1996 grab sampling event indicated that no flammable gas was detected (0 percent of the lower flammability limit). Data from these vapor phase measurements are presented in Appendix B.

2.1.3 Criticality

The safety threshold limit is 1 g ^{239}Pu per liter of waste. Analyses for $^{239/240}$Pu were performed on supernate and sludge from the 1995 grab samples and on solids from the 1996 grab samples. Attributing all $^{239/240}$Pu activity to ^{239}Pu, the activity of ^{239}Pu is well below the 1-g/L limit in both the supernate and the solids. Therefore, the data indicate that tank 241-AW-102 had no criticality concern at the time of sampling.

2.2 WASTE COMPATIBILITY EVALUATION

Tank 241-AW-102 serves as the 242-A Evaporator feed tank and is therefore very active. The compatibility DQO (Fowler 1995a) involves the following two issues.

- "Assurance that no safety problems are created as a result of commingling wastes under interim storage."
- "Assurance of continued operability during waste transfer and waste concentration/minimization..."

In accordance with the compatibility DQO and the waste compatibility SAPs (Schreiber 1995 and Bell 1996), the 1995 and 1996 grab samples from tank 241-AW-102 were analyzed to assess the safety and operational implications of waste commingling and storage before, during, and after 242-A Evaporator campaigns. Safety considerations include criticality, flammable gas accumulation, energetics, and corrosion. Operational considerations include TRU and complexant segregation, heat load, pumpability, and high-phosphate waste. Table 2-1 presents the analyses used to evaluate the waste for compliance with

Table 2-1. Waste Compatibility Data Quality Objective Decision Variables and Criteria for the Tank 241-AW-102 1995 Grab Samples. (3 sheets)

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result - 1995 Grab Samples	Mean Analytical Result - 1996 Grab Samples (Solids only)
Criticality	$^{239/240}Pu$, pH[1]	[$^{239/240}Pu$] < 0.005 g/L[2], pH > 8[2,3] (supernatant); [$^{239/240}Pu$] < 1 g/L (solids)[3]	Liquids: [$^{239/240}Pu$] = 2.36E-06 g/L, pH = 13.6 Solids: [$^{239/240}Pu$] = 0.0114 g/L	[$^{239/240}Pu$] = 0.0101 g/L
Flammable gas accumulation	specific gravity	> 1.41[2,4]	Liquids: 1.082 Solids: 1.42	NP
Energetics	DSC[5], separable organic layer, TOC	DSC < 480 J/g[3]; exotherm below 168 °C or absolute value of exotherm/endotherm < 1 for analysis to 500 °C[2,4]; presence of an organic layer[3]; [TOC] < 3% (dry weight basis)[3]	Liquids: No exotherms observed, no separable organic layer, [TOC] = 2.70% (dry) Solids: NP	No exotherms observed, no separable organic layer, [TOC] = 0.292% (wet)
Corrosion	NO_3^-, OH^-, NO_2^-	If $[NO_3^-] \leq 1.0$ M: $0.01 \text{ M} \leq [OH^-] \leq 5$ M, $0.011 \leq [NO_2^-] \leq 5.5$ M, $[NO_3^-]/([OH^-]+[NO_2^-]) < 2.5$ M[3] $[OH^-] < 8.0$ M	Liquids: $[NO_3^-] = 0.364$ M, $[OH^-] = 0.600$ M, $[NO_2^-] = 0.217$ M $[NO_3^-]/([OH^-]+[NO_2^-]) = 0.446$ M Solids: NP	NP

Table 2-1. Waste Compatibility Data Quality Objective Decision Variables and Criteria for the Tank 241-AW-102 1995 Grab Samples. (3 sheets)

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result - 1995 Grab Samples	Mean Analytical Result - 1996 Grab Samples (Solids only)
Operations Issue				
TRU segregation	$^{239/240}Pu$, ^{241}Am[7]	$[^{239/240}Pu] + [^{241}Am] < 100$ nCi/g[4]	Liquids: $[^{239/240}Pu] + [^{241}Am] =$ 0.455 nCi/g Solids: $[^{239/240}Pu] + [^{241}Am] =$ 2,210 nCi/g	$[^{239/240}Pu] + [^{241}Am] =$ 2,780 nCi/g
Complexant segregation	TOC, NO_2^-, NO_3^-, CO_3^{2-} (TIC), SO_4^{2-}, PO_4^{3-}, OH^-, F^-, Al	TOC ≤ 10 g/L at the double-shell slurry feed limit.[6] Additional concentration data used in computer model to predict complexant status of waste or a boildown test is performed.[4]	See Section B2.0.	See Section B2.0.
Heat load	^{137}Cs, ^{90}Sr[8]	$< 20{,}000$ W[3,4]; $[^{137}Cs] < 5.74E+05$ μCi/L and $[^{90}Sr] < 4.04E+03$ μCi/L[3]	Liquids: $[^{137}Cs] = 3.34E+04$ μCi/L $[^{90}Sr] = 596$ μCi/L Solids: $[^{137}Cs] = 1.23E+05$ μCi/L $[^{90}Sr] = 9.43E+05$ μCi/L	NP
Pumpability	Density (specific gravity), volume percent solids	Data used with pipe diameter, viscosity, and pumping velocity to determine pumpability, volume percent solids ≤ 30[4]	Volume percent solids = 13.9 Liquids: specific gravity = 1.082 Solids: specific gravity = 1.42	NP

Table 2-1. Waste Compatibility Data Quality Objective Decision Variables and Criteria for the Tank 241-AW-102 1995 Grab Samples. (3 sheets)

Safety Issue	Primary Decision Variable[1]	Decision Criteria Threshold	Mean Analytical Result - 1995 Grab Samples	Mean Analytical Result - 1996 Grab Samples (Solids only)
Operations Issue (Cont'd)				
High-phosphate waste	PO_4^{3-}, Na	$[PO_4^{3-}] < 0.1$ M, $[Na^+] < 8.0$ M[2]	Liquids: $[PO_4^{3-}] = 0.0149$ M, $[Na^+] = 2.09$ M Solids: NP	NP

Notes:

NP = not performed
TOC = total organic carbon
TRU = transuranic

[1]Additional analytes are ^{238}Pu, ^{241}Am, ^{237}Np, and volume percent solids (Fowler 1995a).
[2]Decision critertia(on) from Von Bargen (1995).
[3]Decision critertia(on) from WHC (1996).
[4]Decision critertia(on) from Fowler (1995a).
[5]The additional analyte of TGA was requested to aid in interpretation of the DSC results and for calculation of the dry TOC results.
[6]Fowler (1995b)
[7]Additional analyte of total alpha activity (Von Bargen 1995).
[8]Additional analytes are Cm-244, C-14, H-3, Se-79, Tc-99, Np-237, I-129, Total U, Total beta, Ru/Rh-106, Ra-226, Nb-94, Eu-154, Eu-155, Cs-134, Co-60, and Ce-144 (Von Bargen 1995).

the safety and operational considerations that are within the scope of this report. The primary decision variable, the notification limit, and the analytical results from the 1995 and 1996 grab sampling event are listed for each safety or operational issue.

Apparently not all listed analyses and evaluations were within the notification limits imposed by or through the waste compatibility DQO. Some criteria clearly apply only to supernatant (WHC 1996), however other safety and operational considerations could apply to both the supernatant and solid waste in the tank. The solids density measured 1.42 g/mL. The compatibility decision criterion of less than 1.41 g/mL applies to the commingled waste; presumably the solids and liquids in tank 241-AW-102. The average specific gravity of the solids and liquids is less than 1.41, therefore the flammable gas accumulation criterion was met.

The data show that the solids in tank 241-AW-102 were classified as TRU. This does not necessarily violate any compatibility operations issue. The compatilibity DQO requires that these TRU solids be segregated from non-TRU solids and from liquids containing complexing agents that would solubilize the TRU constituents.

A second operational consideration that appeared to have exceeded the threshold was heat load. The ^{90}Sr activity on the solids in the 1995 grab samples is greater than the threshold listed in the third column of Table 2-1. However, despite the high ^{90}Sr activity in the solids, the heat load limit was probably not violated for the following two reasons. WHC (1996) assumes that the tank contained one million gallons of waste when the solids volume was actually 35.5 kgal and the total (liquids plus solids) heat load was calculated at 909 W, well below the 20,000 W limit (Le 1997).

2.3 SUMMARY

Neither the 1995 nor the 1996 sampling event in tank 241-AW-102 was intended to address the requirements of the safety-screening DQO, and the tank cannot be declared safe at this time. However, both the supernatant and solids waste samples analyzed by DSC showed no exothermic behavior. Analysis of the supernatant and solids for $^{239/240}Pu$ were well below the safety screening notification limit, however the $^{239/240}Pu$ and ^{241}Am activities were high enough to designate the solids as TRU waste. Vapor samples in the tank headspace were measured at 0 percent of the lower flammability limit (LFL).

The results from all analyses performed to address the waste compatibility safety and operational issues showed that all the criteria were met. The only potential concern was with flammable gas accumulation caused by the high specific gravity of the solids in tank 241-AW-102. The low specific gravity of the tank liquids, the relatively shallow solids waste layer, and the low total organic carbon (TOC) content of the solids suggest that flammable gas generation is not a concern (Simpson et al. 1993).

Designating the solids as TRU waste does not necessarily present a safety issue. The compatibility DQO only requires that any waste that contacts TRU wastes must not dissolve the TRU material. A summary of the DQO that applied to this tank is presented in Table 2-2. Analytical results are available in Appendix B.

Table 2-2. Summary of Compatibility Data Quality Objectives Evaluation.

Issue	Sub-issue	Result
Waste Compatibility	Criticality	Passed
	Flammable gas accumulation	Passed
	Energetics	Passed
	Corrosion	Passed
	TRU segregation	Passed
	Complexant segregation	Passed
	Heat load	Passed
	Pumpability	Passed
	High-phosphate waste	Passed

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3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank waste 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 waste. Disposal activities involve designing equipment, processes, and facilities for retrieving waste and processing it into a form that is suitable for long-term storage. Chemical inventory information generally is derived using two approaches. Component inventories are estimated using the results of sample analyses and 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. 1997). Not surprisingly, information derived using these two different approaches is often inconsistent.

An effort is under way to provide waste inventory estimates that will serve as standard characterization information for the waste management activities (Hodgson and LeClair 1996). As part of this effort, available chemical information for tank 241-AW-102 was evaluated.

3.1 CHEMICAL INFORMATION SOURCES

Available waste (chemical) information for tank 241-AW-102 includes the following:

- Statistical report for limited analytical data on two solids grab samples–one obtained in August 1995 and the other in August 1996.
- Solids levels from the 242-A Campaign 96-1 post-run document (Guthrie 1996)
- The inventory estimate for this tank generated from the Hanford defined waste (HDW) model (Agnew et al. 1997).

A list of references used in this evaluation is provided in Section D5.0.

A best-basis inventory was developed for tank 241-AW-102. A sample-based inventory was chosen as the best basis for those analytes for which sampling-based analytical values were available. When no analytical data were available, the tank inventory estimates based on double-shell tank saltcake analyses were chosen (Herting 1996) as the basis. When no other data were available, tank radionuclide content based on the HDW model saltcake formulation was used (Agnew et al. 1997). The best-basis inventory estimates for the chemical constituents and radionuclides are listed in Tables 3-1 and 3-2, respectively.

Best-basis inventories listed in Tables 3-1 and 3-2 are estimates only, and should be considered suspect. Core samples of the solids layer in Tank 241-AW-102 are needed for more reliable analyte inventories. Inventory estimates were approximated by assuming that the solids would be comparable with the double-shell tank (DST) saltcake formulation reported by Herting (1996).

Confidence in the inventory estimates derived from the SMMA1 saltcake values is low. However, until additional analyses are completed on solid samples from this tank, no better approximations can be derived.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AW-102. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)	Comment
Al	2,730	E	
Bi	204	E	
Ca	567	E	
Cl	408	E	
TIC as CO_3	2,820	S	
Cr	212	E	
F	119,000	E	
Fe	119,000	E	
Hg	1.15	E	
K	265	E	
Mn	84.1	E	
Na	37,500	E	
Ni	68.7	E	
NO_2	9,260	E	
NO_3	26500	E	
Pb	15,500	E	
PO_4	14,700	E	
Si	3,110	S	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AW-102. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)	Comment
SO_4	3,690	E	
TOC	1,030	S	
U_{TOTAL}	3,720	S	

Notes:

TIC = total inorganic carbon
TOC = total organic carbon

[1]S = Sample based, M = HDW model based, and E = Engineering assessment based.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AW-102.

Analyte	Total Inventory (Ci)	Basis (S, M, or E)	Comment
^{60}Co	12.8	S	
$^{89/90}Sr$	119,000	S	
^{90}Y	119,000	S	(Derived from $^{89/90}Sr$ value)
^{137}Cs	15,500	S	
^{137m}Ba	14,700	S	(Derived from ^{137}Cs value)
$^{239/240}Pu$	96.4	S	
^{241}Am	334	S	

Notes:

[1]S = Sample based, M = HDW model based, and E = Engineering assessment based.

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4.0 RECOMMENDATIONS

The 1995 and 1996 grab sampling efforts in tank 241-AW-102 satisfied the sampling and analysis requirements of the compatibility DQO. All safety and operational criteria of the compatibility DQO were met.

Although the 1995 and 1996 grab sampling of tank 241-AW-102 was not intended to satisfy the safety screening DQO, tank headspace vapor sample data were gathered during the 1996 grab sampling event and are available. In addition, energetics and $^{239/240}Pu$ activity were determined on selected 1995 and 1996 grab samples to determine waste compatibility. The $^{239/240}Pu$ data indicated that no criticality issue is associated with the tank, no exotherms were observed, and the vapor sample showed the tank headspace flammability at 0 percent of the LFL. Nevertheless, neither the 1995 nor 1996 grab sampling event provided a complete vertical profile of the waste, therefore the tank cannot yet be classified as "safe."

Further sampling and analysis will be required before the requirements of the safety screening DQO can be fully evaluated and before a comprehensive characterization best basis inventory for the tank can be developed.

Table 4-1 summarizes the status of the Project Hanford Management Contractor TWRS Program review and acceptance of the sampling and analysis results reported in this TCR. All DQO issues required to be addressed by sampling and analysis are listed in Column 1 of Table 4-1. Column 2 indicates (using "yes" or "no") whether the requirements of the DQO were met by the sampling and analysis activities performed. Column 3 indicates that the TWRS program responsible for the DQO concurs and accepts that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" in Column 3 indicates acceptance or disapproval, respectively, of the sampling and analysis information presented in the TCR.

Table 4-1. Acceptance of Tank 241-AW-102 Sampling and Analysis.

