ENGINEERING CHANGE NOTICE

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

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

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

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Design Authority			Design Agent		
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Safety			Design		
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Other R.J. Cash	R.J. Cash	6/20/97	Other		
N.W. Kirch	N.W. Kirch	6/24/97	DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

Tank Characterization Report for Double-Shell Tank 241-AP-101

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

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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-AP-101. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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Tank Characterization Report for Double-Shell Tank 241-AP-101

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LIST OF TERMS

ANOVA	analysis of variance
Btu/hr	British thermal units per hour
Ci	curie
Ci/g	curies per gram
Ci/L	curies per liter
cm	centimeter
DQO	data quality objective
DSC	differential scanning calorimetry
DSSF	double-shell slurry feed
ft	feet
g/L	grams per liter
GEA	gamma energy analysis
HDW	Hanford Defined Waste
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
J/g	joules per gram
kg	kilogram
kgal	kilogallon
kL	kiloliter
LFL	lower flammability limit
LL	lower limit
m	meter
M	moles per liter
mL	milliliter
mm	millimeter
n/a	not applicable
n/r	not reported
nCi/g	nanocuries per gram
PASF	PUREX ammonia scrubber feed
PHMC	Project Hanford Management Contractor
ppmv	parts per million by volume
PUREX	Plutonium-Uranium Extraction process
QC	quality control
REML	restricted maximum likelihood estimation
RPD	relative percent difference
SAP	sampling and analysis plan
SMM	Supernatant Mixing Model
SpG	specific gravity

LIST OF TERMS (Continued)

TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	Tank Layer Model
TOC	total organic carbon
TRU	transuranic
TWRS	Tank Waste Remediation System
UL	upper limit
W	watt
W/Ci	watts per curie
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter
μg C/g	micrograms of carbon per gram
μg C/mL	micrograms of carbon per milliliter

1.0 INTRODUCTION

One major function of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendixes serve as the TCR for double-shell tank 241-AP-101. The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-AP-101 waste; and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. Section 2.0 summarizes the response to technical issues, Section 3.0 provides the best-basis inventory estimate, and Section 4.0 makes recommendations about safety status and additional sampling needs. The appendixes contain supporting data and information. This report supported the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996), Milestone M-44-05.

1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. Appendix A provides historical information for tank 241-AP-101 including surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a model based upon process knowledge.

Appendix B summarizes recent sampling events (see also Table 1-1) and historical sampling information. Tank 241-AP-101 was grab sampled in November 1995, when the tank contained 2,790 kL (737 kgal) of waste. An additional 1,438 kL (380 kgal) of waste was received from tank 241-AW-106 in transfers on March 1996 and January 1997. This waste was the product of the 242-A Evaporator Campaign 95-1. Characterization information for the additional 1,438 kL (380 kgal) was obtained using grab sampling data from tank 241-AW-106 and a slurry sample from the evaporator. Appendix C reports on the statistical analysis and numerical manipulation of data used in issue resolution. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. Appendix E is a bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-AP-101 and its respective waste types. A majority of the reports listed in Appendix E are available in the Tank Characterization and Safety Resource Center.

Table 1-1. Summary of Recent Sampling Events.

Sample/Date	Phase	Location	Percent Recovery
Headspace gas flammability (November 1995)	Gas	Tank headspace, 6 m (20 ft) below top of risers 1 at 210° and 1 at 330°	n/a
Grab (November 1995)	Liquid	Risers 1 at 210° and 1 at 330°	100%
242-A Evaporator slurry product from Campaign 95-1 (July 1995). Waste was transferred into tank 241-AP-101 via tank 241-AW-106.	Liquid	n/a	Unknown, although likely 100%
The August 1995 grab sample of the tank 241-AW-106 supernatant was transferred into tank 241-AP-101 in March 1996 and January 1997.	Liquid	Riser 16B of tank 241-AW-106	100%

Note:
n/a = not applicable

1.2 TANK BACKGROUND

Tank 241-AP-101 is located in the 200 East Area AP Tank Farm on the Hanford Site. The tank went into service in 1986 and received a small amount of unknown waste (probably water). The tank was almost completely filled with PUREX ammonia scrubber feed (a dilute noncomplexed waste) in 1988. Later in 1988, a majority of this waste was removed for processing through the 242-A Evaporator. The tank has participated in several other evaporator campaigns throughout its service life. Each time, the tank was almost completely filled before the campaign, then emptied by the end of the campaign. The last such campaign occurred in January 1995 when the tank was reduced to 295 kL (78 kgal). Since then, the tank has received 2,498 kL (660 kgal) of double-shell slurry feed (DSSF) from tank 241-AP-105 in August 1995 and 1,438 kL (380 kgal) of dilute noncomplexed waste from tank 241-AW-106 in March 1996 and January 1997.

Table 1-2 summarizes a description of tank 241-AP-101. The tank has an operating capacity of 4,390 kL (1,160 kgal) and contains an estimated 4,224 kL (1,116 kgal) of waste based on a waste level of 1,031 cm (405.8 in.) (LMHC 1997). The waste is classified as DSSF slurry feed (Hanlon 1997). The tank is not on the Watch List (Public Law 101-510).

Table 1-2. Description and Status of Tank 241-AP-101.

TANK DESCRIPTION	
Type	Double-shell
Constructed	1983 to 1986
In service	1986
Diameter	22.9 m (75.0 ft)
Maximum operating depth	10.7 m (35.2 ft)
Capacity	4,390 kL (1,160 kgal)
Bottom shape	Flat
Ventilation	Active
TANK STATUS	
Waste classification	Double-shell slurry feed
Total waste volume (as of January 31, 1997)[1]	4,224 kL (1,116 kgal)
Supernatant volume	4,224 kL (1,116 kgal)
Sludge volume	0 kL (0 kgal)
Waste surface level (January 14, 1997)	1,031 cm (405.8 in.)
Temperature (1989 to 1997)	12 °C (53 °F) to 23 °C (74 °F)
Integrity	Sound
Watch List	None
SAMPLING DATES	
Grab samples and tank headspace flammability	November 1995
Grab samples of the tank 241-AW-106 supernatant transferred into tank 241-AP-101	August 1995
Sample of the 242-A Evaporator slurry from Campaign 95-1 and transferred to tank 241-AP-101	July 1995
SERVICE STATUS	
Active	1986 to present

Note:

[1]Tank 241-AP-101 is active; any transfers will change the tank's volume and contents.

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2.0 RESPONSE TO TECHNICAL ISSUES

The following two technical issues have been identified for tank 241-AP-101.

- Does the waste pose or contribute to any recognized potential safety problems?
- Will the waste pose any safety or operational problems if combined with other wastes in the double-shell tank system?

The tank has not been sampled since the March 1996 and January 1997 waste transfers; therefore, data from different sources must be used to address these two issues. Data from the six grab samples taken in November 1995 can account for the properties of the 2,790 kL (737 kgal) of waste in the tank at that time, and data from samples taken at the 242-A Evaporator and in tank can account for the properties of the 1,438 kL (380 kgal) transferred to tank 241-AP-101 in 1996 and 1997. Results from a tank headspace flammability screening are used to address the vapor flammability issue. The response to technical issues is detailed in the following sections. Appendix B contains the sampling and analysis data for tank 241-AP-101 and other relevant samples.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-AP-101 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste, flammable gases in the waste and/or tank headspace, and criticality conditions in the waste. Each condition is addressed separately.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening data quality objective (DQO) (Dukelow et al. 1995) is to ensure there is not sufficient fuel (organic or ferrocyanide) in tank 241-AP-101 waste to cause a safety hazard. Because of this requirement, energetics in the tank 241-AP-101 waste were evaluated. The threshold for energetics is an exotherm of 480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) indicated that two of six grab samples exhibited exothermic reactions (Esch 1996). The dry weight exotherm for grab sample 1AP-95-4 was 97.5 J/g. The 95 percent confidence interval upper limit for this sample was 356.4 J/g, below the safety screening limit. The initial DSC run on grab sample 1AP-95-6 did not display an exothermic reaction. The duplicate, however, exhibited an exothermic reaction with a magnitude (dry weight) of 877 J/g. The 95 percent confidence interval upper limit for this sample was 1,146 J/g. A triplicate analysis did not show any exothermic reactions. The analysis was rerun in duplicate, and the exothermic reaction could not be reproduced. Consequently, it was concluded that some anomalous material, originating from the sample (for example, a particle of suspended solids) or a foreign material (for example, a piece of plastic "milling" from the pipet tip), interfered with the analysis of the bulk sample resulting in the observed exotherm (Bushaw 1996). Therefore, no secondary analyses were required to address the energetics issue. No exotherms were found in the tank 241-AW-106 sample or the evaporator slurry sample (Esch 1995 and Guthrie 1996).

No other analytical result indicated that exothermic reactions would be expected. No organic layer was observed. The total organic carbon (TOC) mean concentration was only 6,410 μg C/mL (4,890 μg C/g) on a dry weight basis in tank 241-AP-101 samples and 13,900 μg C/mL (10,600 μg C/g) in tank 241-AW-106 and evaporator slurry samples, well below the TOC action limit of 30,000 μg/g.

2.1.2 Flammable Gas

Combustible gas meter measurements were taken in the tank headspace before the grab sampling in November 1995. The readings indicated that no flammable gas was detected (0 percent of the lower flammability limit [LFL]). The action limit is 25 percent of the LFL (Dukelow et al. 1995). Appendix B shows the results from this vapor phase measurement. It is important to note that waste has been transferred into the tank since this measurement was made.

2.1.3 Criticality

The safety screening DQO threshold for criticality, based on the total alpha activity, is 1 g/L. Because total alpha activity is measured in μCi/mL instead of g/L, the 1 g/L limit is converted into units of μCi/mL by assuming that all alpha decay originates from ^{239}Pu. Using the specific activity of ^{239}Pu (0.0615 Ci/g), the 1 g/L limit is converted to 61.5 μCi/mL. No grab sample from tank 241-AP-101 contained detectable quantities of alpha activity. The largest nondetected value was $<$0.00341 μCi/mL. The tank 241-AW-106 supernatant sample and the evaporator slurry sample were also tested for total alpha activity, but the results for each sample were below detection limits. Confidence intervals could not be calculated because of the nondetected results. The results indicate no criticality concern exists for this waste.

2.2 WASTE COMPATIBILITY EVALUATION

The purpose of the waste compatibility evaluation is to assess the safety and operational implications of combining wastes in tank 241-AP-101 with other wastes in the double-shell tank system. Safety considerations include criticality, flammable gas accumulation, energetics, tank corrosion, and chemical compatibility. Operational considerations include transuranic (TRU) and complexant waste segregation, heat generation rates, waste pumpability, mixing of different waste types, and mixing of high phosphate waste. Some safety and operational considerations are outside the scope of this report, namely the chemical reactivity of the waste, waste pumpability, and mixing of different waste types. Data requirements for this evaluation are documented in *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995).

2.2.1 Safety Considerations

The decision criteria threshold for criticality in source wastes is 0.013 g/L plutonium. Using the specific activity of ^{239}Pu, this limit was converted to 0.800 μCi/mL. The tank 241-AP-101 and 241-AW-106 mean results for $^{239/240}$Pu were 1.64E-04 and 2.18E-04 μCi/mL, respectively, well below the threshold.

To prevent the accumulation of flammable gas, a specific gravity decision criteria threshold of 1.3 has been established for source wastes. The tank 241-AP-101 and 241-AW-106 mean specific gravities were 1.31 and 1.26, respectively. Therefore, the specific gravity mean from the six grab samples from tank 241-AP-101 slightly exceeded the limit. Combining the two specific gravity means (and weighting according to the volume of each portion) yielded an overall waste mean of 1.30. Waste with specific gravities greater than 1.3 are still eligible for mixing with other tank wastes if the specific gravity of the commingled waste will be less than or equal to 1.41.

Waste compatibility energetics concerns are evaluated using two decision rules. The first has to do with the exotherm/endotherm ratio for the waste; the waste must have a ratio less than 1 (that is, the net enthalpy change for the sample must be endothermic). Four of six grab samples did not exhibit any exothermic reactions. The two grab samples that did exhibit exothermic reactions had exotherm to endotherm ratios of 0.045 and 0.27, well below the limit. The highest ratio (0.27) was calculated for sample 1AP-95-6. As reported in Section 2.1.1, the exotherm for this sample was attributed to anomalous material; therefore, the actual exotherm/endotherm ratio for the sample is expected to be much lower than 0.27. The tank 241-AW-106 supernatant sample and the evaporator slurry sample exhibited no exotherms. The second decision rule directs an investigation of the samples for a separable organic layer. No organic layer was observed in any sample from either tank.