Issue	Sampling and Analysis Performed	PHMC TWRS Program Office Acceptance
Safety screening DQO	No	Yes
Waste compatibility DQO	Yes	Yes

Note:
PHMC = Project Hanford Management Contractor

Table 4-2 summarizes the status of TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluation specifically outlined in this report is the evaluation to determine whether the tank is safe, conditionally safe, or unsafe. Column 1 lists the different evaluations performed in this report. Columns 2 and 3 are in the same format as in Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as in Table 4-1. No safety categorization of the tank was assigned and the safety evaluation was listed as "partial" in Table 4-2 because a full-depth profile of the waste was not sampled. However, none of the analyses performed on the 1995 or 1996 grab samples indicate any safety problems.

Resampling of tank 241-AW-102 using push-mode core sampling is recommended to provide the two full-depth profiles required by the safety screening DQO.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-AW-102.

Issue	Evaluation Performed	PHMC TWRS Program Acceptance
Safety categorization (tank is safe)	Partial	Partial

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-AW-102 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 often useful for supporting or challenging conclusions based on sampling and analysis.

This appendix contains the following information:

- **Section A1**. Current status of the tank, including the current waste levels and the stabilization and isolation status of the tank
- **Section A2**. Information about the design of the tank
- **Section A3**. Process knowledge of the tank, i.e., the waste transfer history and the estimated contents of the tank based on modeling data
- **Section A4**. Surveillance data for tank 241-AW-102, including surface-level readings, temperatures, and a description of the waste surface based on photographs
- **Section A5**. References for Appendix A.

Historical sampling results (results from samples obtained before 1989) are included in Appendix B.

A1.0 CURRENT TANK STATUS

As of October 31, 1996, tank 241-AW-102 contained an estimated 375 kL (99 kgal) of waste classified as dilute non-complexed waste (Hanlon 1997). The liquid volume was estimated using an ENRAF[1] gauge and manual tape. The volumes of the waste phases found in the tank are shown in Table A1-1.

Tank 241-AW-102 is still in service and is categorized as sound. This actively ventilated tank is not on any Watch List (Public Law 101-510). All monitoring systems were in compliance with documented standards as of October 31, 1996 (Hanlon 1997).

Table A1-1. Estimated Tank Contents (Hanlon 1997).[1, 2]

Waste Type	Estimated Volume	
	kL	kgal
Total waste	375	99
Supernatant	238	63
Sludge	136	36
Saltcake	0	0
Drainable interstitial liquid	0	0
Drainable liquid remaining	238	63
Pumpable liquid remaining	238	63

Note:

[1]For definitions and calculation methods refer to Appendix C of Hanlon (1997).
[2]These data may not represent the current tank contents. Waste transfers to and from tank 241-AW-102 have occurred since the most recent sampling event.

[1]ENRAF is a registered trademark of ENRAF Corporation, Houston, Texas.

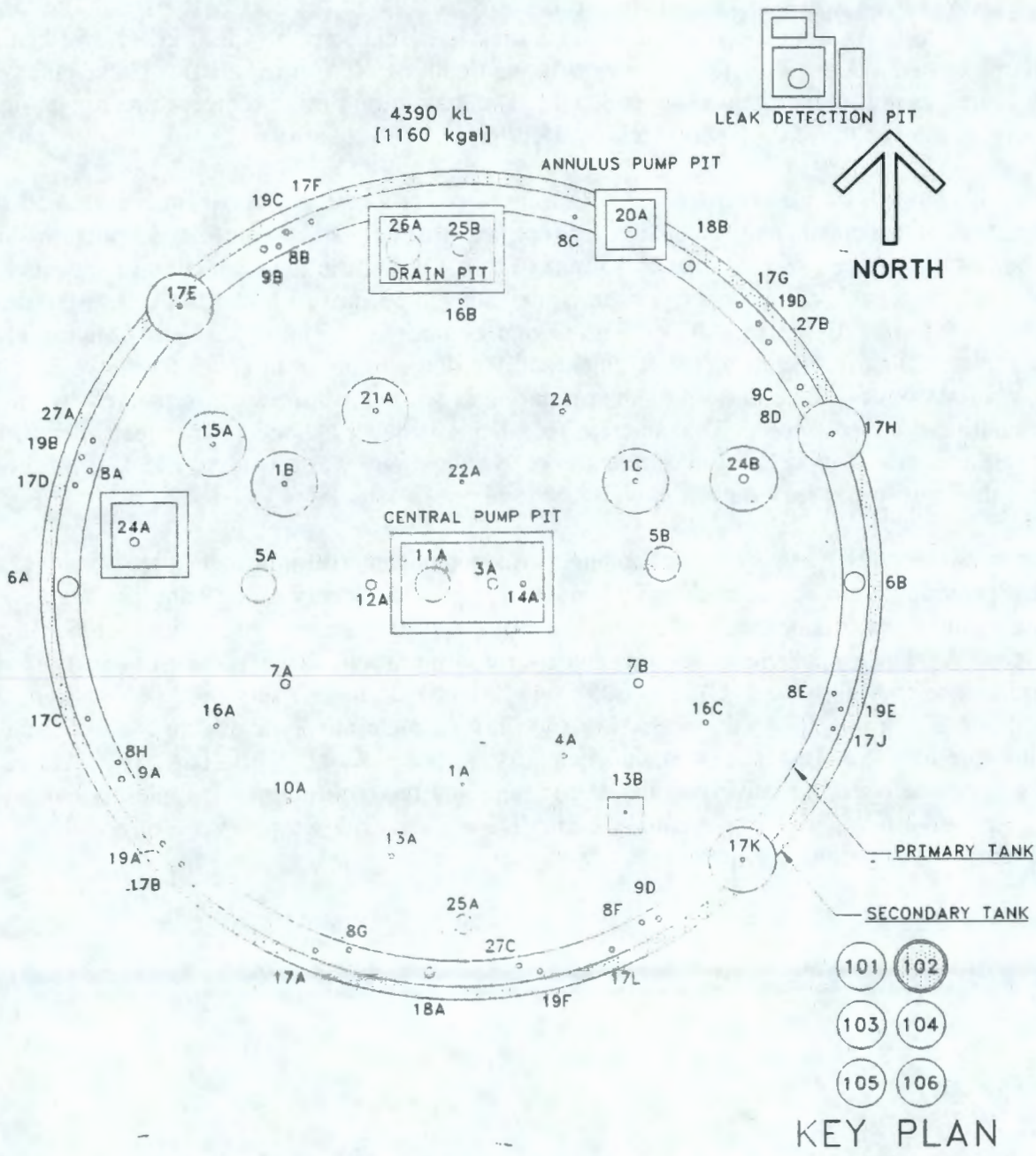
A2.0 TANK DESIGN AND BACKGROUND

The AW Tank Farm was constructed from 1978 to 1980 in the 200 East Area. The tank farm contains six double-shell tanks. Each tank has a capacity of 4,390 kL (1,160 kgal), a diameter of 22.9 m (75.0 ft), and an operating depth of 10.5 m (34.5 ft). These tanks were designed to hold concentrated supernatant. The maximum design temperature for liquid storage is 177 °C (350 °F) (Brevick et al. 1995).

Tank 241-AW-102 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 bottom of the primary and secondary liners are separated by an insulating concrete layer. The concrete foundation beneath the secondary steel liner contains a grid of drain slots. 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-AW-102 has 39 risers ranging in diameter from 100 mm (4 in.) to 1.1 m (42 in.) that provide access to the tank and 25 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 depicting the riser configuration. Two 100-mm (4-in.) diameter risers (no. 15A and no. 16C), two 305-mm (12-inch) diameter risers (no. 12A and no. 24B), and one 508-mm (20-in.) diameter riser (no. 25A) are tentatively available for sampling the tank interior. Six 100-mm (4-in.) diameter risers (nos. 1A, 1B, 13B, 16A, 16B, and 22A) are alternate risers tentatively available for sampling the tank interior (Lipnicki 1996). Figure A2-2 is a tank cross-section showing the approximate waste level along with a schematic of the tank equipment.

Figure A2-1. Riser Configuration for Tank 241-AW-102.



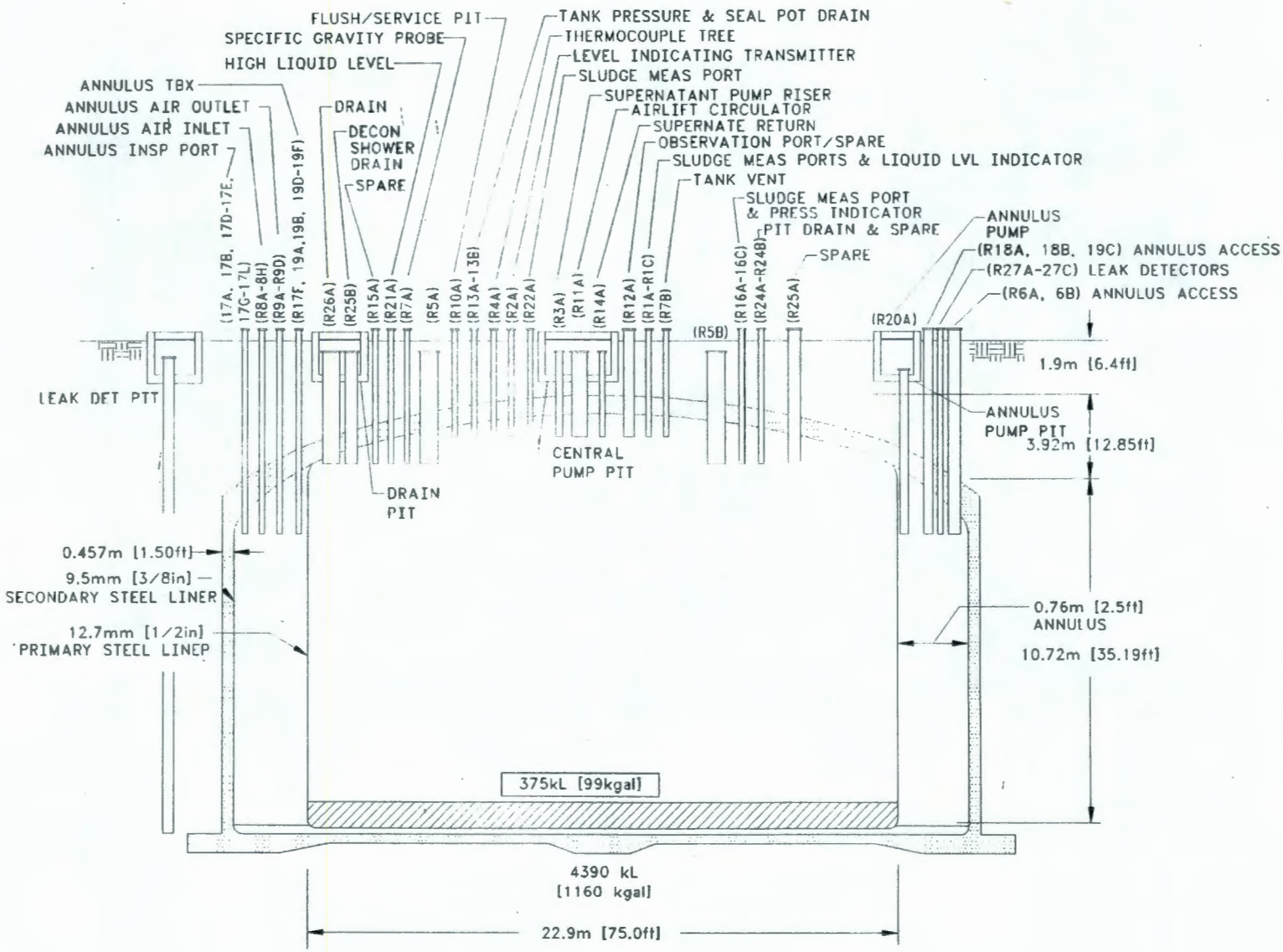


Figure A2-2. Tank 241-AW-102 Cross Section and Schematic.

Table A2-1. Tank 241-AW-102 Risers.[1,2,3,4]

Riser Number	Diameter (in.)	Description and Comments
1A[5]	4	Liquid Level Indicator (Manual)
1B[5]	4	Sludge Measurement Port, (12 in. cover) / Spare
1C	4	Sludge Measurement Port, (12 in. cover) / Spare
2A	4	Level Indicating Transmitter
3A	12	Supernatant Pump, Central Pump Pit
4A	4	Thermocouple Tree
5A	42	Manhole / Spare
5B	42	Manhole / Spare
7A	12	Specific Gravity
7B	12	Tank Ventilation / Spare
10A	4	Flush / Service Pit Drain
11A	42	Air Lift Circulator
12A[5]	12	Observation Port / Spare
13A	4	HVAC Seal Pots Drain
13B[5]	4	Tank Pressure, (24 in. cover)
14A	4	Supernatant Return, Central Pump Pit
15A[5]	4	Spare, (12 in. cover)
16A[5]	4	Sludge Measurement Port / Spare
16B[5]	4	Pressure Indicator
16C[5]	4	Sludge Measurement Port, (12 in. cover) / Spare
21A[5]	4	High Level Sensor, (12 in. cover)
22A	4	Sludge Measurement Port
24A	12	Feed Pump Pit Drain
24B[5]	12	Spare, (24 in. cover)
25A[5]	20	Spare
25B	20	272-AW Decontamination Shower Drain
26A	36	241-AW Valve Pit & 242-A Building Drain

Notes:

HVAC = heating, ventalation, and air conditioning.

[1]Salazar (1994)
[2]WHC (1995a)
[3]WHC (1995b)
[4]If there was a discrepancy between the documents and the drawing, the drawing shall take precedence.
[5]Denotes risers tentatively available for sampling.

A3.0 PROCESS KNOWLEDGE

The following sections provide information about the transfer history of tank 241-AW-102, describe the process waste that made up the transfers, and estimate the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-AW-102 based on Agnew et al. (1997a) from startup to the fourth quarter of 1993 and on the Hanford Site tank transfer database from 1994 to March 1997. This tank has an extensive transfer history because of its role as the feed tank to the 242-A Evaporator. In addition, for most of the tank's active history, water has evaporated through a condenser.

Tank 241-AW-102 entered service in 1980 by receiving dilute caustic solution waste and supernatant waste from tank 241-AW-103. From the first to third quarters of 1981, the tank received waste from tank 241-SY-102 and flush water. In the third and fourth quarters of 1981 and second quarter of 1983, the tank received dilute non-complexed waste from PUREX.