The corrosion decision rule specifies decision criteria thresholds for hydroxide, nitrite, and nitrate to prevent corrosion of the carbon steel tank components. The applicable corrosion decision rule in Fowler (1995) states that if the following conditions are met, a transfer of this waste may be allowed:

$$1.0M < [NO_3^-] \leq 3.0M;\ \text{and}\ 0.1 \times [NO_3^-] \leq [OH^-] < 10.0M;\ \text{and}$$
$$[OH^-] + [NO_2^-] \geq 0.4 \times [NO_3^-]$$

The molarities of 2.48, 0.907, and 2.91 for nitrate, nitrite, and hydroxide (based on the tank 241-AP-101 samples), respectively, satisfied the specifications of this decision rule. Likewise, the tank 241-AW-106 and evaporator slurry samples also satisfied these criteria, with molarities of 1.52, 0.846, and 1.74, for nitrate, nitrite, and hydroxide, respectively.

2.2.2 Operational Considerations

The TRU waste segregation decision criteria threshold is 100 nCi/g (0.1 μCi/g). Waste, which exceeds the criterion, must be stored in a TRU storage tank. For tank 241-AP-101, the mean analytical results for ^{241}Am and $^{239/240}$Pu were summed, then divided by the mean specific gravity (1.31) to derive a TRU concentration of 3.73E-04 μCi/g. Similarly, for tank 241-AW-106 waste, a TRU concentration of 0.00104 μCi/g was obtained using a mean specific gravity of 1.26. Note the value used for ^{241}Am was the highest nondetect value. Based on these calculations, the waste is not TRU.

High phosphate waste should not be mixed with certain other waste types. Wastes with a phosphate concentration greater than 0.1*M* (9,500 μg/mL) are considered high phosphate waste. The mean phosphate results for tanks 241-AP-101 and 241-AW-106 were well below the limit with results of 908 and 1,560 μg/mL, respectively.

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. The waste compatibility DQO decision threshold for the heat generation rate of the waste is the same as the operating specification document limit. Table 2-1 show the radionuclide analytical data used to calculate the tank heat load. Only radionuclides with detected results in both data sets and with decay heats listed in Kirkpatrick and Brown (1984) were used in the calculation. The calculated heat load of 3,170 W (10,800 Btu/hr) is well below the operating specification of 20,500 W (70,000 Btu/hr) for the AP Tank Farm (Harris 1996). No heat load estimates were available based on process history or tank headspace temperatures.

Table 2-1. Tank 241-AP-101 Projected Heat Load.

Radionuclide	Projected Inventory	Decay Heat Generation Rate[1]	Heat Load from Radioactive Decay
	Ci	W/Ci	W
^{137}Cs	6.72E+05	0.00472	3,170
$^{239/240}$Pu	0.709	0.0306	0.0217
$^{89/90}$Sr	548	0.00669	3.67
Total			3,170

Note:

[1]Kirkpatrick and Brown (1984)

2.3 SUMMARY

Because tank 241-AP-101 has not been sampled since the latest transfers of waste into the tank, characterization data from an earlier sampling event and analytical data for the waste transferred into the tank were both evaluated. Together, these results adequately describe the waste currently in the tank. The results from all analyses performed to address potential safety issues of the safety screening DQO (Dukelow et al. 1995) showed that no primary analyte exceeded the decision threshold limits. Although one sample did produce an exothermic reaction greater than the safety screening limit, this observation was not reproducible and was attributed to some anomalous material.

The flammability screening was performed before the last waste additions to the tank.

The waste compatibility evaluation revealed that, except for specific gravity, the results were within the desired ranges of the waste compatibility DQO (Fowler). Although the specific gravity of the tank 241-AP-101 grab samples slightly exceeded the 1.3 limit for source wastes, the mean analytical result of 1.31 was below the commingled waste threshold of 1.41. Table 2-2 summarizes the safety screening and waste compatibility evaluations.

Table 2-2. Summary of Safety Screening and Waste Compatibility Evaluations. (2 sheets)

DQO	Issue	Result
Safety screening	Energetics	Two samples exhibited exothermic reactions. One exotherm exceeded the 480 J/g limit, but it was not reproducible and was attributed to an anomalous material.
	Flammable gas	Vapor measurement (by combustible gas meter) reported 0 percent of LFL. It was performed before waste was added from tank 241-AW-106.
	Criticality	All total alpha activity results and 95 percent confidence interval upper limits were well below 61.5 μCi/mL threshold.
	Separable organic layer	No separable organic layer was found in any grab sample.
Waste compatibility	**Safety Considerations**	
	Criticality	All results were below the limit of 0.013 g/L (0.800 μCi/mL).
	Flammable gas	The mean specific gravity of tank 241-AP-101 grab samples was 1.31 slightly exceeding the 1.3 limit for source wastes, but it was below the 1.41 limit for commingled wastes. The mean tank 241-AW-106 result was below the 1.3 limit.
	Energetics	All samples had an exotherm to endotherm ratio <1. No separable organic layer was observed in any sample.
	Corrosion	Results were within the corrosion specifications.
	Operational Considerations	
	TRU waste segregation	All analytical results were below the 100 nCi/g TRU waste segregation limit; therefore, waste does not need to be segregated for TRU waste reasons.
	Heat generation	The estimated tank heat load was far below the operating specification document limit for tank 241-AP-101.
	High phosphate waste	The waste in tank 241-AP-101 is not high in phosphate; all results were below the 0.1*M* (9,500 μg/mL) limit.

3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage. Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses, and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (Agnew et al. 1996). Information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available chemical information for tank 241-AP-101 was performed. It included the following:

- Characterization results from the July 1993 "bottle-on-a-string" sampling event at a time when 295 kL (78 kgal) of dilute noncomplexed waste was in the tank. Table 5-5 of DiCenso et al. (1994) summarizes the results from the statistical analysis of data from the sample event.

- Beginning in October 1994, the contents of tank 241-AP-108 were transferred to tank 241-AP-101. Characterization results from the June 1994 grab sampling event for tank 241-AP-108 (Miller 1994, Table 14) were used to provide a composition for this waste.

- In August 1995, 2,450 kL (660 kgal) of waste from tank 241-AP-105 were transferred to tank 241-AP-101. The composition for this waste was taken from the characterization results of the March 1993 "bottle-on-a-string" sampling event given in the *Tank Characterization Report for Double-Shell Tank 241-AP-105* (De Lorenzo et al. 1994, Table 5-6).

- The final report for grab samples taken in November 1995 (Esch 1996, Table 1) provides characterization results for tank 241-AP-101 after it received DSSF from tanks 241-AP-105 and 241-AP-108.

- The *242-A Campaign 95-1 Post Run Document* (Guthrie 1996, Table 10) and the final report for the August 1995 tank 241-AW-106 grab samples (Esch 1995) provided characterization results for the 1,438 kL (380 kgal) of DSSF transferred from tank 241-AW-106 to tank 241-AP-101 in March 1996 and January 1997.

- The Hanford Defined Waste (HDW) model document (Agnew et al. 1996) provides tank content estimates derived from the Los Alamos National Laboratory model in terms of component concentrations and inventories. Appendix D provides a complete list of data sources used in this evaluation.

The sample-based data should serve as the basis for the best estimate inventory for tank 241-AP-101 for the following reasons:

1. Although no individual samples of waste currently stored in tank 241-AP-101 exist, data from the tank samples taken in November 1995 and from waste produced in Evaporator Campaign 95-1 can be combined to describe the waste in tank 241-AP-101.

2. The HDW model estimate is outdated because of a large number of waste transfers that have occurred subsequent to the model development.

Tables 3-1 and 3-2 show best-basis inventory estimates for tank 241-AP-101. The data were calculated from sampling data from the 242-A Evaporator (Campaign 95-1), from tank 241-AW-106, and from tank 241-AP-101. Appendix D describes the method used to calculate the inventory from the sampling data.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-101 as of January 31, 1997. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	40,400	S	
Ca	237	S	Campaign 95-1 data not available
Cl	5,680	S	
TIC as CO_3^{2-}	1.13E+05	S	
Cr	662	S	Campaign 95-1 data not available
F	8,990	S	
Fe	23.5	S	
K	1.09E+05	S	Campaign 95-1 data not available
Na	6.01E+05	S	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-101 as of January 31, 1997. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Ni	38.5	S	Campaign 95-1 data not available
NO_2^-	1.63E+05	S	
NO_3^-	5.42E+05	S	
OH^-	1.75E+05	S	
Pb	19.0	S	Campaign 95-1 data not available
PO_4	4,280	S	45 percent disparity between historical and analytical results
Si	512	S	Campaign 95-1 data not available
SO_4	13,400	S	
TOC	12,400	S	
U_{TOTAL}	191	S	

Note:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-101 as of January 31, 1997 (Decayed to January 1, 1994).

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{14}C	0.744	S	
^{90}Sr	679	S	
^{90}Y	679	S	
^{99}Tc	212	S	
^{137}Cs	7.14E+05	S	
^{137m}Ba	6.78E+05	S	
^{154}Eu	210		
^{237}Np	1.11	S	Campaign 95-1 data not available
^{238}U	0.0518	S	Campaign 95-1 data not available
$^{239/240}Pu$	0.713	S	
^{241}Am	0.843	S	

Note:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based

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4.0 RECOMMENDATIONS

The sampling and analysis activities performed for tank 241-AP-101 have met all the requirements of the safety screening and waste compatibility DQOs. However, the flammability screening is no longer valid. Transfers of waste into the tank have occurred since the flammability screening was performed.

All other issues have been addressed. Because no samples have been taken of the waste currently in the tank, results from earlier samples from tank 241-AP-101 and samples of the waste stream later transferred into the tank were considered. As stated in Section 2, comparison of the analytical results with the safety screening thresholds revealed that one sample did exceed the energetics limit. However, the exotherm for this sample was not reproducible and is considered an anomaly. All other safety issues were satisfied. The specific gravity of tank 241-AP-101 samples slightly exceeded the waste compatibility threshold. However, the overall tank mean was within the compatibility specifications. A characterization best-basis inventory was also developed for the tank contents.

Table 4-1 summarizes the status of Project Hanford Management Contractor (PHMC) TWRS Program review and acceptance of the sampling and analysis results reported in this tank characterization report. Column 1 of Table 4-1 addresses all DQO issues required by sampling and analysis. Column 2 indicates whether the requirements of the DQO were met by the sampling and analysis activities performed and is answered with a "yes" or a "no." Column 3 indicates concurrence and acceptance by the program in PHMC TWRS that is responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" indicates acceptance or disapproval of the sampling and analysis information presented in the TCR. If the results and information have not yet been reviewed, "N/R" is shown in the column. If the results and information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown.

Table 4-1. Acceptance of Tank 241-AP-101 Sampling and Analysis.[1]

Issue	Evaluation Performed	Program[2] Acceptance
Safety screening DQO	Yes	No (vapor open)
Waste compatibility DQO	Yes	Yes

Note:

[1]Valid for tank contents as of May 30, 1997.
[2]PHMC TWRS

Table 4-2 summarizes the status of PHMC TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations outlined in this report determine whether the tank is safe, conditionally safe, or unsafe, and whether the tank waste will be compatible with other tank wastes in the double-shell tank system. Column 1 lists the different evaluations performed. Columns 2 and 3 are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as that in Table 4-1.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-AP-101.[1]

Issue	Evaluation Performed	Program[2] Acceptance
Safety categorization (The tank is safe.)	Yes	No (vapor open)
Waste compatibility assessment (Wastes are compatible with other wastes in the double-shell tank system.)	Yes	Yes

Note:
[1]Valid for tank contents as of May 30, 1997.
[2]PHMC TWRS

If tank 241-AP-101 receives waste in the future, the results of this assessment may no longer be valid.