Transfers to and from the 242-A Evaporator were made during the much of the operating life of tank 241-AW-102. From the fourth quarter of 1981 to the third quarter of 1982, the tank received dilute non-complexed waste from tanks including 241-AY-102, 241-AZ-101, 241-AN-102, 241-AW-104, 241-AW-101, 241-AY-101, and 241-AN-103. Also during this time, supernatant and dilute non-complexed waste were transferred from this tank to double-shell tanks including 241-AW-101, 241-AW-104, 241-AZ-101, 241-AZ-102, 241-AN-104, 241-AN-105, 241-AN-102, and 241-SY-102. The tank received flush water from miscellaneous sources in 1982. The tank received supernatant waste from tanks 241-SY-102, 241-AZ-101, 241-AW-104, 241-AW-101, and 241-AZ-102 and a small amount of B Plant low-level waste in 1982. In the second and third quarters of 1982 and the second quarter of 1983, the tank received dilute non-complexed sulfate waste from the 100 N Area. Also in the second quarter of 1983, the tank received waste water from the 300 and 400 Area laboratories as well as other laboratory waste from unknown sources.

In the third and fourth quarters of 1983, the tank received dilute non-complexed phosphate waste from the 100 N Area. During that time, concentrated phosphate waste from the 100 N Area was sent from tank 241-AW-102 to tank 241-AN-106.

Transfers to and from tank 241-AW-102 from the second quarter of 1983 to the first quarter of 1989 were in support of the 242-A Evaporator. During this time, dilute non-complexed waste was transferred to tank 241-AW-102 from tanks 241-AN-103, 241-AW-105, 241-AW-106, 241-AY-102, 241-AW-101, and 241-AW-104. During this time, supernatant waste was sent to tank 241-AW-102 from tanks including 241-AN-102, 241-AZ-102,

241-AW-106, 241-AW-103, 241-AN-105, 241-AW-104, 241-AY-102, 241-AN-101, 241-SY-102, 241-AW-105, 241-AN-103, 241-AY-101, and 241-AW-101. Dilute non-complexed waste was transferred from tank 241-AW-102 to tanks 241-AW-104, 241-AN-103, 241-AN-104, 241-AW-101, 241-AW-106, 241-AN-105, and 241-AW-105. Supernatant waste also was transferred out of the tank to tanks 241-AW-103, 241-AW-105, 241-AY-101, 241-AY-102, 241-AW-104, 241-SY-102, and 241-AW-106 during this time.

Flush water from miscellaneous sources was added from the third quarter of 1984 to the first quarter of 1989. The tank received dilute non-complexed waste from PUREX from the second quarter of 1985 to the third quarter of 1986. In the third quarter of 1985, the tank received salt well liquor from tanks 241-B-105, 241-S-109, and 241-S-111, and the 242-A Evaporator. The tank received laboratory waste from unknown sources in the fourth quarter of 1986 and the second quarter of 1987. From the first quarter of 1987 to the third quarter of 1988, the tank received laboratory waste from the 300 and 400 Areas. From the second quarter of 1987 to the third quarter of 1988, the tank received dilute non-complexed sulfate waste from the 100 N Area. Supernatant waste also was transferred to this tank from tanks 241-AP-102, 241-SY-103, 241-AP-105, 241-AP-103 241-AP-101, and 241-AP-106 from the first quarter of 1988 to the first quarter of 1989. Dilute complexed hot semi-works TRU solids were transferred from the tank to tank 241-AW-105 in 1988. Supernatant waste was transferred to tanks 241-AP-105, 241-AP-103, 241-AP-101, and 241-AP-106 from the first quarter of 1988 to the first quarter of 1989.

Flush water from miscellaneous sources was added to the tank from the second quarter of 1989 to the third quarter of 1990. Supernatant waste was transferred out to tanks 241-AP-101 and 241-AY-102 during this time. Supernatant waste was also transferred to this tank in the first quarter of 1990 from tanks 241-AP-101 and 241-AY-102.

Supernatant waste was transferred to tank 241-AW-106 in the third quarter of 1992 and from tank 241-AW-106 in the fourth quarter of 1993. In the third and fourth quarters of 1992, supernatant transfers were made to the tank from tanks 241-T-104, 241-SX-103, 241-S-104, and 241-TY-101.

Saltwell liquor from the 242-A Evaporator was transferred to the tank from the fourth quarter of 1992 to the second quarter of 1996. From the second quarter of 1994 to the first quarter of 1997, dilute non-complexed waste was transferred to the tank from tanks 241-AW-106, 241-AP-103, 241-AP-107, 241-AP-101, 241-AP-108, 241-AP-106, and 241-AP-104 and the 242-A Evaporator. Flush water from miscellaneous sources was transferred to the tank from 1994 to 1997. Dilute non-complexed waste was sent to tank 241-AW-106 and the 242-A Evaporator from 1994 to 1996. In the first quarter of 1997, waste was transferred to the tank from tank 241-AP-105.

Table A3-1. Tank 241-AW-102 Transfer History.[1,2] (5 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[3]	
				kL	kgal
-	Condenser	Water	1980 - 1990	- 177,137	- 46,795
Dilute Caustic Solution	-	Dilute caustic	1980	72	19
241-AW-103	-	Supernatant	1980	231	61
241-SY-102	-	Supernatant	1981	3,301	872
Miscellaneous Sources	-	Flush water	1981	579	153
PUREX	-	Dilute, Non-complexed	1981, 1983	79	21
-	242-A Evaporator	Non-complexed	1981 - 1989	- 151,298	- 39,969
242-A Evaporator	-	Non-complexed	1981 - 1989	151,298	39,969
241-AY-102, 241-AZ-101, 241-AN-102, 241-AW-104, 241-AW-101, 241-AY-101, 241-AN-103	-	Dilute Non-complexed	1981 - 1982	23,662	6,251
-	241-AW-101, 241-AZ-101, 241-AZ-102, 241-SY-102	Supernatant	1981 - 1982	- 1,703	- 450
Miscellaneous Sources	-	Flush water	1982	905	239
-	241-AW-101, 241-AW-104, 241-AN-104, 241-AN-105, 241-AN-102	Dilute non-complexed	1981 - 1982	- 19,692	- 5,202

Table A3-1. Tank 241-AW-102 Transfer History.[1,2] (5 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[3]	
				kL	kgal
241-SY-102, 241-AZ-101, 241-AW-104, 241-AW-101, 241-AZ-102	-	Supernatant	1982	8,381	2,214
241-BY-104, 241-BY-105, 241-BY-107, 241-BY-108, 241-BY-109, 241-BY-109, 241-BY-110, 241-BY-111 241-BY-112	-	salt well liquor	1982	3,320	877
B Plant	-	Low level	1982	11	3
100 N Area	-	Non-complexed sulfate waste	1982 - 1983	768	203
300 and 400 Area Laboratories	-	waste water	1983	227	60
Miscellaneous Laboratories	-	waste water	1983	265	70
100 N Area	-	Non-complexed phosphate waste	1983	2,983	788
-	241-AN-106	Concentrated phosphate waste	1983	- 1,616	- 427
241-AN-103, 241-AW-105, 241-AW-106, 241-AY-102, 241-AW-101, 241-AW-104	-	Dilute non-complexed	1983 - 1989	21,531	5,688

Table A3-1. Tank 241-AW-102 Transfer History.[1,2] (5 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[3]	
				kL	kgal
241-AN-102, 241-AZ-102, 241-AW-106, 241-AW-103, 241-AN-105, 241-AW-104, 241-AY-102, 241-AN-101, 241-SY-102, 241-AW-105, 241-AN-103, 241-AY-101, 241-AW-101	-	Supernatant	1983 - 1989	277,519	73,313
-	241-AW-104, 241-AN-103, 241-AN-104, 241-AW-101, 241-AW-106, 241-AN-105, 241-AW-105	Dilute non-complexed	1983 - 1989	- 150,727	- 39,818
-	241-AW-103, 241-AW-105, 241-AY-101, 241-AY-102, 24-AW-104, 241-SY-102, 241-AW-106, 241-AN-106	Supernate	1983 - 1989	- 17,159	- 4,533
Miscellaneous Sources	-	Flush water	1984 - 1989	10,917	2,884

Table A3-1. Tank 241-AW-102 Transfer History.[1,2] (5 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[3]	
				kL	kgal
PUREX	-	Dilute Non-complexed	1985 - 1986	3,842	1,015
241-B-105, 241-S-109, 241-S-111, 242-A Evaporator	-	Salt well liquor	1985	1,242	328
Miscellaneous Laboratories	-	Waste water	1986- 1987	204	54
300 and 400 Area Laboratories	-	Waste water	1987 - 1988	386	102
100 N Area	-	Dilute non-complexed sulfate waste	1987 - 1988	908	240
241-AP-102, 241-SY-103, 241-AP-105, 241-AP-103, 241-AP-101, 241-AP-106	-	Supernatant	1988 - 1989	18,140	4,792
-	241-AW-105	Dilute hot semi-works TRU solids	1988	- 322	- 85
-	241-AP-105, 241-AP-103, 241-AP-101, 241-AP-106	Supernatant	1988 - 1989	- 2,907	- 768
Miscellaneous Sources	-	Flush water	1989 - 1990	3,028	800
-	241-AY-102, 241-AP-101	Supernatant	1990	- 1,238	- 327
241-AP-101, 241-AY-102	-	Supernatant	1990	1,359	359

Table A3-1. Tank 241-AW-102 Transfer History.[1,2] (5 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[3]	
				kL	kgal
241-T-104, 241-SX-103, 241-S-104, 241-TY-101	-	Supernatant	1992	235	62
-	241-AW-106	Supernatant	1992	- 1,367	- 361
242-A Evaporator	-	Salt well liquor	1992 - 1996	1,809	478
241-AW-106	-	Dilute non-complexed	1993	49	13
241-AW-106, 241-AP-103, 241-AP-107, 241-AP-101, 241-AP-108, 241-AP-106, 241-AP-104	-	Dilute non-complexed	1994 - 1996	43,638	11,528
-	242-A Evaporator	Dilute non-complexed	1994 - 1996	- 59,392	- 15,690
242-A Evaporator	-	Dilute non-complexed	1994 - 1996	27,138	7,169
-	241-AW-106	Dilute non-complexed	1994 - 1996	- 15,751	- 4,161
Miscellaneous Sources	-	Flush water	1994 - 1997	473	125
241-AP-105	-	Dilute non-complexed	1997	3,146	831

Notes:

TRU = transuranic

[1]Data are from Agnew et al. (1997a) before 1994, and from the Operational Waste Volume Projection database thereafter.
[2]Data in this table are not validated and should be used with caution.
[3]Because only major transfers are listed, the sum of these transfers will not equal the current waste tank 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 Southeast Quadrant of the Hanford 200 East Area* (WSTRS) (Agnew et al. 1997a). WSTRS is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4* (Agnew et al. 1997b). This document contains the Hanford Site defined waste (HDW) list, the supernatant mixing model (SMM), and the tank layer model (TLM).

- Historical Tank Content Estimate for the (Northeast, Northwest, Southeast, Southwest) Quadrant of the Hanford 200 (East or West) Area (HTCE). These four documents compile and summarize much of the process history, design, and technical information regarding the underground waste storage tanks in the 200 Areas.

- 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.

Using these records, the TLM defines 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.

These models have not been updated for waste transfers since January 1, 1994. The volume of waste in tank 241-AW-102 was 3,705 kL (979 kgal) in January 1994, and the volume as of January 26, 1997 is 375 kL (99 kgal). The Tank Layer Model predicts a 4 kL (1 kgal) waste layer of salt slurry from the 242-A Evaporator, although Hanlon (1997) and Guthrie (1997) show a solids volume of 136 kL (36 kgal) and 134 kL (35.5 kgal), respectively. Furthermore, four 242-A Evaporator campaigns have been conducted since January 1994. Therefore, the Tank Layer Model and Historical Tank Inventory Estimate are not representative of the current tank contents and are not presented here.

A4.0 SURVEILLANCE DATA

Tank 241-AW-102 surveillance consists of surface-level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and annulus instrumentation for monitoring conditions outside the primary tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate whether the tank has a major leak. Solid surface-level measurements provide an indication of physical changes in and consistencies of the solid layers of a tank.

A4.1 SURFACE-LEVEL READINGS

Waste surface level monitoring is performed with a manual ENRAF® gauge in riser 1A and a manual tape in riser 16C. Because this is an active tank, the surface level is continually subject to change. The waste surface level on January 26, 1997, from the ENRAF® gauge was 96.02 cm (36.23 in.), and from the manual tape was 90.81 cm (35.75 in.). A graphical representation of the volume measurements is presented as a level history graph in Figure A4-1.

A4.2 INTERNAL TANK TEMPERATURES

Temperature data for tank 241-AW-102 are recorded by 18 thermocouples on one thermocouple tree located in riser 4A. Temperature data are available from the Surveillance Analysis Computer System recorded from July 1989 to January 1997 for thermocouples 1, 3, 5, 7, 11, and 17. The average temperature during this period was 19.9 °C (67.8 °F) with a minimum of 11.7 °C (53 °F) and a maximum of 40.6 °C (105 °F).

A graph of the weekly high temperatures can be found in Figure A4-2. Plots of the thermocouple readings can be found in the *Supporting Document for the Historical Tank Content Estimate for AW Tank Farm* (Brevick et al. 1995).

A4.3 TANK 241-AW-102 PHOTOGRAPHS

Interior photographs are not available.

Figure A4-1. Tank 241-AW-102 Level History.