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-AP-101 based on historical information. For this report, historical information includes information about the fill history, waste types, surveillance, or modeling data about the tank. This information can be used to support or challenge 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.
- **Section A2**: Information about the tank design.
- **Section A3**: Process knowledge about the tank, that is, the waste transfer history and the estimated contents of the tank based on modeling data.
- **Section A4**: Surveillance data for tank 241-AP-101 including surface-level readings and temperatures.
- **Section A5**: References for Appendix A.

Historical sampling results are included in Appendix B.

A1.0 CURRENT TANK STATUS

As of January 31, 1997, tank 241-AP-101 contained an estimated 4,224 kL (1,116 kgal) of waste classified as double-shell slurry feed. The liquid volume was estimated using a Food Instrument Corporation gauge and manual tape (LMHC 1997). Table A1-1 shows the volumes of the waste phases found in the tank.

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

Table A1-1. Estimated Tank Contents as of January 31, 1997.[1]

Waste Type	Estimated Volume	
	kL	kgal
Total waste	4,224	1,116
Supernatant liquid	4,224	1,116
Sludge	0	0
Saltcake	0	0
Drainable interstitial liquid	0	0
Drainable liquid remaining	4,224	1,116
Pumpable liquid remaining	4,224	1,116

Note:

[1]For definitions and calculation methods refer to Appendix C of Hanlon (1997).

A2.0 TANK DESIGN AND BACKGROUND

The AP Tank Farm was constructed from 1983 to 1986 in the 200 East Area. The tank farm contains eight 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 10.7 m (35.2 ft). These tanks were designed to hold concentrated supernatant. The maximum design temperature for liquid storage is 149 °C (300 °F) (Brevick et al. 1995).

Tank 241-AP-101 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. There is a grid of drain slots in the concrete foundation beneath the secondary steel liner. The grid's function is to collect waste that may leak from the tank and divert it to the leak detection well.

Tank 241-AP-101 has 29 risers, ranging in diameter from 100 mm (4 in.) to 1.1 m (42 in.), that provide access to the tank and 42 risers that provide access to the annulus. Table A2-1 shows numbers, diameters, and descriptions of the risers (annular risers not included). Figure A2-1 shows the riser configuration. Eight 100-mm (4-in.)-diameter risers (no. 1 [A-C] 15, 21, 24, 26, and no. 28), three 305-mm (12-in.)-diameter risers (two no. 10s, and no. 12), and two 1.1-m (42-in.)-diameter risers (two no. 5s) are available to reach the tank interior. Figure A2-2 shows a tank cross section, the approximate waste level, and a schematic of tank equipment.

Table A2-1. Tank 241-AP-101 Risers.[1,2,3,4] (2 sheets)

Riser Number[5]	Diameter cm	(in.)	Description and Comments
1	10	4	Sludge measurement port
1	10	4	Sludge measurement port
1	10	4	Sludge measurement port
2	10	4	Automatic liquid indicator tape (Food Instrument Corporation gauge)
3	30	12	Supernatant pump (central pump pit)
4	30	12	Thermocouple probe
5	110	42	Spare, riser plug below grade (manhole)
5	110	42	Spare, riser plug below grade (manhole)
7 at 120°[5]	30	12	Spare, riser plug
7 at 75°[5]	30	12	Primary tank exhaust
10	30	12	Spare, riser plug
10	30	12	Spare, riser plug
11	110	42	Slurry distributor (central pump pit)
12	30	12	Observation port
13	30	12	Tank pressure
14	10	4	Supernatant return
15	10	4	Spare, riser plug
16	30	12	Sludge measurement port
16	30	12	Sludge measurement port
16	30	12	Sludge measurement port
21	10	4	Spare, riser plug
22	10	4	Sludge measurement port
24	10	4	Spare, riser plug
25	10	4	High liquid-level sensor
26	10	4	Liquid-level indicator (manual tape)

Table A2-1. Tank 241-AP-101 Risers.[1, 2, 3, 4] (2 sheets)

Riser Number[5]	Diameter cm	(in.)	Description and Comments
27	10	4	Spare, riser plug
27	10	4	Spare, riser plug
27	10	4	Spare, riser plug
28	10	4	Spare, riser plug

Notes:

[1]Salazar (1994)

[2]WHC (1994)

[3]KEH (1982)

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

[5]Risers having the same number are distinguished by their angle from due north (measured clockwise). These are noted only in cases where the riser descriptions are different (for example, riser 7).

Figure A2-1. Riser Configuration for Tank 241-AP-101.

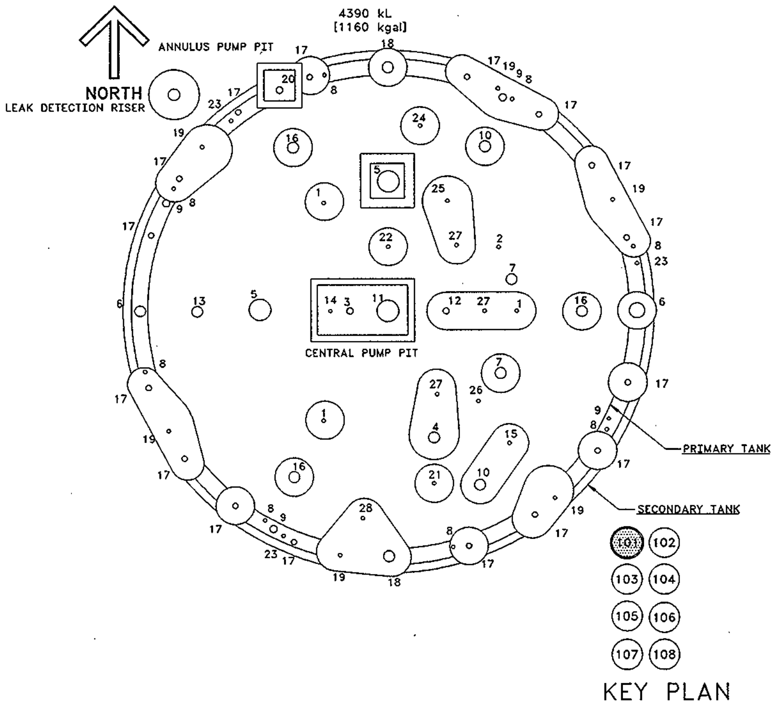
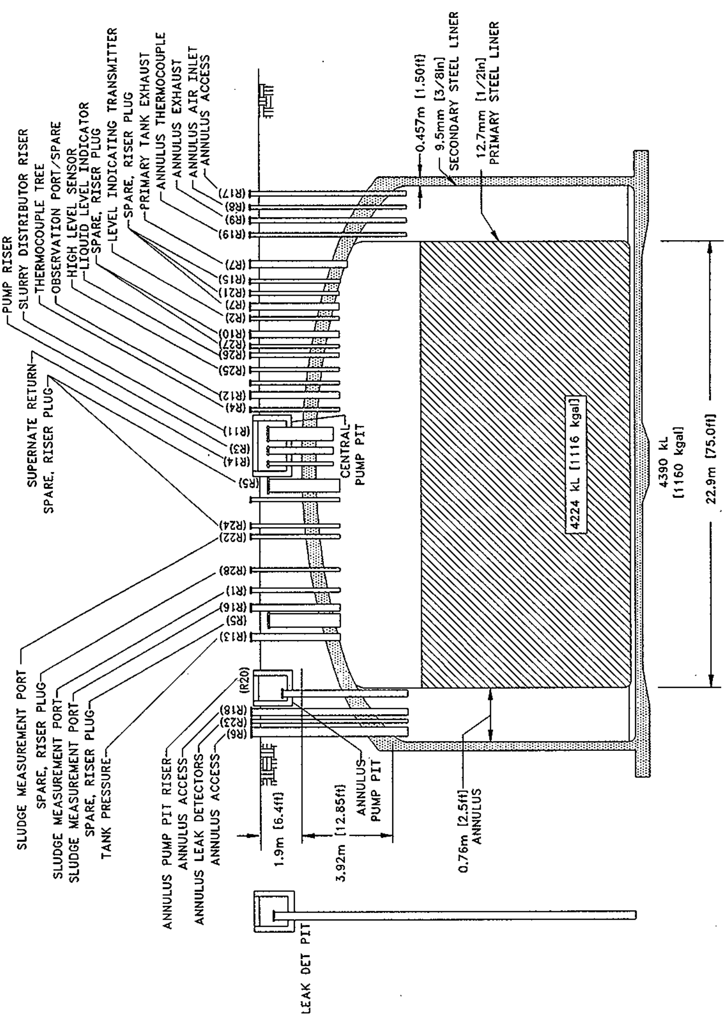


Figure A2-2. Tank 241-AP-101 Cross Section and Schematic.



A3.0 PROCESS KNOWLEDGE

The sections below: 1) provide information about the transfer history of tank 241-AP-101, 2) describe the process wastes that made up the transfers, and 3) give an estimate of the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Tank 241-AP-101 first received about 68 kL (18 kgal) of unknown waste (likely an addition of water) during the fourth quarter of 1986. The tank received a small transfer of 4 kL (1 kgal) of PUREX decladding supernatant and 72 kL (19 kgal) of an unknown waste during the third quarter of 1987. During the second quarter of 1988, the tank received the first of a series of transfers of PUREX ammonia scrubber feed (PASF) from the PUREX Plant. During 1988 and 1989, the tank received a total of about 7,301 kL (1,929 kgal) of PASF. Flush water was sent to the tank in 1988 and 1989. From September through December 1988, more than 2,737 kL (723 kgal) of waste was transferred from tank 241-AP-101 to tank 241-AW-102 (242-A Evaporator feed tank) for processing during Evaporator Campaign 89-1 (Jonas 1989). Also during the fourth quarter of 1988, about 2,188 kL (578 kgal) was transferred from tank 241-AP-101 to tank 241-AP-103.

During the fourth quarter of 1989, tank 241-AP-101 received a transfer of about 2,332 kL (616 kgal) of waste from tank 241-AP-103. This waste consisted of the waste transferred from tank 241-AP-101 to tank 241-AP-103 during the previous year and some additional PASF and flush water.

No further transfer activity was recorded for this tank until August 1994 when the Evaporator Campaign 94-2 began (Guthrie 1995). Near the beginning of the campaign, about 2,816 kL (744 kgal) of waste was transferred from tank 241-AP-101 to tank 241-AW-102 near the beginning of the campaign. In October, about 1,075 kL (284 kgal) of supernatant was added to tank 241-AP-101 from tank 241-AP-108. Subsequently about 1,707 kL (451 kgal) was transferred from tank 241-AP-101 to tank 241-AW-102.

During January 1995, tank 241-AP-101 received a transfer of about 2,896 kL (765 kgal) of dilute noncomplexed waste from tank 241-AP-108. Subsequently about 3,164 kL (836 kgal) of waste was transferred from tank 241-AP-101 to tank 241-AP-107 leaving a total waste volume in tank 241-AP-101 of about 295 kL (78 kgal). During August 1995, tank 241-AP-101 received 2,498 kL (660 kgal) of DSSF from tank 241-AP-105. During March 1996, a transfer of 1,158 kL (306 kgal) of dilute noncomplexed waste was sent tank 241-AP-101 from tank 241-AW-106, and during January 1997, another 280 kL (74 kgal) transfer from 241-AW-106 occurred. This waste consisted of DSSF produced during the 242-A Evaporator Campaign 95-1 (Guthrie 1996).

Table A3-1 summarizes major waste transfers into tank 241-AP-101.

Table A3-1. Tank 241-AP-101 Transfer History.

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[1]	
				kL	kgal
PUREX plant		Supernatant	1987	4	1
Unknown		Unknown	1987	72	19
PUREX plant		PASF	1988 to 1989	7,301	1,929
	241-AW-102	Supernatant	1988	-2,737	-723
Miscellaneous sources		Flush water	1988 to 1989	227	60
241-AP-103		Supernatant	1989	2,332	616
	241-AW-102	Supernatant	1994	-4,523	-1,195
241-AP-108		Supernatant	1994 to 1995	3,970	1,049
	241-AP-107	Supernatant	1995	-3,164	-836
241-AP-105		Supernatant	1995	2,498	660
241-AW-106		Supernatant	1996 to 1997	1,438	380

Note:
[1]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 Southwest Quadrant of the Hanford 200 East Area* (WSTRS) (Agnew et al. 1996). This document is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev 4* (Agnew et al. 1997). This document contains the HDW list, the Supernatant Mixing Model, and the Tank Layer Model).