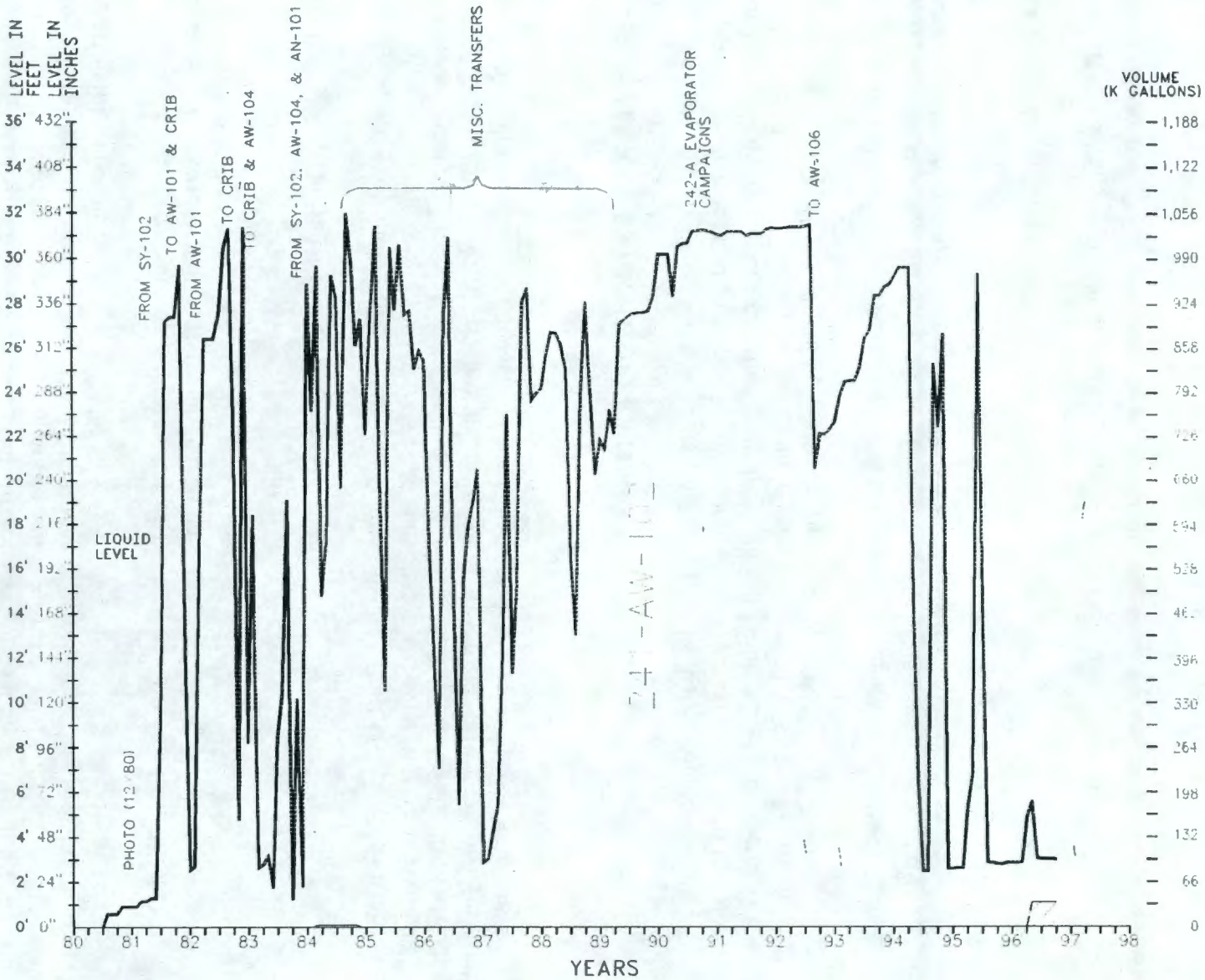
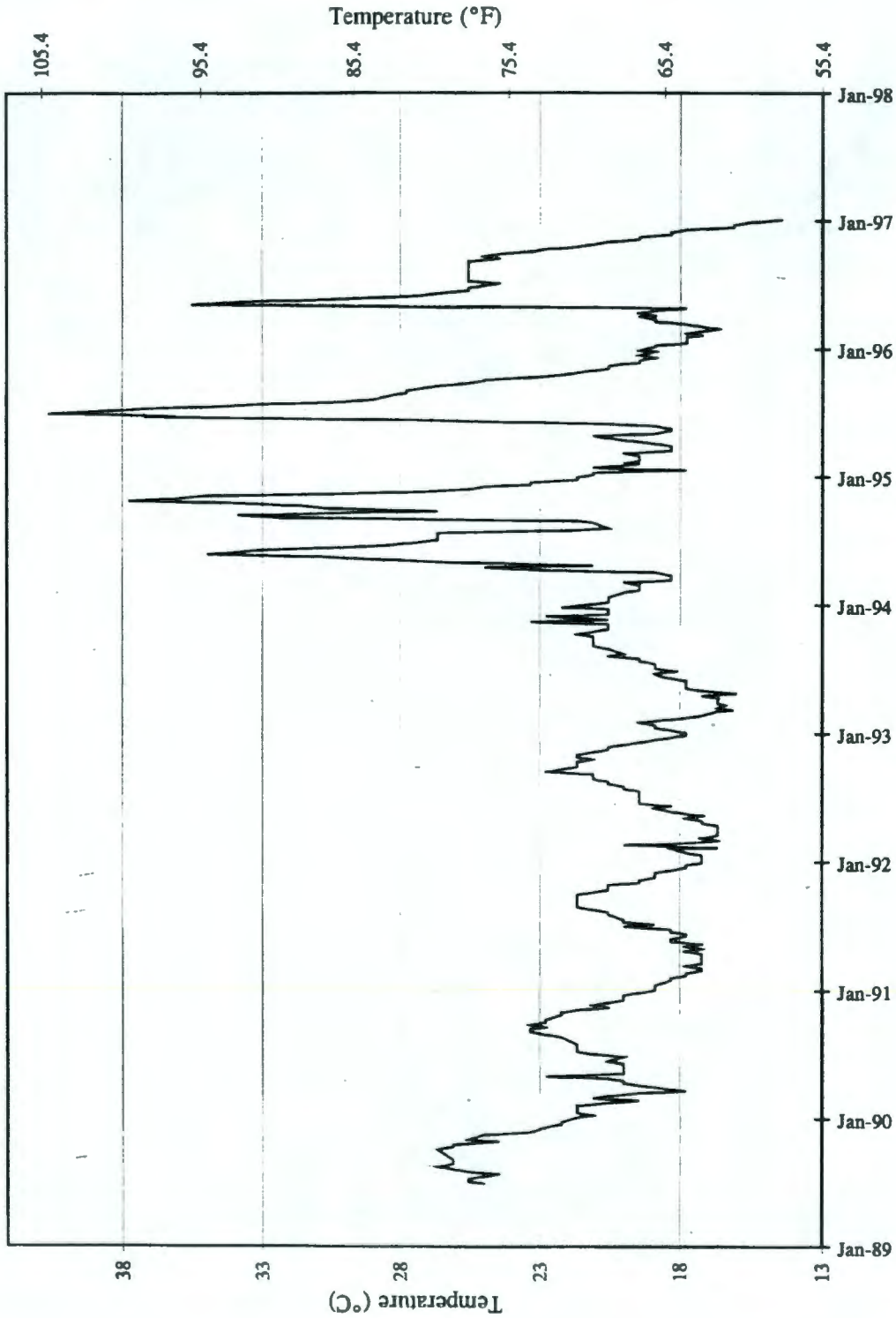


Figure A4-2. Weekly High-Temperature Plot for Tank 241-AW-102.



A5.0 APPENDIX A REFERENCES

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WHC, 1995, *Plan Tank Penetration 241-AW Tanks*, H-14-010502, sheet 2, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

APPENDIX B

SAMPLING OF TANK 241-AW-102

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APPENDIX B

SAMPLING OF TANK 241-AW-102

Appendix B provides sampling and analysis information for each known sampling event for tank 241-AW-102 and provides an assessment of the grab sample 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-AW-102 will be added to this list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the August 1995 and August 1996 sampling and analysis events for tank 241-AW-102. Three grab samples were taken in 1995 to satisfy the requirements of *Data Quality Objectives for the Waste Compatibility Program* (Fowler 1995) and *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives* (Von Bargen 1995) through the compatibility DQO. Two grab samples were taken in 1996 to satisfy the requirements of the compatibility DQO, as well as the evaporator DQO and *Unclassified Operating Specifications for the 241-AN, AP, AW, AY, AZ & SY Tank Farms* (OSD document for the double-shell tanks) (WHC 1996a) through the compatibility DQO. The compatibility DQO requires compliance "with existing requirements and guidelines, which include flow sheets [and] operating specification document (OSD) limits..." Grab sampling was used because past sampling experience indicated that this was the most cost- and time-efficient method of obtaining the necessary samples of sludge and supernatant from tank 241-AW-102. Additional sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (De Lorenzo et al. 1994).

Because Tank 241-AW-102 is the feed tank for the 242-A Evaporator, its contents continually change during evaporator campaigns. A complete characterization of the waste would require a sampling event to be conducted under static conditions with respect to tank farm operations. Because of this, historical data do not represent the current tank contents and are not presented here.

B1.1 DESCRIPTION OF 1995 AND 1996 GRAB SAMPLING EVENTS

The 1995 grab samples were taken following the instructions in the sampling work package (WHC 1995a) and the grab sampling process memorandum (WHC 1995b). Three grab samples, 2AW-95-1, 2AW-95-2, and 2AW-95-3 were removed from riser 16A on August 8, 1995, and received by the 222-S Laboratories on the same day. Samples 2AW-95-1 and 2AW-95-3 consisted of supernatant and sludge, and sample 2AW-95-2 only contained supernatant.

The 1996 grab sampling was performed following the instructions in the sampling work package (WHC 1996b) and *Compatibility Grab Sampling and Analysis Plan* (Bell 1996). Grab samples 2AW961 and 2AW962 were removed from riser 22A and received by the 222-S Laboratory on the same day. Both samples consisted of supernatant and sludge, however the supernatant was discarded after the two samples were combined and centrifuged.

Before removing the 1996 grab samples, the flammability of tank vapors was checked using a combustible gas meter. This was done to meet operational safety requirements (WHC 1996a). To meet these requirements, the vapors in the tank headspace must be less than 25 percent of the lower flammability limit. This measurement was conducted in the field and was recorded in the sampling work package. The highest combustible gas meter reading observed in the tank headspace was 0 percent of the LFL.

The sampling and analytical requirements covering the grab samples are summarized in Table B1-1.

Table B1-1. Integrated Data Quality Objective Requirements for Tank 241-AW-102.

Sampling Event	Applicable DQOs	Minimum Sampling Requirements	Analytical Requirements
1995 and 1996 Grab Sampling	Compatibility	Liquid and solid samples from two risers	Energetics, moisture content, total organic carbon, total carbon, total inorganic carbon, ^{137}Cs, ^{90}Sr, Al, Fe, Na, hydroxide, anions, carbonate, pH, $^{239/240}Pu$, ^{241}Am, specific gravity, volume percent solids, radionuclides

B1.2 SAMPLE HANDLING (1995 AND 1996 GRAB SAMPLES)

Pertinent sampling information for the 1995 and 1996 grab samples is provided in Table B1-2. As directed, both 1996 samples were combined then centrifuged. The supernatant was then discarded. Additional detailed information on sample handling and breakdown of the 1995 and 1996 grab samples is provided in Esch (1995 and 1996). On delivery to the 222-S Laboratory, the 1995 and 1996 grab samples were broken down and subsampled according to Schreiber (1995) and Bell (1996), respectively. Visual inspection of the samples provided an estimate of the percent solids and indicated that no organic layers were present. Color photographs were taken of each grab sample and may be viewed by contacting the 222-S Laboratory.

Table B1-2. Tank 241-AW-102 Subsampling Scheme and Sample Description.[1] (2 sheets)

Riser	Sample Identification	Weight[2] (grams)	Sample Recovery (%)[2]	Sample Portion	Sample Characteristics
16A	2AW-95-1	1.80	1.6[3]	Sludge	This sample contained two solid pieces of material that resembled metal. Sludge material consisted of a light brown material on top of a larger layer of dark brown to black, coarser material.
		113.5	98.4	Liquid	The supernatant was clear and yellow-brown in color.
	2AW-95-2	not provided	n/a	Liquid	The sample was a clear, yellow liquid above a layer of brown, settled solids. The solids were not analyzed (Schreiber 1995).

Table B1-2. Tank 241-AW-102 Subsampling Scheme and Sample Description.[1] (2 sheets)

Riser	Sample Identification	Weight[2] (grams)	Sample Recovery (%)[2]	Sample Portion	Sample Characteristics
16A (Cont'd)	2AW-95-3	20.1	15.6	Sludge	The sludge appeared as a bottom layer of brown settled solids.
		108.3	84.3	Liquid	The supernate was a clear yellow liquid.
22A	2AW961	not provided	n/a	Sludge	The sample was a clear yellow liquid above a layer of fine particulates and some larger pieces of material.
	2AW962	not provided	n/a	Sludge	The sample was a clear yellow liquid above a layer of fine particulates and some larger pieces of material.

Note:

[1]From Esch (1995 and 1996).
[2]Weight and sample recovery based on desired sample matrix sampled, i.e., sludge or liquid.
[3]Percent recovery did not include "metal."

B1.3 SAMPLE ANALYSIS (1995 AND 1996 GRAB SAMPLES)

The analyses performed on the 1995 grab samples were not limited to those needed to satisfy the compatibility and evaporator DQO requirements. Additional analytical results for ^{60}Co were obtained as the opportunity arose (Kristofzski 1996) while meeting the DQO requirements. The analyses performed on the 1996 grab samples were limited to those needed to satisfy the compatibility DQO requirements. Results of the grab sample analyses were reported in Esch (1995 and 1996).

Liquid grab subsamples taken in 1995 were analyzed directly or after dilution in water or acid. Depending on the analysis, solid subsamples from the 1995 grab samples were analyzed directly or after a fusion or water digestion. The 1996 solid grab samples were analyzed directly or after a fusion digestion. Analysis for bulk density (solids), specific gravity (liquids), volume percent solids, total organic carbon (TOC), and total inorganic carbon (TIC) was performed directly. Analysis by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) was performed directly under a nitrogen purge. Inductively coupled plasma (ICP) and all radiochemistry analyses were performed on samples that had been fused with potassium hydroxide and then dissolved in acid.

The results of the analyses are presented and discussed in Section B2.0. The results of the quality control (QC) tests and the implications for data quality are discussed in Section B3.2. A summary of the samples, sample portions, individual sample numbers, and the analyses performed on each sample are available in Table B1-3. All reported analyses were performed in accordance with approved laboratory procedures. The procedure numbers are presented in the discussion in Section B2.0.

Table B1-3. Tank 241-AW-102 Sample Analysis Summary. (2 sheets)

Sample	Sample Portion	Sample Number	Analysis
2AW-95-1	Supernate	S95T002157	TIC, TC, SpG, Si
		S95T002158	^{137}Cs, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha, total beta, total U, $^{60}Co^{1}$
	Sludge (direct)	S95T002300	TC, % Solids
	Sludge (fusion)	S95T002304	^{137}Cs, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha, total beta, total U, $^{60}Co^{1}$
2AW-95-2	supernatant	S95T002556	DSC, TGA, TOC, TIC, TC, Al, Fe, Na, Cl^-, F^-, PO_4^{3-}, SO_4^{2-}, NO_2^-, NO_3^-, pH, OH^-, SpG
		S95T002308	^{137}Cs, ^{238}Pu, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, ^{244}Cm, total alpha, total beta, ^{14}C, ^{3}H, ^{79}Se, ^{99}Tc, ^{237}Np, ^{129}I, total U, $^{106}Ru/Rh$, ^{226}Ra, ^{94}Nb, ^{154}Eu, ^{155}Eu, ^{134}Cs, ^{60}Co, ^{144}Ce
2AW-95-3	supernatant	S95T002309	TIC, TC, SpG, Si, ^{137}Cs, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha, total beta, total U
	Sludge (direct)	S95T002303	TIC, TC, % Solids, SpG
	Sludge (fusion)	S95T002305	^{137}Cs, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha, total beta, total U, Si, $^{60}Co^{1}$

Table B1-3. Tank 241-AW-102 Sample Analysis Summary. (2 sheets)

Sample	Sample Portion	Sample Number	Analysis
2AW961 and 2AW962	Sludge composite (direct)	S96T004803	DSC, TOC
	Sludge composite (fusion)	S96T004804	$^{239/240}Pu$, ^{241}Am, total alpha

Notes:

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

[1]This analyte was not required by the Schreiber (1995) TSAP, but was reported in Esch (1995).

B2.0 ANALYTICAL RESULTS

B2.1 OVERVIEW

This section summarizes the analytical results associated with the August 1995 and August 1996 sampling and analysis of tank 241-AW-102. The results associated with the 1995 and 1996 samples are presented in Table B2-1, and are documented respectively in Esch (1995 and 1996).

Table B2-1. Analytical Presentation Tables.

Analysis	Table Number
Specific gravity	B2-2
Volume percent solids	B2-3
pH	B2-4
Percent water	B2-5
Hydroxide	B2-6
TC	B2-7
TOC	B2-8
TIC	B2-9
Summary data for metals by ICP	B2-10 through B2-13
Anions by IC	B2-14 through B2-19
Total uranium	B2-20
Radionuclides	B2-21 through B2-43

Notes:

IC = ion chromotography
ICP = inductively coupled plasma
TC = total carbon
TIC = total inorganic carbon
TOC = total organic carbon

The four QC parameters assessed in conjunction with the 1995 and 1996 tank 241-AW-102 grab samples were standard recoveries, spike recoveries, duplicate analyses, and blanks with the following exceptions, in accordance with the respective sampling and analysis plans (SAP).Duplicate analysis or spikes were not required for sample 2AW-95-2, 2) spikes were not required on samples 2AW961 and 2AW962. The QC criteria specified in the respective SAPs (Schreiber 1995) (Bell 1996) were 80 to 120 percent recovery for standards and spikes and less than 20 percent for RPDs. These criteria applied to all analytes. The only QC parameter for which limits are not specified in the SAP is blank contamination. The limits for blanks are set forth in guidelines followed by the laboratory, and all data results presented in this report have met those guidelines. Sample and duplicate pairs in which any of the QC parameters were outside these limits are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, or e 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 that the blank was contaminated.

In each 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 expressed as a detected value. If both values were detected, the mean was expressed as a detected value.

B2.2 PHYSICAL MEASUREMENTS

B2.2.1 Specific Gravity

Analyses for specific gravity were performed directly on the supernate from the three 1995 grab samples and on the sludge from sample 2AW-95-3. The samples were analyzed following Procedure LA-510-112 (supernatant) or LA-510-116 (sludge). The supernatant with the highest measured specific gravity (1.12) came from sample 2AW-95-2. Results are provided in Table B2-2.

Table B2-2. Tank 241-AW-102 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**unitless**	**unitless**	**unitless**
S95T002157	Riser 16A	Grab sample	1.02	1.02	1.02
S95T002309	Riser 16A	Grab sample	1.10	1.11	1.105
S95T002556	Riser 16A	Grab sample	1.14	1.10	1.12
Sludge			**unitless**	**unitless**	**unitless**
S95T002303	Riser 16A	Grab sample	1.20	1.64	1.42[QC:e]
2AW-95-3	Riser 16A	Grab sample	1.26[1]	n/a	1.26
2AW961 and 2AW962	Riser 22A	Solids composite	1.20[2]	n/a	1.20

Notes:

[1]Result reported in Esch (1995).
[2]Result rerorted in Esch (1996).

B2.2.2 Settled and Volume Percent Solids

The percent settled solids present in the three 1995 grab samples was approximated by calculating the ratio of the measured height of the settled solids to that of the entire sample. The results were reported in the narrative of Esch (1995), but were not reported in the LABCORE database. The results were 18 percent for sample 2AW-95-1, 10 percent for 2AW-95-2, and 32 percent for 2AW-95-3.

The volume percent solids determined after centrifugation was measured only on sample 2AW-95-3 according to procedure LA-519-132. The result is given in Table B2-3.

Table B2-3. Tank 241-AW-102 Analytical Results: Volume Percent Solids.

Sample Number	Sample Location	Sample Portion	Result	Mean
Whole Sample			**percent**	**percent**
S95T002160	Riser 16A	Whole sample	13.90	13.90

B2.2.3 pH

The determination of pH was made only on the supernatant from sample 2AW-95-2 using procedure LA-212-106. As expected, the liquid was quite alkaline. The analytical report (Esch 1995) indicated that pH values greater that 12.5 are suspect and should be considered estimates. The results are shown in Table B2-4.

Table B2-4. Tank 241-AW-102 Analytical Results: pH Measurement.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			unitless	unitless	unitless
S95T002556	Riser 16A	Grab sample	13.54	13.57	13.56

B2.2.4 Thermodynamic Analyses

Analyses for percent water by TGA and energetics by DSC were required on the supernatant from the 1995 grab sample 2AW-95-2. Only an analysis for energetics by DSC was required on the sludge composite of 1996 grab samples 2AW961 and 2AW962.

B2.2.4.1 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 degrees Celsius [°C]) is caused by 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.

The 1995 grab sample was analyzed by TGA using procedure LA-560-112. The TGA results are presented in Table B2-5.

Table B2-5. Tank 241-AW-102 Analytical Results: Percent Water.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			percent	percent	percent
S95T002556	Riser 16A	Grab sample	84.14	83.84	83.99

B2.2.4.2 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the sample is heated 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-AW-102 were performed on the supernatant from the 1995 grab sample 2AW-95-2 using procedure LA-514-113, and on the sludge composite of the 1996 grab samples 2AW961 and 2AW962 using procedure LA-514-114. No exothermic reactions were observed on any samples.

B2.3 INORGANIC ANALYSES

B2.3.1 Hydroxide

The determination of hydroxide was made only on the supernatant from sample 2AW-95-2 using procedure LA-211-102. The results are shown in Table B2-6.

Table B2-6. Tank 241-AW-102 Analytical Results: Hydroxide.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	10,200	10,200	10,200

B2.3.2 Total Carbon

All supernatant and sludge subsamples of the 1995 grab samples were analyzed for total carbon. The supernatant subsamples were analyzed directly by furnace oxidation according to procedure LA-344-105. Persulfate oxidation by procedure LA-342-100 was used to perform the total carbon analyses on the sludge samples. All results are shown in Table B2-7.

Table B2-7. Tank 241-AW-102 Analytical Results: Total Carbon. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002157	Riser 16A	Grab sample	2,382	2,363	2,373
S95T002309	Riser 16A	Grab sample	4,412	5,480	4,946[QC:e]
S95T002556	Riser 16A	Grab sample	4,755	n/a	4,755
Sludge			**µg/g**	**µg/g**	**µg/g**
S95T002300	Riser 16A	Grab sample	5,820	6,430	6,125
S95T002303	Riser 16A	Grab sample	11,800	11,400	11,600

B2.3.3 Total Organic Carbon

Analysis for TOC was performed on the 1996 grab samples and on the supernatant from sample 2AW-95-2. The supernatant sample was analyzed directly by furnace oxidation according to procedure LA-344-105. Persulfate oxidation by procedure LA-342-100 was used to perform the TOC analysis on the 1996 composite sludge sample. All results are shown in Table B2-8.

Table B2-8. Tank 241-AW-102 Analytical Results: Total Organic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	4,030	4,620	4,325
Sludge			**µg/g**	**µg/g**	**µg/g**
S96T004803	Riser 22A	Grab sample	2,780	3,060	2,920

B2.3.4 Total Inorganic Carbon

Analysis for TIC was performed on the supernatant subsamples of all three 1995 grab samples, and on the sludge subsample of sample 2AW-95-3. All samples were analyzed directly by coulometry according to procedure LA-622-102. The results are shown in Table B2-9.

Table B2-9. Tank 241-AW-102 Analytical Results: Total Inorganic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002157	Riser 16A	Grab sample	1,824	1,824	1,824
S95T002309	Riser 16A	Grab sample	4,069	3,912	3,990[QC:f]
S95T002556	Riser 16A	Grab sample	3,637	n/a	3,637[QC:f]
Sludge			**µg/g**	**µg/g**	**µg/g**
S95T002303	Riser 16A	Grab sample	3,230	3,170	3,200
S96T004803	Riser 22A	Grab sample	3,380	2,770	3,080

B2.3.5 Inductively Coupled Plasma

Analysis by ICP was performed on the 1995 grab samples. Supernatant subsample 2AW-95-2 was analyzed directly for aluminum, iron, and sodium following acid dilution. Sludge subsamples were prepared by fusion digestion before analysis for silicon. The ICP analyses were performed in accordance with procedure LA-505-161. The concentrations of metals in the samples are shown in Tables B2-10 through B2-13.

Table B2-10. Tank 241-AW-102 Analytical Results: Aluminum.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	1,716	1,717	1,717

Table B2-11. Tank 241-AW-102 Analytical Results: Iron.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	< 10.05	< 10.05	< 10.05

Table B2-12. Tank 241-AW-102 Analytical Results: Silicon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002157	Riser 16A	Grab sample	375.2	397.6	386.4
S95T002309	Riser 16A	Grab sample	511.1	530.3	520.7
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
S95T002304	Riser 16A	Grab sample	18,861	18,446	18,654
S95T002305	Riser 16A	Grab sample	16,390	15,536	15,963

Table B2-13. Tank 241-AW-102 Analytical Results: Sodium.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	48,238	48,046	48,142

B2.3.6 Ion Chromatography

Sample 2AW-95-2 of the 1995 grab samples was analyzed for chloride, fluoride, nitrate, nitrite, phosphate, and sulfate directly by IC following dilution. Procedure LA-533-105 was used. The results appear in Tables B2-14 through B2-19.

Table B2-14. Tank 241-AW-102 Analytical Results: Chloride.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	505	505

Table B2-15. Tank 241-AW-102 Analytical Results: Fluoride.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	5,190	5,190

Table B2-16. Tank 241-AW-102 Analytical Results: Nitrate.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	22,600	22,600

Table B2-17. Tank 241-AW-102 Analytical Results: Nitrite.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	9,990	9,990

Table B2-18. Tank 241-AW-102 Analytical Results: Phosphate.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	1,420	1,420

Table B2-19. Tank 241-AW-102 Analytical Results: Sulfate.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µg/mL**	**µg/mL**
S95T002556	Riser 16A	Grab sample	2,750	2,750

B2.3.7 Total Uranium

Procedure LA-508-101 was used to determine uranium by the phosphorescence method. Supernatant samples were analyzed directly; sludge samples were prepared by a fusion digestion before analysis. The results are presented in Table B2-20.

Table B2-20. Tank 241-AW-102 Analytical Results: Total Uranium.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Sludge: fusion			**µg/g**	**µg/g**	**µg/g**
S95T002304	Riser 16A	Grab sample	9,100	9,140	9,120[QC:f]
S95T002305	Riser 16A	Grab sample	33,400	31,300	32,350
Liquids			**µg/mL**	**µg/mL**	**µg/mL**
S95T002158	Riser 16A	Grab sample	2.990	3.039	3.015[QC:f]
S95T002308	Riser 16A	Grab sample	16.47	n/a	16.47[QC:f]
S95T002309	Riser 16A	Grab sample	12.16	9.906	11.03[QC:e,f]

B2.3.8 Radionuclides

Both the 1995 and 1996 grab samples were analyzed for selected radionuclides. All the 1995 supernatant and sludge subsamples were analyzed for ^{137}Cs by gamma energy analysis (GEA). Sample 2AW-95-2 was analyzed for ^{137}Cs, ^{1324}Cs, ^{60}Co, ^{94}Nb, $^{106}Ru/Rh$, ^{144}Ce, ^{154}Eu, ^{155}Eu, and ^{226}Ra by GEA using procedure LA-548-121. Procedure LA-220-101 was used to analyze for ^{90}Sr in the 1995 samples. The samples were also analyzed for the following: ^{3}H by Procedure LA-218-114, ^{14}C by Procedure LA-348-104, ^{99}Tc by Procedure LA-438-101, ^{129}I by Procedure LA-378-103, ^{238}Pu by Procedure LA-943-127, ^{237}Np using Procedure LA-933-141, total beta by Procedure LA-508-101, ^{79}Se according to Procedure LA-365-132, and ^{244}Cm according to Procedure LA-953-103. In all cases, supernatant samples were analyzed directly and sludge samples were analyzed following a fusion digestion.

All the 1995 subsamples and the 1996 sludge composite were analyzed for $^{239/240}Pu$, ^{241}Am, and total alpha activity. The respective procedures used were: LA-943-127 (1995 and 1996), LA-953-103 (1995) and LA-953-103, and LA-508-101 (1995) and LA-508-101 (1996).

The radiochemical results are shown in Tables B2-21 through B2-42.