- The *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area* (Brevick et al. 1996), *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area* (Brevick et al. 1997a), *Historical Tank Estimate for the Southeast Quadrant of the Hanford 200 East Area* (Brevick et al. 1997b), and the *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area* (Brevick et al. 1997c) 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 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.

This sources are combined to produce a historical tank inventory estimate for each of 177 tanks. These predictions have not been validated and should be used with caution. In some cases, the available data are incomplete, thereby reducing the reliability of the transfer data and the modeling results derived from them. Therefore, these predictions can be 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-AP-101 was 295 kL (78 kgal) in January 1995, and the current volume is 4,225 kL (1,116 kgal). Therefore, the HDW model estimate for tank 241-AP-101 is not given here because it does not represent the waste currently in the tank.

A4.0 SURVEILLANCE DATA

Tank 241-AP-101 surveillance data consist of surface-level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and leak detection well monitoring for radioactive liquids outside the primary tank. Liquid-level measurements indicate major leaks into or out of the tank. Leak detection systems within the annulus of the tank will detect leaks from the primary tank. These data provide the basis for determining tank integrity.

A4.1 SURFACE LEVEL READINGS

Waste surface-level monitoring is performed with a Food Instrument Corporation gauge (riser 2) and a manual tape (riser 26). Because this is an active tank, the surface level is continually subject to change. The waste surface level on January 14, 1997, was 10.31 m (405.8 in.) by an automatic Food Instrument Corporation gauge (LMHC 1997). Figure A4-1 is a graph of the volume measurements.

A4.2 INTERNAL TANK TEMPERATURES

Temperature data for tank 241-AP-101 are recorded by 18 thermocouples on one thermocouple tree located in riser 4. Data are recorded weekly. Temperature data were evaluated from the Surveillance Analysis Computer System (LMHC 1997) recorded from July 1989 to January 1997. Not all thermocouples have data covering the entire period. Currently, data are only reported for thermocouples 1, 3, 5, 7, 11, and 17. The average temperature during this period was 17 °C (62 °F) with a minimum of 12 °C (53 °F) and a maximum of 23 °C (74 °F).

The minimum temperature on January 6, 1997, was 17.9 °C (64.2 °F) at thermocouple 17; the maximum temperature on the same date was 19.8 °C (67.8 °F) at thermocouple 11. Figure A4-2 shows a graph of the weekly high temperatures.

A4.3 TANK 241-AP-101 PHOTOGRAPHS

No interior photographs are available.

Figure A4-1. Tank 241-AP-101 Level History.

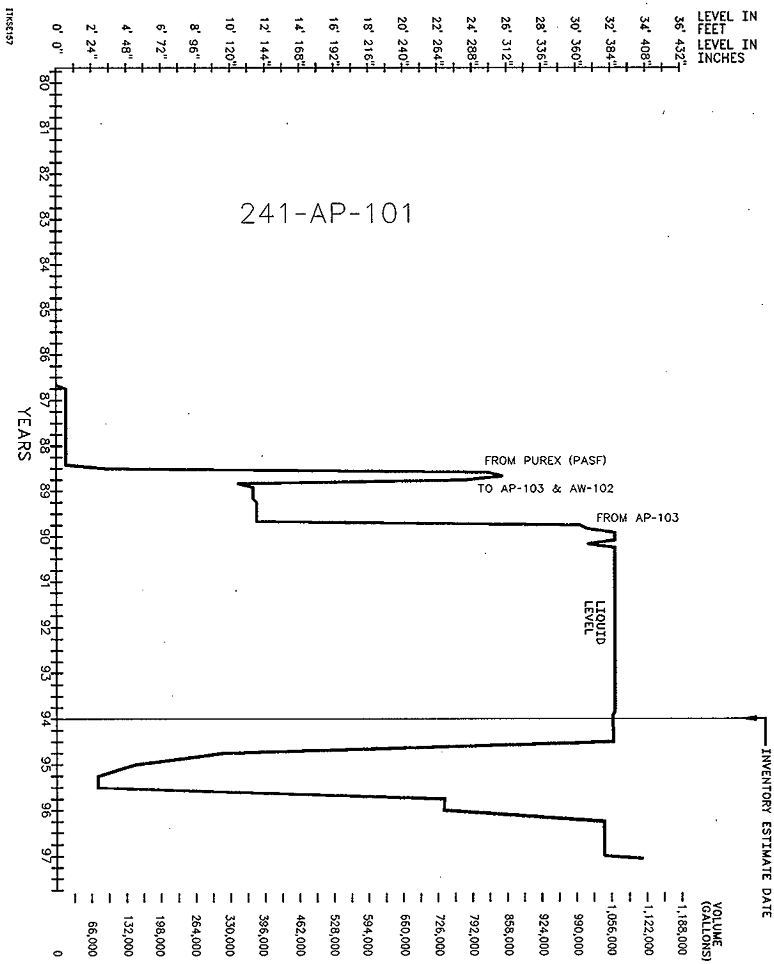
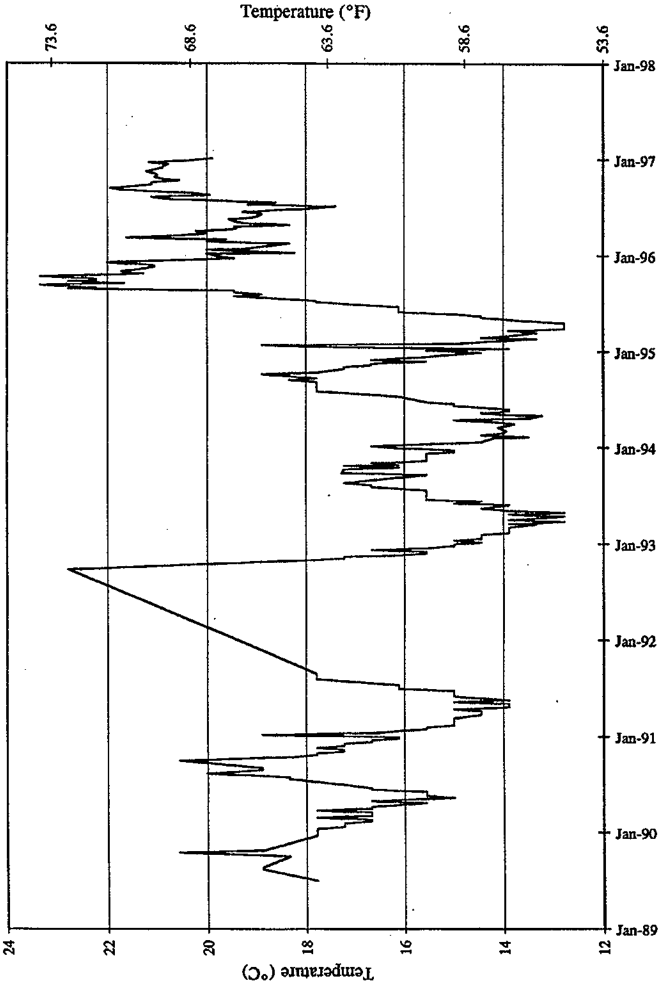


Figure A4-2. Tank 241-AP-101 High Temperature Plot.



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APPENDIX B

SAMPLING OF TANK 241-AP-101

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APPENDIX B

SAMPLING OF TANK 241-AP-101

Appendix B provides sampling and analysis information for each known sampling event for tank 241-AP-101, and it assesses the November 1995 grab sampling results.

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

B1.0 TANK SAMPLING OVERVIEW

This section describes the November 1995 sampling and analysis event for tank 241-AP-101 and two other sampling events used in the characterization of this tank. During November 1995, six supernatant grab samples and one field blank were taken to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). The sampling and analysis were performed in accordance with the *Tank 241-AP-101 Grab Sampling and Analysis Plan* (Esch 1995b).

After the November 1995 sampling, 1,438 kL (380 kgal) of evaporated waste were transferred from tank 241-AW-106 to tank 241-AP-101 (March 1996 and January 1997). A sample obtained from the 242-A Evaporator in July 1995 during Campaign 95-1 and a grab sample taken from tank 241-AW-106 on August 24, 1995, provide characterization data for the evaporator slurry waste. Section B1.2 describes these two sampling events. For further discussion of the sampling and analysis procedures, refer to the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

B1.1 TANK 241-AP-101 1995 GRAB SAMPLING

B1.1.1 Description of Sampling Event

Six supernatant grab samples and one field blank were collected from tank 241-AP-101 on November 10 and 13, 1995, using the bottle-on-a-string method. Three supernatant samples each were obtained from risers 1 at 210° (SW) and 1 at 330° (NW) at depths specified by the sampling and analysis plan (Esch 1995b). All samples were received by the 222-S Laboratory on the same day the samples were collected. Table B1-1 summarizes applicable DQOs and sampling and analysis requirements for this sampling event.

Before collecting the grab samples, the tank headspace was sampled below risers 1 SW and 1 NW and analyzed for the presence of flammable gases as required by Esch (1995a).

Table B1-1. Integrated Data Quality Objective Requirements for Tank 241-AP-101.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
1995 grab sampling	Safety screening (Dukelow et al. 1995)	Vertical profiles from two widely spaced risers	• Energetics • Moisture content • Total alpha activity • Specific gravity • Visual check for organic layer
	Waste compatibility (Fowler 1995)	Grab samples from varying depths	• Energetics • Moisture content • Visual check for organic layer • Metals by ICP • Anions by IC • Radionuclides • TIC, TOC • Hydroxide • Specific gravity • pH • Percent solids
Combustible gas meter reading	Safety screening	Flammable gas concentration measured in the tank headspace	• Percent of LFL

Note:

[1]Esch (1995a)

B1.1.2 Sample Handling

The samples were prepared for analysis at the 222-S Laboratory. All samples were visually inspected for color, clarity, solids content, and the presence of a potential organic layer. All samples (except for the field blank) were described as yellow and clear. Two 20-mL subsamples were then removed from each sample for analysis; the remainder of each sample was archived. Table B1-2 relates sample numbers used in the field with sample numbers assigned in the laboratory. It also shows the riser location and height from which each sample was obtained. Note that sample 1AP-95-1 was actually taken from a lower depth than sample 1AP-95-2. In addition, over-the-top dose rate readings and data from the visual inspection conducted at the laboratory are shown.

Table B1-2. Grab Sample Descriptions.[1]

Customer Identification Number	Laboratory Identification Number	Sampling Elevation[2] m (in.)	Color	Clarity	Solids	Potential Organic Layer	Over-the-Top Dose Rate (mR/hr)
Riser 1 at 210° (SW)							
1AP-95-1	S95T003717	3.40 (134)	Yellow	Clear	None	None	3,300
1AP-95-2	S95T003718	6.78 (267)	Yellow	Clear	None	None	3,500
1AP-95-3	S95T003719	0.25 (10)	Yellow	Clear	None	None	3,500
1AP-95-7 (Field blank)	S95T003720	10.4 (410)	Colorless	Clear	None	None	0.5
Riser 1 at 330° (NW)							
1AP-95-4	S95T003725	6.78 (267)	Yellow	Clear	None	None	3,000
1AP-95-5	S95T003726	3.40 (134)	Yellow	Clear	None	None	3,400
1AP-95-6	S95T003727	0.25 (10)	Yellow	Clear	None	None	3,800

Notes:

mR/hr = millirad per hour

[1]Esch (1996)
[2]Above the tank bottom

B1.1.3 Sample Analysis

The grab samples were analyzed for safety screening and waste compatibility assessments. As noted in Table B1-1, the safety screening DQO required analyses for energetics by DSC, weight percent water by thermogravimetric analysis (TGA), fissile content by total alpha analysis using an alpha proportional counter, and specific gravity. The analyses required by the waste compatibility DQO included all primary safety screening analytes (except total alpha activity) and the following: total inorganic carbon (TIC) and TOC by furnace oxidation; hydroxide by potentiometric titration; pH; ^{137}Cs by gamma energy analysis (GEA); ^{90}Sr by beta proportional counting; ^{241}Am and $^{239/240}Pu$ by alpha proportional counting; aluminum, iron, and sodium by inductively coupled plasma spectroscopy (ICP); anions (Cl^-, F^-, NO_3^-, NO_2^-, PO_4^{3-}, SO_4^{2-}) by ion chromatography (IC); and centrifugation for volume percent solids. The tank vapor phase was screened in the field by means of a combustible gas meter.