Table B2-21. Tank 241-AW-102 Analytical Results: Americium-241.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	< 1.570E-05	< 6.630E-05	< 4.100E-05
S95T002308	Riser 16A	Grab sample	< 1.440E-05	n/a	< 1.440E-05
S95T002309	Riser 16A	Grab sample	3.270E-04	3.680E-04	3.475E-04
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	0.743	0.748	0.746
S95T002305	Riser 16A	Grab sample	2.65	2.68	2.66
S96T004804	Riser 22A	Sludge composite	2.29	2.02	2.15

Table B2-22. Tank 241-AW-102 Analytical Results: Total Alpha.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	3.53	3.51	3.52[QC:e]
S95T002305	Riser 16A	Grab sample	0.555	0.676	0.626
S96T004804	Riser 22A	Sludge composite	3.25	2.86	3.06
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	<0.00126	<0.00126	<0.00126
S95T002308	Riser 16A	Grab sample	<0.00126	n/a	<0.00126
S95T002309	Riser 16A	Grab sample	<0.00184	<0.00256	<0.0022

Table B2-23. Tank 241-AW-102 Analytical Results: Total Beta.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	16.3	16.3	16.3[QC:f]
S95T002308	Riser 16A	Grab sample	44.3	n/a	44.3[QC:f]
S95T002309	Riser 16A	Grab sample	46.6	46.3	46.45[QC:f]
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	385	376	380.5
S95T002305	Riser 16A	Grab sample	1,930	1,870	1,900

Table B2-24. Tank 241-AW-102 Analytical Results: Plutonium-238.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	1.900E-05	1.900E-05

Table B2-25. Tank 241-AW-102 Analytical Results: Plutonium-239/240.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	0.175	0.159	0.167
S95T002305	Riser 16A	Grab sample	0.831	0.816	0.823
S96T004804	Riser 22A	Sludge composite	0.659	0.582	0.621
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	4.620E-05	4.750E-05	4.685E-05
S95T002308	Riser 16A	Grab sample	1.490E-04	n/a	1.490E-04
S95T002309	Riser 16A	Grab sample	2.360E-04	2.430E-04	2.395E-04

Table B2-26. Tank 241-AW-102 Analytical Results: Curium-243/244.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	< 1.440E-05	< 1.440E-05

Table B2-27. Tank 241-AW-102 Analytical Results: Carbon-14.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	6.970E-05	6.970E-05

Table B2-28. Tank 241-AW-102 Analytical Results: Cerium/Praseodymium-144.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<0.0788	<0.0788

Table B2-29. Tank 241-AW-102 Analytical Results: Cesium-134.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	0.0784	0.0784

Table B2-30. Tank 241-AW-102 Analytical Results: Cesium-137.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	40.71	41.70	41.20
S95T002305	Riser 16A	Grab sample	131.2	132.0	131.6
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	15.5	15.6	15.6[QC:f]
S95T002308	Riser 16A	Grab sample	40.3	n/a	40.3
S95T002309	Riser 16A	Grab sample	45.9	42.9	44.4[QC:f]

Table B2-31. Tank 241-AW-102 Analytical Results: Cobalt-60.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	<0.0304	<0.0308	<0.0306
S95T002305	Riser 16A	Grab sample	0.114	0.106	0.110
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	<8.650E-04	<8.660E-04	<8.655E-04
S95T002308	Riser 16A	Grab sample	0.00349	n/a	0.00349
S95T002309	Riser 16A	Grab sample	<0.00296	<0.00305	<0.003005

Table B2-32. Tank 241-AW-102 Analytical Results: Europium-154.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<0.00841	<0.00841

Table B2-33. Tank 241-AW-102 Analytical Results: Europium-155.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<0.0179	<0.0179

Table B2-34. Tank 241-AW-102 Analytical Results: Niobium-94.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<0.00477	<0.00477

Table B2-35. Tank 241-AW-102 Analytical Results: Radium-226.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<0.0994	<0.0994

Table B2-36. Tank 241-AW-102 Analytical Results: Ruthenium/Rhodium-106.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<0.134	<0.134

Table B2-37. Tank 241-AW-102 Analytical Results: Iodine-129.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	3.160E-05	3.160E-05

Table B2-38. Tank 241-AW-102 Analytical Results: Neptunium-237.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	<2.060E-05	<2.060E-05[QC:a]

Table B2-39. Tank 241-AW-102 Analytical Results: Tritium.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	0.00511	0.00511

Table B2-40. Tank 241-AW-102 Analytical Results: Selenium-79.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	4.680E-05	4.680E-05[QC:f]

Table B2-41. Tank 241-AW-102 Analytical Results: Strontium-89/90.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T002304	Riser 16A	Grab sample	207	209	208
S95T002305	Riser 16A	Grab sample	1,130	1,110	1,120
Liquids			**µCi/mL**	**µCi/mL**	**µCi/mL**
S95T002158	Riser 16A	Grab sample	<0.00209	0.00296	<0.00253[QC:e,f]
S95T002308	Riser 16A	Grab sample	0.0301	0.0230	0.0266[QC:f]
S95T002309	Riser 16A	Grab sample	1.13	1.20	1.16[QC:f]

Table B2-42. Tank 241-AW-102 Analytical Results: Technetium-99.

Sample Number	Sample Location	Sample Portion	Result	Mean
Liquids			**µCi/mL**	**µCi/mL**
S95T002308	Riser 16A	Grab sample	0.00964	0.00964

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

This chapter covers the overall quality and consistency of the current sampling results for tank 241-AW-102, and to present the results of the calculation of an analytical-based inventory.

This section also evaluates sampling and analysis factors that may affect interpretation of the data. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data.

B3.1 FIELD OBSERVATIONS

Sample recovery for the 1995 grab samples was nearly sufficient to meet all the analytical and archiving requirements of the SAP (Schreiber 1995). Insufficient solids were available in sample 2AW-95-1 to analyze for TIC and specific gravity or to archive, but all remaining analytical and archiving requirements were met.

The 1995 grab samples were redesignated as to which samples were supernatant and which were solids. Sample 2AW-95-1 was originally designated as supernatant and samples 2AW-95-2 and 2AW-95-3 were originally designated as solids samples. However, after visual observation of the samples, 242-A Evaporator Engineering and East Tank Farms Transition Projects Engineering requested that the samples be redesignated as follows: Sample 2AW-95-2 as supernatant and samples 2AW-95-1 and -3 as sludge (Le 1995).

All sampling and analytical requirements for the 1996 grab samples were met. The two grab samples were combined and centrifuged as prescribed in the SAP (Bell 1996).

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes evaluations of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent QC tests were conducted on the 1995 and 1996 grab samples, allowing a full assessment of the data's accuracy and precision. The respective SAPs established the specific criteria for all analytes. Sample and duplicate pairs that had one or more QC results outside the specified criteria were identified by footnotes in the data summary tables.

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, respectively. The precision is estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100.

The criterion for standard recovery was not met for one analysis–^{237}Np analysis on sample 2AW-95-2. The standard recovery was 74.3 percent, which was outside the 80- to 120-percent limit. The sample was not rerun because the standard recovery was within the laboratory statistical control limits for this analyte.

The RPD values for three analyses on the 1995 grab samples were above the SAP limits. The RPD for total alpha activity on the solids from sample 2AW-95-1 was high at 22.5 percent. The high RPD was attributed to the low activity of the sample (Esch 1995). Similarly, the ^{90}Sr analysis on sample 2AW-95-2 showed a RPD of 26.7 percent that was attributed to low activity. Finally, the specific gravity, TOC, and uranium analyses of sample 2AW-95-3 had high RPD values. The analytical report notes that during centrifugation of sample 2AW-95-3, the solids were found to contain a piece of metal and some possible metal sediment. The result of this may have been a heterogeneous solid sample leading to the RPD values with high specific gravity. The TOC and total uranium RPD values were 21.6 and 20.4 percent, respectively. No reruns were requested because the RPD values were so close to the 20-percent limit.

Blank contamination was found for many analyses in all three 1995 grab samples. However, in all cases the contamination level in the blank was either below the detection limit or it was at least 10 times less than the sample result.

In summary, the vast majority of the QC results were within the boundaries specified in the SAPs. The discrepancies mentioned here and footnoted in the data summary tables should not affect 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. Several comparisons were possible with the data set provided by the 1995 and 1996 grab samples. These include comparison of total alpha activity with the sum of the $^{239/240}$Pu and ^{241}Am activities, comparison of total beta activity with the sum of the ^{137}Cs and ^{90}Sr activities, and comparison of TOC with the difference between the total carbon and TIC results. In addition, mass and charge balances were calculated to help assess the data's overall consistency.

B3.3.1 Total Alpha Results

The mean total alpha activity results from the 1995 and 1996 grab sample solids were each compared with the respective $^{239/240}Pu$ and ^{241}Am results. The total alpha result from the 1995 supernate was less than detectable, therefore no comparison was made with the $^{239/240}Pu$ and ^{241}Am results on the supernatant.

1995 solids: Total alpha = 2.07 μCi/g, [$^{239/240}Pu$] + [^{241}Am] = 2.20 μCi/g

1996 solids: Total alpha = 3.06 μCi/g, [$^{239/240}Pu$] + [^{241}Am] = 2.78 μCi/g

These calculations show less than 10 percent relative difference between the total alpha activity and the sum of the major alpha emitters.

B3.3.2 Total Beta Results

The mean total beta activity results from the 1995 grab sample solids and supernatant were each compared with the respective ^{137}Cs and ^{90}Sr results.

1995 supernatant: Total beta = 35.7 μCi/mL, [^{137}Cs] + (2)[^{90}Sr] = 34.2 μCi/mL

1995 solids: Total beta = 1,140 μCi/g, [^{137}Cs] + (2)[^{90}Sr] = 1,414 μCi/g

The factor of two arises because ^{90}Sr is in equilibrium with ^{90}Y, which has a much shorter half life. Thus, for every beta decay from strontium, there is an additional beta decay from the yttrium. Again, the data consistency between the total beta activity and the sum of the major beta emitters is good at a relative percent difference of 21.

B3.3.3 Total Carbon Results

Data are available from the 1995 supernatant grab samples for comparison of the TC results with the TOC and TIC results. The mean TC result should equal the sum of the mean TOC and TIC results.

[TC] = 4,755 μg/mL, [TOC] + [TIC] = 7,962 μg/mL

The TC and TIC and TOC data are inconsistent. Given the process history of the waste in tank 241-AW-102 (Section A3.1), the TIC result is more likely to be in error than in the TOC result. In addition, the mass and charge balance data suggest that the TIC data are incorrect. To determine the mass and charge balance, the TIC value used was calculated by the difference between the TC and TOC. The result was 430 μg/mL, which is less than the 1,000-μg/mL threshold.

B3.3.4 Mass and Charge Balance

Mass and charge balances were only performed on sample 2AW-95-2 (supernatant) because data were available only on that sample. The principal objective in performing mass and charge balances is to determine whether the measurements are self-consistent. In calculating the balances, only analytes listed in Section B2.0 detected at a concentration of 1,000 μg/g or greater were considered.

Aluminum was assumed to be in its most common soluble hydroxide form, and the concentrations of the assumed species were calculated stoichiometrically. All positive charge was attributed to the sodium cation. Because the mass and charge balances were only calculated on a supernatant sample, all anions and cations were water soluble. 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 μg/g to weight percent.

$$\text{Mass balance} = \%\ \text{Water} + 0.0001 \times \{\text{Total Analyte Concentration}\} = \%\ \text{Water} + 0.0001 \times \{Al(OH)_4^- + Na^+ + F^- + NO_3^- + NO_2^- + PO_4^{-3} + SO_4^{2-} + OH^- + HCOO^-\}$$

The total analyte concentrations calculated from this equation is 109,400 μg/g. The mean weight percent water (obtained from the gravimetric analyses reported in Table B2-3) is 84.0 percent, or 840,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 94.9 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) = $[Na^+]/23.0$ = 2,090 μeq/mL

Total anions (μeq/g) = $[Al(OH_4)^-]/95.0 + [F^-]/19.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 + [PO_4^{-3}]/31.7 + [SO_4^{2-}]/96.1 + [OH^-]/17.0$ = 1,980 μeq/mL

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 1.06.

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

Table B3-1. Cation Mass and Charge Data.

Analyte	Concentration (μg/mL)	Assumed Species	Concentration of Assumed Species (μg/mL)	Charge (μeq/mL)
Na	48,140	Na^+	48,140	2,090
Total			48,140	2,090

Table B3-2. Anion Mass and Charge Data.

Analyte	Concentration (μg/mL)	Assumed Species	Concentration of Assumed Species (μg/mL)	Charge (μeq/mL)
Al	1,717	$Al(OH)_4^-$	6,045	63.6
F^-	5,190	F^-	5,190	273
NO_3^-	22,600	NO_3^-	22,600	365
NO_2^-	9,990	NO_2^-	9,990	217
PO_4^{-3}	1,420	PO_4^{-3}	1,420	44.8
SO_4^{-2}	2,750	SO_4^{-2}	2,750	57.3
OH^-	10,200	OH^-	10,200	600
TOC	4,325	$HCOO^-$	16,220	360
Total			74,395	1,980

Table B3-3. Mass Balance Totals.

Totals	Concentrations[1] (μg/g)
Total from Table B3-1	42,980
Total from Table B3-2	66,420
Percent water	840,000
Grand total	949,400

Note:

[1]Analyte concentrations were converted from μg/mL to μg/g by dividing by the density of 1.12 g/mL.

B3.4 CALCULATION OF ANALYTICAL BASED MEANS

Because tank 241-AW-102 is the feed tank for the 242-A Evaporator, the supernatant in the tank is constantly changing. However, according to Guthrie (1996) and Le (1997), the solids in the tank had not changed appreciably between the last two sampling events. Therefore, the following statistical evaluation was performed using the solids analytical data generated from tank 241-AW-102 grab samples. One set of grab samples was obtained in August 1995 from riser 16A at two different depths. Two other grab samples were obtained in August 1996 from riser 22A at the same depth. Sample depth is measured from the top of the riser to the mouth of the sample bottle. The 1996 grab samples were composited and centrifuged. The analyses were performed on subsamples from the sludge composite.

A mean concentration and the associated variability were calculated for each analyte. A two-sided 95 percent confidence interval for the mean concentration also was calculated for each analyte. The confidence interval takes into account the sampling and analytical uncertainties. The upper and lower limits (UL and LL) of a two-sided 95 pecent 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.

B3.4.1 Mean Concentrations

The statistics in this section were based on analytical data from both the 1995 and 1996 sampling events of tank 241-AW-102. Only four analytes were measured on subsamples from both the 1995 and the 1996 grab samples. The data for three of the four analytes were statistically evaluated using two different models. The first model used a nested analysis of variance (ANOVA)–the data are identified by grab sample within riser. The second model used one-way ANOVA–the data are identified by one variable (the grab sample). For the fourth analyte (TIC measurements), the riser and sample variabilities are confounded (1 grab sample from each riser). The data were analyzed using one-way ANOVA. The remainder of the 1995 data (samples from one riser only) were evaluated using one-way ANOVA.

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.

The mean and the variance of the mean were only calculated for the analytes DSC and TOC measured on the 1996 composite subsamples. In the variance of the mean for these two analytes, only the analytical variability is accounted for.

The mean concentration estimates, along with the two-sided 95 percent confidence interval for the mean concentration, are given in Table B3-1 (nested ANOVA), Table B3-2 (one-way ANOVA), and Table B3-3 (one sample results) for those analytes with at least 50 percent of the reported data as quantitative values. For analytes that had a mixture of quantitative values and "less than" values, the upper value of the "less than" (e.g., 3.5 for <3.5) was used to represent all "less than" analytical values. 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 the analyte that was statistically analyzed using "less than" values. For some of the analytes, the lower limit of the 95 percent confidence interval was a negative value because of the magnitude of the variability. Because the actual concentration of a tank sample cannot be less than zero, the lower limit is reported as zero.

The nested ANOVA results indicated that $\hat{\sigma}_{riser}$ is not significantly different from zero for the three analytes. For these analytes, the mean concentrations and the variances of the mean concentrations calculated using the one-way ANOVA and nested ANOVA statistical models are not significantly different. In these cases, the one-way ANOVA model is more appropriate.

Table B3-4. Summary Statistics - Mean Concentrations (Nested ANOVA).

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
^{241}Am.aea[1]	μg/g	1.86E+00	5.74E-01	1	0.00E+00	9.15E+00
$^{239/240}$Pu[1]	μCi/g	5.37E-01	1.94E-01	1	0.00E+00	3.00E+00
Total Alpha[1]	μCi/g	2.40E+00	8.97E-01	1	0.00E+00	1.38E+01

Note:

[1]$\hat{\sigma}_{riser}$ is not significantly different from zero.

Table B3-5. Summary Statistics - Mean Concentrations (One-Way ANOVA).

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
^{241}Am.aea	μCi/g	1.86E+00	5.74E-01	2	0.00E+00	4.33E+00
^{60}Co.gea.w	μCi/g	7.03E-02	3.97E-02	1	0.00E+00	5.74E-01
^{137}Cs.gea	μCi/g	8.64E+01	4.52E+01	1	0.00E+00	6.61E+02
$^{239/240}$Pu	μCi/g	5.37E-01	1.94E-01	2	0.00E+00	1.37E+00
Si.icp	μg/g	1.73E+04	1.35E+03	1	2.15E+02	3.44E+04
$^{89/90}$Sr	μCi/g	6.64E+02	4.56E+02	1	0.00E+00	6.46E+03
TIC	μg/g	3.14E+03	1.30E+02	1	1.48E+03	4.79E+03
Total Alpha	μCi/g	2.40E+00	8.97E-01	2	0.00E+00	6.26E+00
Total Beta	μCi/g	1.14E+03	7.60E+02	1	0.00E+00	1.08E+04
Total carbon	μg/g	8.86E+03	2.74E+03	1	0.00E+00	4.36E+04
U.phos	μg/g	2.07E+04	1.16E+04	1	0.00E+00	1.68E+05

Table B3-6. Summary Statistics - Mean Concentrations (one sample).

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
DSC	J/g dry	0.00E+00	0.00E+00	1	0.00E+00	0.00E+00
TOC	μg/g	2.92E+03	1.40E+02	1	1.14E+03	4.70E+03

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 1980).

The data were statistically evaluated using two different models. The first model used a nested analysis of variance. The nested analysis of variance statistical model used to describe the structure of the data is

$$Y_{ijk} = \mu + R_i + S_{ij} + A_{ijk},$$

$$i=1,2,\ldots,a;\ j=1,2,\ldots,b_i;\ k=1,2,\ldots,n_{ij};$$

where

Y_{ijk} = concentration from the kth analytical result from the jth grab sample from the ith riser

μ	=	the grand mean
R_i	=	the effect of the ith riser
S_{ij}	=	the effect of the jth grab sample from the ith riser
A_{ijk}	=	the effect of the kth analytical result from the jth grab sample from the ith riser
a	=	the number of risers
b_i	=	the number of grab samples from the ith riser
n_{ij}	=	the number of analytical results from the jth grab sample from the ith riser.

The variables R_i and S_{ij} are assumed to be random effects. These variables, as well as A_{ijk}, are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$, $\sigma^2(S)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(R)$, $\sigma^2(S)$, 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 (StatSci 1993). The *df* associated with the standard deviation of the mean (a function of $\sigma^2(R)$, $\sigma^2(S)$, and $\sigma^2(A)$) is the number of risers minus one.

The second model used 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 jth analytical result from the ith grab sample
μ	=	the grand mean
S_i	=	the effect of the ith grab sample
A_{ij}	=	the effect of the jth analytical result from the ith grab sample
a	=	the number of grab samples
n_i	=	the number of analytical results from the ith grab sample.

The variable S_i is assumed to be a random effect. S_i, as well as A_{ij}, is 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. The results using the REML techniques were obtained using the statistical analysis package S-PLUS (StatSci 1993).

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

C1.0 STATISTICS FOR SAFETY SCREENING DATA QUALITY OBJECTIVES

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, one-sided confidence limits supporting the safety screening DQO are calculated for tank 241-AW-102 solids. The data in this section are from the 1995 and 1996 sampling events for tank 241-AW-102.

For the solid samples, confidence intervals were computed for each sample number from tank 241-AW-102 analytical data (Esch 1995 and Esch 1996). The upper limit (UL) 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-AW-102 data (per sample number), *df* equals the number of observations minus one.

C1.1 DIFFERENTIAL SCANNING CALORIMETRY

No exotherms were observed in any of the DSC scans, therefore no statistical calculations were performed on the DSC data and the hypothesis that the DSC results are greater than 480 J/g dry is rejected for this sample.

C1.2 TOTAL ALPHA ACTIVITY

The upper limit of the 95-percent confidence interval was calculated for each solid sample that had total alpha measurements. The sample numbers and the upper limit of the 95-percent confidence intervals are listed in Table C1-1. Each confidence interval can be used to make the following statement. If the upper limit is less than 61.5 μCi/mL (47 μCi/g using a density of 1.3 g/mL), one would reject the null hypothesis that total alpha is greater than or equal to 47 μCi/g at the 0.05 level of significance. For all three grab samples, the upper limit is less than 47 μCi/g. Thus, the hypothesis that the total alpha results are greater than 47 μCi/g is rejected for all three grab samples.

Table C1-1. Summary Statistics - Total Alpha - Tank 241-AW-102.

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\mu}$	UL
2AW-95-1	Riser 16A sludge	6.26E-01 μCi/g	7.05E-02	1.07E+00
2AW-95-3	Riser 16A sludge	3.52E+00 μCi/g	1.00E-02	3.58E+00
S96T004803	Riser 22A sludge	3.06E+00 μCi/g	1.95E-01	4.29E+00

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR TANK 241-AW-102

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-AW-102

An effort is under way to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for double-shell tank (DST) 241-AW-102 was performed, and a limited best basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

Available waste (chemical) information for tank 241-AW-102 includes the following:

- Statistical report for limited analytical data on two solids grab samples - one obtained in August 1995 and the other in August 1996.
- Solids levels from the 242-A Campaign 96-1 Post Run Document (Guthrie 1996)
- The inventory estimate for this tank generated from the Hanford Defined Waste (HDW) model (Agnew et al. 1997b).

Section D5.0 is a list of references used in this evaluation.

D2.0 COMPARISON OF COMPONENT INVENTORIES

Tank 241-AW-102 is currently used as the feed tank to the 242-A Evaporator. The waste to be processed during 242-A Evaporator operations is initially transferred to tank 241-AW-102. Between evaporator campaigns tank 241-AW-102 receives transfers of miscellaneous waste for temporary storage.

The tank inventory estimates reported in Agnew et al. (1997b) were valid as of January 1, 1994. Four evaporator campaigns have been conducted in the 242-A Evaporator since that date, therefore the inventory estimates in Agnew et al. (1997a) for supernatants in tank 241-AW-102 are no longer valid. The HDW Model does not identify any TLM solids in this tank. Thus, no current HDW Model results are available to be included in this section.

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 WASTE HISTORY TANK 241-AW-102

Double-shell tank (DST) 241-AW-102 went into service in 1980 and was designated as the 242-A Evaporator feed tank. All waste processed in the 242-A Evaporator since 1980 was first transferred to tank 241-AW-102, so the tank has been emptied and refilled many times since 1981.

For a more complete history of the waste in this tank, see Appendix A.

D3.2 EXPECTED TYPE OF WASTE BASED ON THIS ASSESSMENT

The waste types expected to be present in tank 241-AW-102 are SMMA2 (Agnew et al. 1997b) and sludge (Hanlon 1997). The waste type SMMA2 is a mixture of different concentrated supernatants coming from the 242-A Evaporator that are a blend of other waste types that precipitate some saltcake on cooling.

As of January 1, 1994, Agnew et al. (1997b) identifies the waste in tank 241-AW-102 as 3,710 kL (979 kgal) of SMMA2 supernatant. This waste (minus the solids heel) was processed through the 242-A Evaporator during Campaign 94-1. This makes the HDW Model estimates of limited value in estimating current tank inventories.

Hanlon (1997) lists the tank as containing 136 kL (36 kgal) of solids and 242 kL (64 kgal) of supernatant. The volume of liquids in this tank changes frequently because it is the 242-A Evaporator receiver tank. The Hanlon (1997) estimate of 136 kL solids is used in this document.

D3.3 ASSUMPTIONS USED

The following evaluation provides an engineering assessment of the tank 241-AW-102 contents. For this evaluation, the following assumptions and observations are made.

- The HDW Model information for tank 241-AW-102 is of limited value in developing a best basis tank inventory estimate.
- The waste transfer history for tank 241-AW-102 is too complex for a reliable modeling estimate of the solids heel.
- Analytical data from grab samples offer a limited basis for tank inventory estimates of the tank solids.
- To a first approximation, the solids layer in tank 241-AW-102 is assumed to be comparable to a generic 242-A Evaporator saltcake. This section does not provide inventory estimates for the supernatant liquid.

D3.4 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

The general approach in this engineering assessment is to use all available information to formulate the best basis estimate of the tank's contents. The sources of information may include analytical data from samples taken from the tank of interest, analytical data from other tanks believed to contain waste types similar to those believed to be in the tank of interest, and data from models created using historical process records. The confidence level assigned to the best basis inventory values then depends on the level of agreement among the various information sources. However, the liquids in tank 241-AW-102 change frequently because this tank is part of ongoing 242-A Evaporator operations. Because this is an active tank with frequent waste transfers, this engineering assessment does not attempt to develop a tank inventory estimate for the supernatant. Rather, it addresses the solids heel.

Based on information in the 242-A Campaign 96-1 post-run document (Guthrie 1996), the solids level in this tank has remained relatively constant since the completion of Campaign 95-1. However, the solids level measurement information reported in Guthrie (1996) indicates that a relative standard deviation of approximately 60 percent is associated with this solids volume estimate.

The HDW model results reported by Agnew et al. (1997b) do not identify a solids layer in tank 241-AW-102, although direct measurements in this tank indicate the solids volume to be 136 kL (36.0 kgal). The solids layer in this tank likely accumulated from solids that separated from 242-A Evaporator slurry feed that was temporarily being stored in the tank. Because of the large volume of waste that has passed through this tank, there is little hope of identifying the origin of the solids heel based on 242-A Evaporator process history. Rather, an empirical approach was coupled with the limited analytical data available from grab

samples taken from this tank in 1995 and 1996 to establish an approximation of a tank inventory.

D3.4.1 Analytical Results From Solids Grab Samples

Two solids grab samples were taken from tank 241-AW-102; the first in August 1995 and the second in August 1996. As can be seen by the information in Table D3-1, the scope of analyses for this sample was limited. The grab-sampling methodology used to collect these samples limits the likelihood that the analytical results would be representative of the complete solids layer. However, these are the only data that are currently available.

Table D3-1. Solids Sample Analytical Results for Tank 241-AW-102.

Radiochemical Analyte	Concentration (uCi/g)	Tank Inventory based on Solids Sample[1] (Ci)	Chemical Components	Concentration (ug/g)	Tank Inventory based on Solids Sample[1] (kg)
^{241}Am	1.86	334	TIC (as CO_3)	3,140 (15,700)	564 (2,820)
^{137}Cs	86.4	15,500	Total carbon (TC)	8,860	1,590
$^{89/90}Sr$	664	119,000	U	20,700	3,720
$^{239/240}Pu$	0.537	96.4	Si	17,300	3,110
Total alpha	2.40	431	TOC (TC-TIC)	5,720	1,030
Total beta	1,140	205,000			
^{60}Co	0.0703	12.6			

Note:

[1]Based on a solids volume of 136 kL and a density of 1.32 g/mL.

D3.4.2 Inventory Estimates Based on Modified Hanford Defined Waste Model Values

Because analytical data and modeling information were limited, the tank inventory estimate for the solids layer was developed by assuming that the solids layer was similar in

composition to a generic 242-A Evaporator saltcake. Two generic saltcake compositions were chosen. The first was based on DST saltcake analysis data; the second was based on the HDW model.

A 242-A Evaporator saltcake composition was developed in Herting (1996) using analyses of saltcakes from DSTs 241-AN-102 and 241-AN-107. This saltcake composition (listed as DST SltCk) and calculated inventory estimates for tank 241-AW-102 solids are shown in Table D3-2 for chemical constituents and in Table D3-3 for the radionuclides.

Because Agnew et al. (1997b) does not list a global composition for the SMMA2 solids, the A1-Saltcake listed in Agnew et al. (1997a) also was used to develop an inventory estimate for the solids. The A1-Saltcake composition and estimated solids inventory values are listed in Table D3-2 for the chemical constituents and in Table D3-3 for the radionuclides. Analysis-based inventory estimates for the radionuclides reported from the 1995 and 1996 grab samples also are listed in Table D3-3.

Differences in the inventory estimates developed using the two different saltcake compositions can be evaluated by comparing columns 3 and 5 in Tables D3-2 and D3-3. Inventory estimates based on the radioanalytical work do not favor one inventory estimate over the other.

Table D3-2. Estimated Tank Inventory for Chemical Components in the Tank 241-AW-102 Solids Layer[1]. (2 sheets)

Analyte	DST SltCk Data[2] (ug/g)	DST SltCk Inventory Estimate (kg)	A1-SltCk Composition[3] (ug/g)	A1-SltCk Inventory Estimate (kg)	Analysis-Based Inventory Estimate[4] (kg)
Al	13,400	2,730	31,657	8,180	NR
Bi	NR	NR	788	204	NR
Ca	567	116	1,197	309	NR
Chloride	2,000	408	2,158	558	NR
Cr	1,040	212	3,826	989	NR
F	1,200	245	1,141	295	NR
Fe	2,200	449	456	118	NR
Hg	NR	NR	4.44	1.15	NR
K	1,300	265	2,186	565	NR
Mn	413	84.3	159	41.1	NR
Na	184,000	37,500	232,562	60,100	NR
NH_3	NR	NR	1,289	333	NR

Table D3-2. Estimated Tank Inventory for Chemical Components in the Tank 241-AW-102 Solids Layer[1]. (2 sheets)

Analyte	DST SltCk Data[2] (ug/g)	DST SltCk Inventory Estimate (kg)	A1-SltCk Composition[3] (ug/g)	A1-SltCk Inventory Estimate (kg)	Analysis-Based Inventory Estimate[4] (kg)
Ni	337	68.7	316	81.7	NR
nitrite	45,400	9,260	75,169	19,400	NR
nitrate	130,000	26,500	263,183	68,000	NR
hydroxide	NR	NR	101,369	26,200	NR
Pb	265	54.1	114	29.5	NR
phosphate	3,830	781	21,059	5,440	NR
Si	NR	NR	2,566	663	3,110
sulfate	18,100	3,690	20,812	5,380	NR
TIC as carbonate[4]	63,500	12,600	19,289	4,980	2,820
TOC	22,100	4,510	7,788	2,010	1,030
U	NR	NR	2,269	586	3,720
Zr	NR	NR	105	27.1	NR
Density (g/mL)[5]	1.5	NA	1.9	n/a	n/a
H_2O (Wt%)	42.3	n/a	22.8	n/a	n/a

Notes:

NR = not reported

[1]Solids volume assumed to be 136 kL.
[2]Herting (1996)
[3]Agnew et al. (1997b)
[4]Analytical-based solids inventory estimates from Table D3-1.
[5]Analytical data reported as $^{239/240}Pu$.