All reported analyses were performed directly on subsamples according to approved laboratory procedures. Because of the absence of solids in the samples, the volume percent solids by centrifugation test was not performed. Specific gravity was not performed in duplicate for subsample S95T003724 because of an insufficient amount of sample material. Laboratory quality control (QC) checks included, where appropriate, laboratory control standards, matrix spikes, duplicate analyses, and blanks. Section B3.2 shows an assessment of the QC procedures and data.

Table B1-3 lists the sample numbers and applicable analyses.

Table B1-3. Sample Analysis Summary.[1] (2 sheets)

Customer Identification	Laboratory Identification	Analyses
Riser 1 at 210° (SW)		
1AP-95-1	S95T003721	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003731	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity
1AP-95-2	S95T003722	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003732	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity
1AP-95-3	S95T003723	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003733	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity
1AP-95-7 (Field blank)	S95T003724	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003734	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity

Table B1-3. Sample Analysis Summary.[1] (2 sheets)

Customer Identification	Laboratory Identification	Analyses
Riser 1 at 330° (NW)		
1AP-95-4	S95T003728	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003735	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity
1AP-95-5	S95T003729	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003736	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity
1AP-95-6	S95T003730	DSC, TGA, TIC/TOC, ICP, IC, pH, OH^-, SpG
	S95T003737	GEA, $^{239/240}Pu$, ^{90}Sr, ^{241}Am, total alpha activity

Notes:

SpG = specific gravity

[1]Esch (1996)

B1.2 EVAPORATOR SLURRY SAMPLING

B1.2.1 242-A Evaporator Campaign 95-1 Sampling

Tank 241-AW-106 was one of four tanks providing feed for Evaporator Campaign 95-1, and it also acted as the slurry receiver for the Evaporator Campaign 95-1 (Guthrie 1996). A sample (T2270) was drawn of the slurry product on July 21, 1995, and it was subsequently analyzed in accordance with the *242-A Evaporator Sample Schedule for Campaign 95-1* (Le 1995). The over-the-top dose rate was 1,250 millirad per hour, and the settled percent solids was 3.4 volume percent. The sample was analyzed for the following: DSC, pH, specific gravity, TIC, TOC, total carbon, fluoride, nitrite, nitrate, phosphate, sulfate, hydroxide, ammonia, aluminum, sodium, total beta activity, total alpha activity, uranium, ^{3}H, ^{14}C, ^{60}Co, ^{79}Se, $^{89/90}Sr$, ^{94}Nb, ^{99}Tc, $^{106}RuRh$, ^{129}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu, ^{226}Ra, ^{237}Np, ^{238}Pu, $^{239/240}Pu$, ^{241}Am, and ^{244}Cm.

B1.2.2 Tank 241-AW-106 August 1995 Grab Sampling

Three grab samples (one liquid and two sludge) were taken from riser 16B of tank 241-AW-106 on August 24, 1995 (Esch 1995a). The samples were collected and analyzed to support the waste compatibility safety program and to resolve process control questions from the most recent evaporator campaign. Because only the supernatant sample (sample 6AW-95-1) represents the waste transferred to tank 241-AP-101 in March 1996 and

January 1997, this discussion is limited to the handling and analysis of the supernatant sample. The sample was received by the 222-S Laboratory on the same day it was collected from the tank. Visual observation indicated it was a clear yellow liquid with a trace of settled solids. No organic layer was present. The dose rate on contact was 3.0 rads per hour. Two 20-mL subsamples were taken; one (S95T002016) was analyzed for inorganic analytes and the other (S95T002017) for radionuclides (see Table B1-4). The remainder of the liquids and the trace of solids were archived and later submitted for viscosity analyses.

The subsamples were analyzed in accordance with the *Compatibility Grab Sampling and Analysis Plan* (Jones 1995). Reported analyses were performed directly on the subsamples according to approved laboratory procedures. Laboratory control standards, matrix spikes, duplicate analyses, and blanks were used where appropriate.

Table B1-4. Tank 241-AW-106 Sample Analysis Summary.[1]

Customer Identification	Laboratory Identification	Analyses
Riser 16B		
6AW-95-1	S95T002016	DSC, TGA, TIC/TOC, TC, ICP for Al, Fe, and Na, IC for anions, pH, OH, SpG
	S95T002017	GEA, ^{238}Pu, $^{239/240}$Pu, ^{90}Sr, ^{241}Am, U by phosphorescence, total alpha activity, total beta activity, ^{3}H, ^{14}C, ^{79}Se, ^{99}Tc, ^{129}I, ^{237}Np

Note:

[1]Esch (1995b)

B1.3 DESCRIPTION OF HISTORICAL SAMPLING EVENTS

B1.3.1 March 1995 Grab Sampling

To determine whether tank 241-AP-101 was within tank corrosion control specifications, two grab samples were removed on March 30, 1995. Sampling was performed in accordance with the *Letter of Instruction for Tank 241-AP-101 Grab Samples* (Schreiber 1995). Because the sampling was for process control purposes, no tank characterization plan was required. Sample depths and sample risers were not available. There is some confusion regarding sample numbering. Schreiber (1995) assigns the numbers 1AP-95-1 and 1AP-95-2 to the samples, but the internal memorandum containing the analytical results (Rollison 1995a) refers to the samples as 1AP-95-2 and 1AP-95-3. In addition, attachment 2 of Rollison, which contains the chain-of-custody form for the two grab samples, designates the samples as

101-AP-2 and 101-AP-3. Dose rates on contact were 25 and 40 millirads per hour, respectively. A full recovery of 125 mL was obtained for both grab samples. No other information regarding the sampling event was available.

The samples were received by the 222-S Laboratory on March 30, 1995. The required analytes included pH, chloride, fluoride, hydroxide, nitrate, nitrite, phosphate, sulfate, and TIC. Section B2.3.1 shows the results from the sampling event. Because tank 241-AP-101 has been active, that is, wastes have been received and transferred since the sampling event, the results no longer represent current tank contents.

B1.3.2 December 1994 Grab Sampling

The December 1994 grab samples were also taken to determine whether tank 241-AP-101 was within tank corrosion control specifications. Again, no tank characterization plan was required because sampling was done for process control reasons. The sampling was directed by "Letter of Instruction for Tank 241-AP-101 Grab Samples" (Bratzel 1994).

Information regarding the sampling event was limited. Two grab samples were obtained, and were assigned numbers 101-AP-1 and 101-AP-2 (Bratzel (1994). Sample depths and sample risers were not available. The samples were received by the 222-S Laboratory on December 16, 1994. Before analysis, the samples were assigned laboratory identification numbers R 6833 and R 6834. The required analytes included pH, chloride, fluoride, hydroxide, nitrate, nitrite, phosphate, sulfate, and TIC. Results for these analytes were reported in Rollison (1995b) and are shown in Section B2.3.2. These results should be used with caution because they no longer represent current tank contents.

B1.3.3 July 1993 Grab Sampling

Tank 241-AP-101 was sampled in 1993 to evaluate the fitness of the tank waste to be processed in the 242-A Evaporator. Analytical results from these samples were previously reported in the *222-S Validation Summary for Double-Shell Tank 241-AP-101* (Miller 1993) and Revision 0 of this TCR. Given the active waste transfer history of the tank, analytical results from these samples do not represent the current contents of the tank.

On July 20, 1993, supernatant samples were collected in duplicate from risers 1 at 90° (E), 2 at 210° (SW), and 3 at 330° (NW) at five locations within the waste using the bottle-on-a-string method. An additional sample was collected (from riser 1 at 210°) from the waste surface level for a TOC analysis. Each sample bottle collected approximately 100 mL of liquid. One complete set of samples was delivered to the Pacific Northwest Laboratory for organic analyses; the remaining set was delivered to the 222-S Laboratory where it underwent inorganic and physical property analyses. A composite sample was prepared from equal portions of the five samples for radiological analyses at the

222-S Laboratory. All samples were described as being similar in appearance: colorless and clear liquids containing no visible solids. Section B2.3.3 shows the analytical results.

B2.0 ANALYTICAL RESULTS

This section summarizes the sampling and analytical results associated with the November 1995 sampling and analysis of tank 241-AP-101. Table B2-1 shows the total alpha activity, radionuclide, percent water, energetics, specific gravity, pH, IC, and ICP analytical results associated with this tank. The results are documented in Esch (1996).

This section also summarizes the sampling and analytical results associated with the July 1995 sampling of 242-A Evaporator slurry and the August 1995 sampling of tank 241-AW-106. These results are documented in Guthrie (1996) and Esch (1995b). These sampling events provide data for supernatant which was transferred from tank 241-AW-106 to tank 241-AP-101 in March 1996 and January 1997.

Table B2-1. Analytical Presentation Tables.

Analysis	Table Number
Results From Sampling of Tank 241-AP-101	
Metals by ICP	B2-2 through B2-4
Anions by IC and hydroxide by potentiometric titration	B2-5 through B2-11
Total inorganic and organic carbon	B2-12 and B2-13
Radionuclides	B2-14 through B2-19
Weight percent water	B2-20
Differential scanning calorimetry	B2-21
Specific gravity	B2-22
pH	B2-23
Vapor phase measurements	B2-24
Results From Sampling of Tank 241-AW-106 and 242-A Evaporator Slurry	
Chemical data	B2-25
Weight percent water	B2-26
Differential scanning calorimetry	B2-27
Results From Historical Sampling	
Results from March 1995 grab sampling	B2-28
Results from December 1994 grab sampling	B2-29
Results from July 1993 grab sampling	B2-30

B2.1 RESULTS FROM 1995 GRAB SAMPLING OF TANK 241-AP-101

The four QC parameters assessed in conjunction with tank 241-AP-101 samples were standard recoveries, spike recoveries, duplicate analyses (relative percent differences [RPDs]), and blanks. The QC criteria specified in the sampling and analysis plan (SAP) (Esch 1995b) were 90 to 110 percent for standards and spikes and ≤10 percent for RPDs for DSC and TGA. For all other analytes, the QC criteria were 80 to 120 percent for standards and spikes and ≤20 percent for RPDs. The only QC parameter for which limits are not specified in the SAP is blank contamination. The limits for blanks are in laboratory guidelines, and all data results in this report have met those guidelines. Sample and duplicate pairs, in which any of the QC parameters were outside of these limits, are footnoted in the sample mean column of the data summary tables with an a, b, c, d, or e as follows:

- "a" indicates the standard recovery was below the QC limit.
- "b" indicates the standard recovery was above the QC limit.
- "c" indicates the spike recovery was below the QC limit.
- "d" indicates the spike recovery was above the QC limit.
- "e" indicates the RPD was above the QC limit.

In each data table, the "Mean" column is the average of result and duplicate values. All values, including those below the detection level (designated by <), were averaged. If result and duplicate values were detected, the mean is expressed as a detected value. If both values were nondetected, or if one value was detected and the other nondetected, the mean is expressed as a nondetected value.

Samples 1AP-95-1 and 1AP-95-2 have been switched from their normal order in the data tables. This was done to maintain depth consistency because sample 1AP-95-1 was actually taken from a lower depth than sample 1AP-95-2.

B2.1.1 Inorganic Analyses

B2.1.1.1 Inductively Coupled Plasma. The ICP analyses were performed according to procedure LA-505-161, Rev. B-0. Only aluminum, iron, and sodium results were reported. The ICP results are shown in Tables B2-2 through B2-4.

Table B2-2. Tank 241-AP-101 Analytical Results: Aluminum. (2 sheets)

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			μg/mL	μg/mL	μg/mL
S95T003722	1 at 210°	1AP-95-2	10,700	11,400	11,000
S95T003721		1AP-95-1	11,500	11,600	11,600

Table B2-2. Tank 241-AP-101 Analytical Results: Aluminum. (2 sheets)

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
S95T003723	1 at 210°	1AP-95-3	12,700	12,600	12,600
S95T003728	1 at 330°	1AP-95-4	11,500	11,400	11,500
S95T003729		1AP-95-5	12,500	14,100	13,300
S95T003730		1AP-95-6	12,500	12,900	12,700

Table B2-3. Tank 241-AP-101 Analytical Results: Iron.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	<20.0	<20.0	<20.0
S95T003721		1AP-95-1	<20.0	<20.0	<20.0
S95T003723		1AP-95-3	<20.0	<20.0	<20.0
S95T003728	1 at 330°	1AP-95-4	<20.0	<20.0	<20.0
S95T003729		1AP-95-5	<20.0	<20.0	<20.0
S95T003730		1AP-95-6	<20.0	<20.0	<20.0

Table B2-4. Tank 241-AP-101 Analytical Results: Sodium.