Table D3-3. Comparison of Estimated Tank Inventory Radioactive Components in Tank 241-AW-102 Solids Layer[1].

Analyte	DST SltCk Data[2] (uCi/g)	DST SltCk Inventory Estimate (Ci)	A1SltCk Composition[3] (uCi/g)	A1SltCk Composition Estimate (Ci)	Analysis-based Inventory Estimate[4] (Ci)
^{90}Sr	130	26,500	88.4	22,800	119,000
^{239}Pu	0.085	17.3	0.048	12.4	96.4
^{137}Cs	267	54,500	151	39,000	15,500
^{241}Am	NR	NR	0.030	7.75	334

Notes

[1]Solids volume assumed to be 136 kL.
[2]Herting (1996)
[3]Agnew et al. (1997b)
[4]Analytical-based solids inventory estimates from Table D3-1.

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

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

Chemical and radiological inventory information is generally derived using one of three approaches. Component inventories are estimated using results of sample analyses, component inventories are estimated using the HDW Model based on process knowledge and historical information, or a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material use, and other operating data. The information derived from these different approaches is often inconsistent.

An effort is under way to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and

LeClair 1996). As part of this effort, available information for tank 241-AW-102 was evaluated. The assessment of available chemical information for tank 241-AW-102 included the following:

- An inventory estimate generated by assuming the solids to be comparable with a 242-A Evaporator saltcake formulation that was generated from DST saltcake analytical data (Herting 1996).
- An inventory estimate generated by assuming the solids to be comparable with the A-Saltcake formulation from the HDW model (Agnew et al. 1997b).
- Analytical results from solid samples collected in 1995 and 1996.

Based on this engineering assessment, a best basis inventory was developed for the solids in tank 241-AW-102 using the limited amount of analytical data and by assuming that the solids would be comparable with the DST saltcake formulation reported by Herting (1996).

In this engineering assessment, inventory estimates based on analysis of samples from tank 241-AW-102 were given the highest credence. Where no sample-based information was available, the tank inventory estimates based on DST saltcake analyses were chosen. When no other data were available, tank inventories based on the HDW-model saltcake formulation were used. The best-basis inventory estimates for the chemcal constituents are listed in Table D4-1 and Table D4-2 for the radionuclides.

Best basis inventories listed in Tables D4-1 and D4-2 are estimates only, and should be considered suspect. Core samples of the solids layer in Tank 241-AW-102 are needed for more reliable analyte inventories.

Table D4-1. Best Basis Inventory Estimates for Nonradioactive Components in Tank 241-AW-102 (May 31, 1997). (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	2,730	E	
Bi	204	E	
Ca	567	E	
Chloride	408	E	
TIC as carbonate	2,820	S	
Cr	212	E	
F	119,000	E	

Table D4-1. Best Basis Inventory Estimates for Nonradioactive Components in Tank 241-AW-102 (May 31, 1997). (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	2,730	E	
Fe	119,000	E	
Hg	1.15	E	
K	265	E	
La	NR		
Mn	84.1	E	
Na	37,500	E	
Ni	68.7	E	
nitrite	9,260	E	
nitrate	26500	E	
hydroxide	NR	E	
Pb	15,500	E	
phosphate	14,700	E	
Si	3,110	S	
sulfate	3,690	E	
Sr	NR		
TOC	1,030	S	
U_{TOTAL}	3,720	S	
Zr	NR		

Notes:

H = High
M = Medium
L = Low

[1]S = Sample based, M = HDW model based, and E = Engineering assessment based.

Table D4-2. Best Basis Inventory Estimates for Radioactive Components in Tank 241-AW-102 (May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	NR		
^{14}C	NR		
^{59}Ni	NR		
^{60}Co	12.8	S	
^{63}Ni	NR		
^{79}Se	NR		
$^{89/90}Sr$	119,000	S	
^{90}Y	119,000	S	(Derived from $^{89/90}Sr$ value)
^{93}Zr	NR		
^{93m}Nb	NR		
^{99}Tc	NR		
^{106}Ru	NR		
^{113m}Cd	NR		
^{125}Sb	NR		
^{126}Sn	NR		
^{129}I	NR		
^{134}Cs	NR		
^{137}Cs	15,500	S	
^{137m}Ba	14,700	S	(Derived from ^{137}Cs value)
^{151}Sm	NR		
^{152}Eu	NR		
^{154}Eu	NR		
^{155}Eu	NR		
^{226}Ra	NR		
^{227}Ac	NR		
^{228}Ra	NR		
^{229}Th	NR		
^{231}Pa	NR		
^{232}Th	NR		

Table D4-2. Best Basis Inventory Estimates for Radioactive Components in Tank 241-AW-102 (May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}U	NR		
^{233}U	NR		
^{234}U	NR		
^{235}U	NR		
^{236}U	NR		
^{237}Np	NR		
^{238}Pu	NR		
^{238}U	NR		
$^{239/240}Pu$	96.4	S	
^{240}Pu	NR		
^{241}Am	334	S	
^{241}Pu	NR		
^{242}Cm	NR		
^{242}Pu	NR		
^{243}Am	NR		
^{243}Cm	NR		

D5.0 APPENDIX D REFERENCES

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Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending October 31, 1997*, WHC-EP-0182-99, Westinghouse Hanford Company, Richland, Washington.

Herting, D.L., 1996, *Evaluation to Establish Best-Basis Inventory for Single Shell Tank Tank 241-AX-102*, WHC-SD-WM-ER-472, Rev. 0, 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 Corp., Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AW-102

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AW-102

Appendix E is a bibliography that supports the characterization of tank 241-AW-102. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, modeling information, and processing occurrences associated with tank 241-AW-102 and its respective waste types.

The references in this bibliography are separated into four broad categories with references contained in subgroups. These categories and their subgroups are listed below. The bibliography is broken down into the appropriate sections of material to use, with an annotation at the end of each reference describing the information source. Where possible, a reference is provided for information sources. Most of the information listed below may be found in the Tank Characterization Resource Center.

I. NON-ANALYTICAL DATA

- Ia. Fill History/Waste Transfer Records
- Ib. Surveillance/Tank Configuration
- Ic. Sample Planning/Tank Prioritization
- Id. Data Quality Objectives/Customers of Characterization Data

II. ANALYTICAL DATA

- IIa. Sampling of Tank Waste and Waste Types
- IIb. Sampling of 242-A Evaporator Streams

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

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

I. NON-ANALYTICAL DATA

Ia. Fill History/Waste Transfer Records

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, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains spreadsheets depicting all available data on tank additions/transfers for SE quadrant.

Barton, B. W., 1997, *Double-Shell Tank Inventory and Material Balance for January, 1997*, (internal memorandum LMHC-9751198 to Distribution, February 10), Lockheed Martin Hanford Corporation, Richland, Washington.

- Memorandum contains tank transfer data and tank inventory information for all double-shell tanks.

Le, E. Q., 1994, *Process Control Plan for 241-A Evaporator Campaign 94-1*, WHC-S-WM-PCP-008, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains process control information for the 242-A Evaporator 94-1 campaign.

Ib. Surveillance/Tank Configuration

Foster, J. L., 1989, *Ammonia Releases from Tank Farms*, (internal memorandum 13331-89-396 to D. D. Woodrich, October 10), Westinghouse Hanford Company, Richland, Washington.

- Internal memorandum contains locations of ammonia gas on Hanford Site as well as background on the source of the ammonia.

Harris, J. P., 1994, *Unclassified Operating Specifications for the 241-AN, AP, AW, AY, AZ & SY Tank Farms*, OSD-T-151-00007, Rev. H-18, Westinghouse Hanford Company, Richland, Washington.

- Document contains the operating specifications for the listed double-shell tanks. This includes composition, liquid levels, dome loading, vapor space pressure, etc.

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. 0B Westinghouse Hanford Company, Richland, Washington.

- Document provides a ready reference to the tank farms safety envelope.

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 tank riser locations in relation to tank aerial view as well as a description of riser and its contents.

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

- Document contains information pertaining to thermocouple trees installed in the Hanford Site underground waste tanks.

Ic. Sample Planning/Tank Prioritization

Bell, K. E., 1994, *Tank Waste Remediation System Tank Waste Analysis Plan*, WHC-SD-WM-PLN-077, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Early version of the characterization planning document.

Bell, K. E., 1996, *Compatibility Grab Sampling and Analysis Plan*, WHC-SD-WM-TSAP-037, Rev. 2B, Westinghouse Hanford Company, Richland, Washington.

- Document contains sampling and analysis requirements for 1996 grab samples taken from tank 241-AW-102.

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

De Lorenzo, D. S., A. T. DiCenso, D. B. Hiller, K. W. Johnson, J. H. Rutherford, D. J. Smith, 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.

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.

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Jones, J. M., 1995, "Request for Supernate and Sludge Samples from Tank 241-AW-102," (Process memorandum PM # 2E95-081 to shift managers, August 8), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains a request and instructions for obtaining 1995 grab samples from tank 241-AW-106.

Loll, C. M., 1993, *242-A Evaporator Waste Analysis Plan*, WHC-SD-WM-EV-060, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Document is the waste analysis plan for the 242-A Evaporator and includes short- and long-term goals and analysis needs.

Schreiber, R. D., 1995, *Compatibility Grab Sampling and Analysis Plan*, WHC-SD-WM-TSAP-037, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains sampling and analysis requirements for 1995 grab samples taken from tank 241-AW-102.

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*.

- Document creates the Safety Watch List for the Hanford Site tank farms.

Winkelman, W. D., 1996, *Fiscal Year 1997 Tank Waste Analysis Plan*, WHC-SD-WM-PLN-120, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document identifies plans and requirements for tanks to be sampled and analyzed and tank characterization reports to be written during FY 1997.

Id. Data Quality Objectives/Customers of Characterization Data

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- Document contains objectives to sample all tanks for safety concerns (ferrocyanide, organic, flammable gas, and criticality) as well as decision thresholds for energetics, criticality, and flammability.

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.

- Document contains data needs and requirements for the compatibility program.

Von Bargen, B. H., 1995, *242-A Evaporator/Liquid Effluent Retention Facility Data Quality Objectives*, WHC-SD-WM-DQO-014, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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II. ANALYTICAL DATA

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- Document contains safety screening analytical results for grab samples obtained in 1995.

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- Document summarizes and compares the analytical data for operational limits.

IIb. Sampling of 242-A Evaporator Streams

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Wehner, K. B., 1994, Semi-Volatile Analytical Results - T831, (internal memorandum to E. Q. Le, May 25), Westinghouse Hanford Company, Richland, Washington.

Wehner, K. B., 1994, Semi-Volatile Analytical Results - T901, (internal memorandum to E. Q. Le, May 25), Westinghouse Hanford Company, Richland, Washington.

Wehner, K. B., 1994, Semi-Volatile Analytical Results - T937, (internal memorandum to E. Q. Le, May 25), Westinghouse Hanford Company, Richland, Washington.

Wehner, K. B., 1994, Volatile Organics Analytical Results Trerun - T734, (internal memorandum to E. Q. Le, May 25), Westinghouse Hanford Company, Richland, Washington.

- Series of internal memorandums containing organic data for April 1994 grab samples from tank 241-AW-106 mixed with samples from tanks 241-AW-102 and 241-AP-103 for evaporator feed analyses.

WHC, 1994, 242-A Feed Data, Sample Status Report for T734, (internal report, May 25), Westinghouse Hanford Company, Richland, Washington.

- Status report contains analytical data for T734 samples taken April, 1994.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories from 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 Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains waste type summaries, primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids, as well as supernatant mixing model, tank layer model, and individual tank inventory estimates.

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

- Document 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, Revisions B (Draft) and C (Draft), Westinghouse Hanford Company, Richland, Washington.

- Documents contain 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.

- Document contains a global inventory based on process knowledge and radioactive decay estimations. Plutonium and uranium 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 data from other sources physical and chemical

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.

Albaugh, J. F., 1983, *Resolution of the Material Balance Discrepancy During the AW-106 to AW-102 Transfer*, (internal memorandum 65950-83-819 to G. T. Dukelow, February 18), Rockwell Hanford Operations, Richland, Washington.

- Memorandum contains a material balance for tank 241-AW-106 in support of 242-A Evaporator operations.

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

- Document contains summary information from the supporting document for Tank Farms AN, AP, AW, AY, AZ, and SY as well as in-tank photo collages and the solid (including the interstitial liquid) composite inventory estimates.

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

- This document contains summary tank farm and tank write-ups on historical data and solid inventory estimates as well as appendices for the data. The appendices contain tank Level History sketches; Temperature Graphs; Surface Level Graphs; Cascade/Drywell Chart; Riser Configuration Drawings; In-Tank Photos; and a Tank Layer Model Bar Chart and Spreadsheet.

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 a quick reference to sampling information in spreadsheet or graphical form for 23 chemicals and 11 radionuclides for all tanks.

Guthrie, M. D., 1994, "102-AW and 106-AW Sludge Level Measurements," (process memorandum PM #94-165 to 242-A Shift Office, December 15), Westinghouse Hanford Company, Richland, Washington.

- Process memorandum directs sludge measurements to be taken in support of the Campaign 94-2 Post Run Document.

Hanlon, B. M., 1997, *Tank Farm Surveillance and Waste Status Summary Report for Month Ending October 31, 1996*, WHC-EP-0182-103, Westinghouse Hanford Company, Richland, Washington.

- These documents contain a monthly summary of: fill volumes, Watch List tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information. Grouped here are all the monthly summaries from December 1947 to present; however, Hanlon has only authored the monthly summaries from November 1989 to present.

Husa, E. I., R. E. Raymond, R. K. Welty, S. M. Griffith, B. M. Hanlon, R. R. Rios, and 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 as well as summaries on the tank description, leak detection system, and tank status.

Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document gives assessment of relative dryness between tanks.

Hartley, S. A., G. Chen, C. A. LoPresti, T. M. Ferryman, A. M. Liebetrau, K. M. Remund, S. A. Allen, and B. C. Simpson, 1996, *A Comparison of Historical Tank Content Estimate (HTCE) Model, Rev. 3, and Sample-Based Estimates of Hanford Waste Tank Contents*, PNL-11429, Pacific Northwest National 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.

Remund, K. M. and B. C. Simpson, 1996, *Hanford Waste Tank Grouping Study*, PNNL-11433, Pacific Northwest National Laboratory, Richland, Washington.

- Document contains a statistical evaluation to group tanks into classes with similar waste properties.

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.

Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories for the Double-Shell Tanks*, WHC-SD-WM-TI-543, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains selected sample analysis tables before 1993 for double-shell tanks.

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 memorandums and letters concerning tank or process sampling. Grouped here are all of the process aids documents from 1969 to 1993.

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