Sample Number	Riser	Grab Sample	Result	Duplicate	Sample Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	1.48E+05	1.58E+05	1.53E+05
S95T003721		1AP-95-1	1.58E+05	1.60E+05	1.59E+05
S95T003723		1AP-95-3	1.72E+05	1.71E+05	1.72E+05
S95T003728	1 at 330°	1AP-95-4	1.58E+05	1.57E+05	1.58E+05
S95T003729		1AP-95-5	1.67E+05	1.87E+05	1.77E+05
S95T003730		1AP-95-6	1.71E+05	1.77E+05	1.74E+05

B2.1.1.2 Anions. The IC analyses for anion concentrations were performed according to procedure LA-533-105, Rev. D-1. Hydroxide analyses were performed by potentiometric titration according to procedure LA-211-102, Rev. C-0. The IC and hydroxide results are shown in Tables B2-5 through B2-11.

Table B2-5. Tank 241-AP-101 Analytical Results: Chloride.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	1,930	1,900	1,910
S95T003721		1AP-95-1	2,000	1,970	1,980
S95T003723		1AP-95-3	2,150	2,130	2,140
S95T003728	1 at 330°	1AP-95-4	2,120	2,120	2,120
S95T003729		1AP-95-5	2,010	2,010	2,010
S95T003730		1AP-95-6	2,110	1,930	2,020

Table B2-6. Tank 241-AP-101 Analytical Results: Fluoride.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	2,690	2,710	2,700
S95T003721		1AP-95-1	2,450	2,440	2,450
S95T003723		1AP-95-3	2,070	2,030	2,050
S95T003728	1 at 330°	1AP-95-4	2,820	2,830	2,820
S95T003729		1AP-95-5	1,320	1,320	1,320
S95T003730		1AP-95-6	982.0	1,310	1,150[QC:e]

Table B2-7. Tank 241-AP-101 Analytical Results: Hydroxide.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	41,700	42,800	42,200
S95T003721		1AP-95-1	50,600	47,900	49,200
S95T003723		1AP-95-3	53,700	54,100	53,900
S95T003728	1 at 330°	1AP-95-4	51,400	50,000	50,700
S95T003729		1AP-95-5	49,900	50,300	50,100
S95T003730		1AP-95-6	51,700	48,900	50,300

Table B2-8. Tank 241-AP-101 Analytical Results: Nitrate.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	1.47E+05	1.47E+05	1.47E+05
S95T003721		1AP-95-1	1.50E+05	1.51E+05	1.50E+05
S95T003723		1AP-95-3	1.82E+05	1.80E+05	1.81E+05
S95T003728	1 at 330°	1AP-95-4	1.56E+05	1.56E+05	1.56E+05
S95T003729		1AP-95-5	1.48E+05	1.45E+05	1.46E+05
S95T003730		1AP-95-6	1.46E+05	1.41E+05	1.44E+05

Table B2-9. Tank 241-AP-101 Analytical Results: Nitrite.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	38,700	38,600	38,700
S95T003721		1AP-95-1	40,900	40,000	40,500
S95T003723		1AP-95-3	47,100	46,500	46,800
S95T003728	1 at 330°	1AP-95-4	41,800	42,300	42,000
S95T003729		1AP-95-5	41,700	41,900	41,800
S95T003730		1AP-95-6	41,200	40,000	40,600

Table B2-10. Tank 241-AP-101 Analytical Results: Phosphate.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	<1,210	<1,210	<1,210
S95T003721		1AP-95-1	<1,214	<1,210	<1,212
S95T003723		1AP-95-3	<613	<613	<613
S95T003728	1 at 330°	1AP-95-4	998.9	1,030	1,010
S95T003729		1AP-95-5	614.0	619.0	616.5
S95T003730		1AP-95-6	745.7	828.0	786.9

Table B2-11. Tank 241-AP-101 Analytical Results: Sulfate.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			μg/mL	μg/mL	μg/mL
S95T003722	1 at 210°	1AP-95-2	3,510	3,530	3,520
S95T003721		1AP-95-1	3,220	3,220	3,220
S95T003723		1AP-95-3	2,110	2,170	2,140
S95T003728	1 at 330°	1AP-95-4	2,930	2,940	2,940
S95T003729		1AP-95-5	2,120	2,130	2,120
S95T003730		1AP-95-6	1,780	1,710	1,740

B2.1.2 Total Inorganic Carbon and Total Organic Carbon

The TIC analyses were performed by furnace oxidation according to procedure LA-622-102, Rev. C-0. The TOC analyses were performed by furnace oxidation according to procedure LA-344-105, Rev. C-0. The results of these analyses are shown in Tables B2-12 and B2-13.

Table B2-12. Tank 241-AP-101 Analytical Results: Total Inorganic Carbon.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			μg/mL	μg/mL	μg/mL
S95T003722	1 at 210°	1AP-95-2	5,290	5,440	5,360
S95T003721		1AP-95-1	4,970	4,940	4,960
S95T003723		1AP-95-3	4,280	4,310	4,300
S95T003728	1 at 330°	1AP-95-4	5,040	5,100	5,070
S95T003729		1AP-95-5	3,780	3,740	3,760
S95T003730		1AP-95-6	3,810	3,820	3,820

Table B2-13. Tank 241-AP-101 Analytical Results: Total Organic Carbon.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µg/mL	µg/mL	µg/mL
S95T003722	1 at 210°	1AP-95-2	2,100	2,100	2,100
S95T003721		1AP-95-1	2,040	2,070	2,060
S95T003723		1AP-95-3	2,260	2,430	2,340
S95T003728	1 at 330°	1AP-95-4	3,160	3,570	3,360
S95T003729		1AP-95-5	3,210	3,260	3,240
S95T003730		1AP-95-6	3,070	2,940	3,000

B2.1.3 Radionuclides

Analyses for total alpha activity and various radionuclides were performed on samples recovered from tank 241-AP-101. Alpha proportional counting was performed to determine the activities of total alpha (procedure LA-508-101, Rev. D-2), ^{241}Am (procedure LA-953-103, Rev. A-4), and $^{239/240}$Pu (procedure LA-943-127, Rev. B-1). Gamma energy analysis was used to measure the ^{137}Cs and ^{60}Co activities according to procedure LA-548-121, Rev. D-1. Procedure LA-220-101, Rev. D-1, was used for determining the ^{90}Sr activity by beta proportional counting. The sample results for the radionuclides are given in Tables B2-14 through B2-19.

Table B2-14. Tank 241-AP-101 Analytical Results: Total Alpha Activity.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µCi/mL	µCi/mL	µCi/mL
S95T003732	1 at 210°	1AP-95-2	<0.00311	<0.00251	<0.00281
S95T003731		1AP-95-1	<0.00159	<0.00341	<0.00250
S95T003733		1AP-95-3	<0.00341	<0.00189	<0.00265
S95T003735	1 at 330°	1AP-95-4	<0.00256	<0.00256	<0.00256
S95T003736		1AP-95-5	<0.00225	<0.00256	<0.00241
S95T003737		1AP-95-6	<0.00287	<0.00287	<0.00287

Table B2-15. Tank 241-AP-101 Analytical Results: Americium-241.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µCi/mL	µCi/mL	µCi/mL
S95T003732	1 at 210°	1AP-95-2	3.00E-04	2.97E-04	2.98E-04
S95T003731		1AP-95-1	2.95E-04	3.04E-04	3.00E-04
S95T003733		1AP-95-3	3.02E-04	3.05E-04	3.04E-04
S95T003735	1 at 330°	1AP-95-4	<3.77E-04	<3.65E-04	<3.71E-04
S95T003736		1AP-95-5	3.00E-04	<3.38E-04	<3.19E-04
S95T003737		1AP-95-6	3.16E-04	<3.94E-04	<3.55E-04

Table B2-16. Tank 241-AP-101 Analytical Results: Cesium-137.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µCi/mL	µCi/mL	µCi/mL
S95T003732	1 at 210°	1AP-95-2	170.0	176.0	173.0
S95T003731		1AP-95-1	181.0	182.0	181.5
S95T003733		1AP-95-3	197.0	195.0	196.0
S95T003735	1 at 330°	1AP-95-4	168.0	172.0	170.0
S95T003736		1AP-95-5	212.0	211.0	211.5
S95T003737		1AP-95-6	195.0	200.0	197.5

Table B2-17. Tank 241-AP-101 Analytical Results: Cobalt-60.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			µCi/mL	µCi/mL	µCi/mL
S95T003732	1 at 210°	1AP-95-2	<0.0378	<0.0372	<0.0375
S95T003731		1AP-95-1	<0.0372	<0.0378	<0.0375
S95T003733		1AP-95-3	<0.0357	<0.0443	<0.0400
S95T003735	1 at 330°	1AP-95-4	<0.0373	<0.0354	<0.0364
S95T003736		1AP-95-5	<0.0232	<0.0273	<0.0253
S95T003737		1AP-95-6	<0.0318	<0.0306	<0.0312

Table B2-18. Tank 241-AP-101 Analytical Results: Plutonium-239/240.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			μCi/mL	μCi/mL	μCi/mL
S95T003732	1 at 210°	1AP-95-2	1.64E-04	1.67E-04	1.66E-04
S95T003731		1AP-95-1	1.56E-04	1.55E-04	1.55E-04
S95T003733		1AP-95-3	1.59E-04	1.45E-04	1.52E-04
S95T003735	1 at 330°	1AP-95-4	1.46E-04	1.58E-04	1.52E-04
S95T003736		1AP-95-5	1.61E-04	1.86E-04	1.73E-04
S95T003737		1AP-95-6	1.79E-04	1.87E-04	1.83E-04

Table B2-19. Tank 241-AP-101 Analytical Results: Strontium-89/90.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant			μCi/mL	μCi/mL	μCi/mL
S95T003732	1 at 210°	1AP-95-2	0.159	0.146	0.152
S95T003731		1AP-95-1	0.133	0.135	0.134
S95T003733		1AP-95-3	0.163	0.163	0.163
S95T003735	1 at 330°	1AP-95-4	0.179	0.189	0.184
S95T003736		1AP-95-5	0.195	0.184	0.190
S95T003737		1AP-95-6	0.107	0.111	0.109

B2.1.4 Physical Properties Analyses

As required by the safety screening and waste compatibility DQOs, TGA, DSC, specific gravity, and pH analyses were performed on the samples. No other physical tests were required or performed.

B2.1.4.1 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 analysis represents a loss of gaseous matter from the sample, through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all sample weight loss up to a certain temperature (typically 150 to 200 °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 also be differentiated by inflection points.

Tank 241-AP-101 samples were analyzed by TGA using procedure LA-514-114, Rev. C-1 on a Perkin-Elmer[1] instrument. All samples exhibited a large weight loss between the ambient temperature and 200 °C (392 °F). In all runs, the weight loss occurred in one transition. Again, this weight loss is attributed to water evaporation. The TGA results are presented in Table B2-20.

Table B2-20. Tank 241-AP-101 Analytical Results: Weight Percent Water by Thermogravimetric Analysis.

Sample Number	Riser	Grab Sample	Result		Duplicate		Mean
Supernatant[1]			% H_2O	Temp. Range (°C)	% H_2O	Temp. Range (°C)	% H_2O
S95eT003722	1 at 210°	1AP-95-2	60.56	35 - 170	60.37	35 - 160	60.47
S95T003721		1AP-95-1	59.69	35 - 170	58.13	35 - 170	58.91
S95T003723		1AP-95-3	56.79	35 - 170	56.85	35 - 170	56.82
S95T003728	1 at 330°	1AP-95-4	60.22	35 - 170	60.36	35 - 180	60.29
S95T003729		1AP-95-5	56.03	35 - 160	56.96	35 - 200	56.50
S95T003730		1AP-95-6	56.31	35 - 160	56.63	35 - 160	56.47

Notes:

Temp. = temperature

[1]All analyses were performed with a Perkin-Elmer® instrument.

B2.1.4.2 Differential Scanning Calorimetry. Differential scanning calorimetry analysis measures the heat absorbed or emitted by a sample 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 an exothermic event is determined graphically.

[1]Perkin Elmer is a registered trademark of Perkins Research and Manufacturing Company, Inc., Canoga Park, CA.

The DSC analyses of the tank 241-AP-101 samples were performed using procedure LA-514-113, Rev. C-1 on a Mettler[2] instrument or procedure LA-514-114, Rev. C-1 on a Perkin-Elmer® instrument. All samples exhibited an initial endothermic reaction, which represents the evaporation of free and interstitial water. Most samples exhibited endothermic reactions only. However, samples S95T003728 and S95T003730 exhibited exothermic reactions in the second transition. The magnitudes of the exotherms on a dry weight basis for these samples were 97.5 and 877 J/g, respectively. The 95 percent upper confidence interval values for these samples were 356.4 and 1,146 J/g, respectively (Esch 1996).

No additional analyses were required for sample S95T003728 because the 95 percent upper confidence interval value was below the safety screening decision criteria threshold of 480 J/g.

Sample S95T003730 exhibited no exothermic reactions in sample or triplicate analyses, only in the duplicate analysis. The chemist indicated that tank 241-AP-101 samples had a tendency to spill out of the sample pan and contaminate the sensor. However, this type of contamination would have been observed as "noise" in the baseline on the DSC thermogram. This "noise" was not evident on the duplicate scan. The analysis was rerun in duplicate with a new sensor installed. The exothermic reaction could not be reproduced in the rerun. It was concluded that the exothermic reaction in the original sample may have been caused by the presence of some anomalous material, originating from the sample (for example, a particle of suspended solids) or from a foreign material (for example, a piece of plastic "milling" from a pipet tip), which was present only in that sample portion (Esch 1996; Bushaw 1996). Therefore, no secondary analyses were requested (Esch 1996).

The DSC results, including peak temperatures and magnitude of enthalpy changes on a wet basis, are shown in Table B2-21.

[2]Mettler is a registered trademark of Mettler Electronics, Anaheim, CA.

Table B2-21. Tank 241-AP-101 Analytical Results: Differential Scanning Calorimetry.

Sample Number[1]	Riser	Grab Sample	Run	Transition 1		Transition 2		Transition 3	
Supernatant				Peak Temp. (°C)	Δ H (J/g)	Peak Temp. (°C)	Δ H (J/g)	Peak Temp. (°C)	Δ H (J/g)
3722[2]	1 at 210°	1AP-95-2	1	118	1,858	324	15.9	--	--
			2	119	1,612	236	10.6	324	16.8[4]
3721[2]		1AP-95-1	1	123	1,730	323	18.2	--	--
			2	125	1,510	323	12.9	--	--
3723[2]		1AP-95-3	1	115	1,433	324	9.621	--	--
			2	122	1,541	323	11.24	--	--
3728[2]	1 at 330°	1AP-95-4	1	129	1,305	231	38.7[QC:e]	324	17.7
			2	122	843.7	248	-38.7[QC:e]	324	6.5[3]
3729[2]		1AP-95-5	1	126	1,726	205	74.7	322	32.0[3]
			2	118	1,117	323	9.9	436	41.8
3730[2] (12/95)[4]	1 at 330°	1AP-95-6	1	118	1,912	322	10.4[QC:e]	--	--
			2	121	1,392	395	-381.8[QC:e]	--	--
			3	143	1,486	322	10.0[QC:e]	--	--
3730[2] (1/96)[4]		1AP-95-6	1	124	1,164	241	18.8	327	12.5
			2	129	1,196	237	17.5	325	10.2

Notes:

[1]Sample numbers begin with "S95T00."

[2]Analyses were performed with a Mettler® instrument.

[3]Fourth transitions have small endotherms measured between 442°C and 453°C.

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

B2.1.4.3 Specific Gravity. The specific gravity analyses for tank 241-AP-101 were performed using procedure LA-510-112, Rev. C-3. The specific gravity results are shown in Table B2-22.

Table B2-22. Tank 241-AP-101 Analytical Results: Specific Gravity.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant					
S95T003722	1 at 210°	1AP-95-2	1.290	1.300	1.295
S95T003721		1AP-95-1	1.280	1.290	1.285
S95T003723		1AP-95-3	1.320	1.360	1.340
S95T003728	1 at 330°	1AP-95-4	1.290	1.260	1.275
S95T003729		1AP-95-5	1.290	1.300	1.295
S95T003730		1AP-95-6	1.370	1.330	1.350

B2.1.4.4 pH. The pH analyses for tank 241-AP-101 were performed according to procedure LA-212-106, Rev. A-0. The pH results are shown in Table B2-23.

Table B2-23. Tank 241-AP-101 Analytical Results: pH.

Sample Number	Riser	Grab Sample	Result	Duplicate	Mean
Supernatant					
S95T003722	1 at 210°	1AP-95-2	13.86	13.88	13.87
S95T003721		1AP-95-1	13.77	13.78	13.77
S95T003723		1AP-95-3	13.86	13.87	13.86
S95T003728	1 at 330°	1AP-95-4	13.95	13.95	13.95
S95T003729		1AP-95-5	13.90	13.93	13.91
S95T003730		1AP-95-6	13.92	13.93	13.93

B2.1.5 Vapor Phase Measurement

Before the November 1995 grab sampling of tank 241-AP-101, vapor phase measurements were taken as required by the safety screening DQO (Dukelow et al. 1995). The vapor phase screening was done for flammability issues. The vapor phase measurements were taken from risers 1 at 210° and 1 at 330° in the headspace of the tank according to procedures IH 1.4 and IH 2.1 (WHC 1996). The results were obtained in the field (that is, no gas sample was sent to the laboratory for analysis). The combustible gas meter used to sample the vapor phase measures flammability as a percent of the lower explosive limit. Because the National Fire Protection Association defines the terms lower explosive limit and LFL identically, the two terms may be used interchangeably (NFPA 1995). The results of the vapor phase measurements are provided in Table B2-24.

Table B2-24. Vapor Phase Measurement Results for Tank 241-AP-101.

Vapor Characteristic Measured	Results	
	Riser 1 at 210°	Riser 1 at 330°
Vapor flammability as percent of LFL	0%	0%
Oxygen	20.7%	20.8%
Ammonia	125 ppmv	<200 ppmv
Total organic carbon	9.8 ppmv	7.9 ppmv

Note:

ppmv = parts per million by volume

B2.2 TANK 241-AW-106 ANALYTICAL RESULTS

This section summarizes the analytical results associated with the July 1995 sampling of 242-A Evaporator slurry and the subsequent August 1995 sampling of tank 241-AW-106. These results provide characterization data for waste that was transferred from tank 241-AW-106 into tank 241-AP-101 in March 1996 and January 1997. The results for Evaporator slurry sampling are documented in Guthrie (1996). The results for tank 241-AW-106 sampling are documented in Esch (1995b). This discussion does not address tank 241-AW-106 sludge samples because only supernatant was transferred to tank 241-AP-101.

No information is available regarding QC parameters associated with the Evaporator slurry sample. The four QC parameters assessed in conjunction with the tank 241-AW-106 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. The QC criteria specified in the SAP (Jones 1995) were 80 to 120 percent for standards and spikes and ≤ 20 percent for RPDs. The only QC parameter for which limits are not specified in the SAP is blank contamination. The limits for blanks are set forth in laboratory guidelines, and all data results in this report have met those guidelines. It should be noted that all QC parameters for data in Tables B2-25 through B2-27 were within the specified QC limits. Therefore, no footnoting of the data tables was needed.

Table B2-25 summarizes all data for the Evaporator and tank 241-AW-106 samples except for TGA and DSC for tank 241-AW-106, which are shown in Tables B2-26 and B2-27, respectively. Evaporator data which were reported in units of *M* or g/L were converted to units of μg/mL. The "Evaporator Slurry" value in column 2, Table B2-25, is the lone result from analysis of the evaporator sample. Column 5, "Sample Mean," is a mean of the primary and duplicate results from the tank 241-AW-106 supernatant sample. For an overall mean derived by combining these two data sets, see Section B3.4.

Table B2-25. Evaporator Campaign 95-1 Slurry and Tank 241-AW-106 Analytical Results. (2 sheets)

Analyte	Evaporator Slurry (Sample Number T2270)	Tank 241-AW-106 Sample, 6AW-95-1 (Sample Numbers S95T002016/S95T002017)		
		Result	Duplicate	Sample Mean
Radionuclides	μCi/mL	μCi/mL	μCi/mL	μCi/mL
Total alpha activity	<0.00299	<0.0134	n/a	<0.0134
Total beta activity	144	94.80	n/a	94.8
Americium-241	6.52E-04	<0.00109	n/a	<0.00109
Carbon-14	1.74E-04	1.35E-04	n/a	1.35E-04
Cerium-144	<0.351	<0.292	n/a	<0.292
Cesium-134	0.308	0.224	n/a	0.224
Cesium-137	142	112.0	n/a	112
Cobalt-60	<0.0184	<0.00426	n/a	<0.00426
Curium-243/244	<3.08E-04	<0.00109	n/a	<0.00109
Europium-154	<0.0446	<0.0226	n/a	<0.0226
Europium-155	<0.158	<0.0676	n/a	<0.0676
Iodine-129	6.00E-05	5.76E-05	n/a	5.76E-05
Neptunium-237	<2.06E-05	<2.06E-05	n/a	<2.06E-05
Niobium-94	<0.0157	<0.0132	n/a	<0.0132
Plutonium-238	<8.57E-05	<4.84E-05	n/a	<4.84E-05
Plutonium-239/240	2.98E-04	1.38E-04	n/a	1.38E-04

Table B2-25. Evaporator Campaign 95-1 Slurry and Tank 241-AW-106 Analytical Results. (2 sheets)

Analyte	Evaporator Slurry (Sample Number T2270)	Tank 241-AW-106 Sample, 6AW-95-1 (Sample Numbers S95T002016/S95T002017)		
		Result	Duplicate	Sample Mean
Radionuclides (Continued)	μCi/mL	μCi/mL	μCi/mL	μCi/mL
Radium-226	<1.48	<0.646	n/a	<0.646
Ruthenium/Rhodium-106	<1.17	<0.429	n/a	<0.429
Selenium-79	8.81E-05	1.22E-04	n/a	1.22E-04
Strontium-89/90	0.164	0.0339	n/a	0.0339
Technetium-99	0.0291	0.0352	n/a	0.0352
Tritium	0.00570	0.0113	n/a	0.0113
Physical Properties				
Specific gravity	1.309	1.220	1.210	1.215
pH	13.5	14.19	14.16	14.18
Metals	μg/mL	μg/mL	μg/mL	μg/mL
Aluminum	5,290	4,600	4,580	4,590
Iron	n/a	<20.05	<20.05	<20.05
Sodium	1.20E+05	1.03E+05	1.03E+05	1.03E+05
Uranium	67.2	71.10	n/a	71.1
Anions/Cations	μg/mL	μg/mL	μg/mL	μg/mL
Ammonia	2.94	n/a	n/a	n/a
Chloride	n/a	1,340	n/a	1,340
Fluoride	2,740	3,870	n/a	3,870
Hydroxide	31,500	27,500	27,900	27,700
Nitrate	95,500	92,900	n/a	92,900
Nitrite	40,500	37,300	n/a	37,300
Phosphate	1,190	1,930	n/a	1,930
Sulfate	5,780	5,510	n/a	5,510
Carbon	μg C/mL	μg C/mL	μg C/mL	μg C/mL
Total carbon	12,600	27,100	27,800	27,400
TIC	9,060	8,220	8,380	8,300
TOC	3,310	5,510	5,080	5,300

Table B2-26. Tank 241-AW-106 Analytical Results: Weight Percent Water.

Sample Number	Riser	Grab Sample	Result		Mean
Supernatant[1]			% H_2O	Temperature Range (°C)	% H_2O
S95T002016	16B	6AW-95-1	68.88	35 to 190	68.9

Note:

[1]The analysis was performed with a Mettler® instrument.

Table B2-27. Tank 241-AW-106 Analytical Results: Differential Scanning Calorimetry.[1]

Sample Number	Riser	Grab Sample	Transition 1	
Supernatant[2]			Peak Temperature (°C)	Δ H (J/g)
S95T002016	16B	6AW-95-1	113	1,869

Notes:

[1]No exotherms were found in the Evaporator sample. However, no other information was provided.
[2]The analysis was performed using Perkin-Elmer® instrument.

Viscosity measurements were also made on sample 6AW-95-1 at 25 °C and 44 °C (Esch 1995a). The viscosities were recorded with shear rates increasing from 0 s^{-1} to 300 s^{-1} and decreasing from 300 s^{-1} to 0 s^{-1}. At 25 °C, the sample exhibited the non-Newtonian behavior of viscosity decreasing with shear rate. Above a 50 s^{-1} shear rate, the viscosity remained constant at approximately 4 centipoise. Crystal formation during the 44 °C run caused the viscosity curve to be erratic. No further interpretation of the results from the run at this temperature were made, but the raw data were included in Esch (1995b). Performance checks were made with 10 centipoise and 100 centipoise certified Newtonian standards before the sample runs. The performance checks were within the required 20 percent range. See Esch (1995b) for all raw viscosity data and viscosity versus shear rate curves.

B2.3 HISTORICAL SAMPLE RESULTS

Three historical sampling events have been identified for tank 241-AP-101. Grab sampling was performed in March 1995, December 1994, and July 1993. However, because of significant changes in the waste composition through transfer activity, results from these three sampling events may no longer reflect current contents. Therefore, these results should be used with caution.

B2.3.1 Results from March 1995 Grab Sampling

Table B2-28 summarizes the results of the March 1995 grab sampling of tank 241-AP-101. Two grab samples were analyzed, and the results were reported in Rollison (1995a). As stated in Section B1.3.1, conflicting information exists about sample numbering. According to Rollison (1995a), grab sample 1AP-95-2 was assigned laboratory identification number S95T000340 and grab sample 1AP-95-3 was given number S95T000342 at the laboratory. No duplicate was performed for the IC analyses. The mean in column 6 is a mean of all individual primary and duplicate results.

Table B2-28. Results from March 1995 Grab Sampling.

Analyte	Sample #S95T000340		Sample #S95T000342		Mean
	Result	Duplicate	Result	Duplicate	
	μg/mL	μg/mL	μg/mL	μg/mL	μg/mL
Chloride	66.9	---	65.5	---	66.2
Fluoride	3,730	---	3,600	---	3,670
Hydroxide	5,530	5,460	5,690	5,630	5,580
Nitrate	10,000	---	9,990	---	10,000
Nitrite	1,560	---	1,520	---	1,540
Phosphate	142	---	147	---	145
Sulfate	329	---	330	---	330
TIC	342	345	347	353	347
pH (unitless)	13.23	13.25	13.27	13.28	13.26

B2.3.2 Results from December 1994 Grab Sampling

Two grab samples were taken from tank 241-AP-101 in December 1994 and analyzed for anion and TIC content and for pH. Results from the sampling event were reported in Rollison (1995b). The data sheets in Rollison (1995b) report the laboratory identification numbers as R 6833 and R 6834. No distinction was made in Rollison (1995b) about which grab sample matched which laboratory identification number. Table B2-29 shows the results from the December 1994 sampling. Because no duplicates were performed for the analyses, the table does not include a "Duplicate" column. The mean in column 4 is a mean of two results.

Table B2-29. Results from December 1994 Grab Sampling.

Analyte	Sample #R 6833 Result μg/mL	Sample #R 6834 Result μg/mL	Mean μg/mL
Chloride	15.4	17.1	16.3
Fluoride	26.9	29.9	28.4
Hydroxide	<125	875	<500
Nitrate	1,080	1,120	1,100
Nitrite	1,240	1,280	1,260
Phosphate	30.0	32.4	31.2
Sulfate	107	119	113
TIC	329	339	334
pH (unitless)	10.67	10.64	10.66

B2.3.3 Results from July 1993 Grab Sampling

Table B2-30 summarizes the results of the July 20, 1993, grab sampling of tank 241-AP-101 as reported in DiCenso et al. (1994). Table B2-30 shows only overall mean results. Refer to Dicenso et al. for more detailed information.

The overall mean results were calculated using a straight average of the sample means from all grab samples. Results, which were rejected based on validation guidelines or were below the detection limit (indicated by the less-than symbol "<"), were not used in calculating the overall means. If all results for an analyte were below the detection limit, then the detection limit was used for the overall mean.

Table B2-30 does not include the data for a wide range of volatile and semivolatile organics because no organics were detected, and no detection limits were specified in DiCenso et al. (1994).

Table B2-30. 1993 Historical Data Summary for Tank 241-AP-101. (2 sheets)

Analyte	Samples[1]	Overall Mean	Standard Deviation
Metals		µg/mL	µg/mL
Aluminum	5	0.667	0.277
Arsenic	0.00	<0.013	n/a
Barium	2	0.226	n/a
Calcium	0.00	<10.0	n/a
Cadmium	3	0.143	0.098
Chromium	3	0.0393	0.00127
Iron	4	0.281	0.079
Lead	3	0.445	0.325
Mercury	0.00	<0.005	n/a
Magnesium	4	0.657	0.136
Manganese	0.00	<0.0150	n/a
Selenium	1	0.014	n/a
Sodium	5	1,290	107
Uranium	1	0.212	n/a
Zinc	4	0.494	0.644
Anions/Cations		µg/mL	µg/mL
Ammonia	5	1,960	91.5
Chloride	0.00	<22.0	n/a
Cyanide	5	0.34	0.041
Fluoride	5	68.6	1.01
Hydroxide	5	1,820	121
Nitrate	5	1,580	4.47
Nitrite	5	13,400	207
Phosphate	0.00	<10	n/a
Sulfate	5	86.2	0.421
Radionuclides		µCi/mL	µCi/mL
^{241}Am (Alpha energy analysis)	0	<3.18E-04	n/a
^{241}Am (GEA)	0	<0.00136	n/a
^{14}C	0	<4.66E-06	n/a
^{144}Ce/Pr	0	<0.0212	n/a

Table B2-30. 1993 Historical Data Summary for Tank 241-AP-101. (2 sheets)

Analyte	Samples[1]	Overall Mean	Standard Deviation
Radionuclides (Cont'd)		μCi/mL	μCi/mL
^{134}Cs	0	<2.88E-04	n/a
^{137}Cs	1	0.00326	n/a
^{60}Co	0	<2.73E-04	n/a
$^{243/244}Cm$	0	<3.18E-04	n/a
^{154}Eu	0	<9.68E-04	n/a
^{155}Eu	0	<6.53E-04	n/a
^{129}I	0	<4.08E-05	n/a
^{237}Np	0	<4.70E-05	n/a
^{94}Nb	0	<2.49E-04	n/a
^{238}Pu	0	<3.02E-04	n/a
$^{239/240}Pu$	0	<2.13E-04	n/a
^{226}Ra	0	<0.00465	n/a
^{103}Ru	0	<2.35E-04	n/a
$^{106}Ru/Rh$	0	<0.00473	n/a
^{79}Se	0	<6.15E-06	n/a
$^{89/90}Sr$	1	5.63E-04	n/a
^{99}Tc	0	<3.07E-05	n/a
^{3}H	1	0.00210	n/a
Total alpha	1	5.94E-06	n/a
Total beta	1	0.00548	n/a
Carbon		μg/mL	μg/mL
TIC	5	190	6.08
TOC	3	23.7	15.1
Physical Properties			
Specific gravity	5	0.986	0.00182

Note:

[1]The number of samples used for overall mean and standard deviation calculations. Rejected and nondetected data were not used in calculations.

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The purpose of this section is to discuss overall quality and consistency of current sampling results for tanks 241-AP-101 and 241-AW-106 and the evaporator slurry sample from Evaporator Campaign 95-1 and to identify limitations in data use. This is accomplished by evaluating sampling and analysis factors that may impact data interpretation. In addition, internal data checks are performed.

B3.1 FIELD OBSERVATIONS

Because different depths from two separate risers were sampled during the November 1995 grab sampling event for tank 241-AP-101, the safety screening DQO requirement that vertical profiles of the waste be obtained from at least two widely spaced risers was fulfilled. No problems were recorded for the November 1995 grab sampling event. Esch (1996) did note that the sampling depths for 1AP-95-1 and 1AP-95-2 were switched from those indicated in the SAP (that is, 1AP-95-1 was taken from a lower depth than 1AP-95-2). However, this did not compromise or impact the usefulness of the data.

No problems were noted during the August 1995 grab sampling of the tank 241-AW-106 supernatant (later transferred into tank 241-AP-101). Little sampling information was available for the slurry sample taken during the Evaporator Campaign 95-1. However, no problems with the sampling were noted in Guthrie (1996).

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes an evaluation of the appropriate standard recoveries, matrix spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent QC tests were conducted on the grab samples from the November 1995 tank 241-AP-101 sampling event and the August 1995 tank 241-AW-106 sampling event. The specific criteria for the QC checks were provided in the tank 241-AP-101 SAP (Esch 1995b) and the tank 241-AW-106 SAP (Jones 1995). Appendix B identifies QC results outside of the given criteria by superscripts in the data tables. This section summarizes the QC results. No QC information was available for the evaporator slurry sample from Campaign 95-1. Because no QC problems were found during the analysis of the tank 241-AW-106 sample, the following discussion focuses on tank 241-AP-101 samples.

The standard and matrix spike recovery results provide an estimate of the analysis accuracy. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. All standard and spike recoveries were within the defined criteria. Analytical precision is estimated by the RPD, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100. Only fluoride and the DSC analysis for tank 241-AP-101 had RPDs outside of the desired range. One of six fluoride samples had an RPD slightly above the criterion, and two DSC samples had RPDs above the criterion. For both DSC samples, an RPD was caused when an exothermic reaction was not observed in the primary run but was exhibited during the duplicate run. Finally, no sample exceeded the criteria for preparation blanks; therefore, contamination was not a problem for any analyte.

In summary, all QC results were within the boundaries specified in the SAPs (Esch 1995b and Jones 1995). The few discrepancies should not impact data validity or use.

B3.3 DATA CONSISTENCY CHECKS

Different analytical methods can be compared to assess data consistency and quality. The data set enabled the following comparisons: total alpha activity to the sum of the activities of the individual alpha emitters, total beta activity to the sum of the individual beta emitters, and mass to charge balances. Where possible, comparisons were made for tank 241-AP-101 analytical data and for data for tank 241-AW-106 supernatant which was transferred to tank 241-AP-101 in March 1996 and January 1997 (includes tank 241-AW-106 grab sample results and 242-A Evaporator Campaign 95-1 slurry sample results). Mass and charge balances also were performed.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare results from two analytical methods. Close agreement between the two methods strengthens the credibility of both results, but poor agreement brings the reliability of the data into question. All analytical mean results were taken from Section B3.4.

A comparison was made between the measured total alpha activity and the sum of the activities of the alpha-emitting radionuclides (see Table B3-1). The sum of the activities of the individual alpha emitters was determined by adding the ^{241}Am and $^{239/240}$Pu activities. (No other alpha-emitting radionuclides were present in detectable quantities.) A true comparison could not be made because all results from the total alpha activity analysis were below the detection limit. However, the total alpha activity results indicated the sum of the activities of the individual alpha emitters should be less than 0.00263 and 0.00820 μCi/mL, respectively (based on a mean of the nondetect values) for tank 241-AP-101 and tank 241-AW-106 data. This expectation was confirmed, as the sum of the activities of the individual alpha emitters were 4.89E-04 and 0.00109 μCi/mL.

Table B3-1. Comparison of Total Alpha Activity with the Sum of the Activities of the Individual Alpha Emitters.

Analyte	Tank 241-AP-101 Overall Mean (μCi/mL)	Tank 241-AW-106 Overall Mean (μCi/mL)
^{241}Am	3.25E-04	8.71E-04[1]
$^{239/240}$Pu	1.64E-04	2.18E-04
Sum of alpha-emitter activities	4.89E-04	0.00109
Measured total alpha activity	<0.00263[1]	<0.00820[1]

Note:
[1]The reported value is a mean of the nondetected results.

A comparison was made between the measured total beta activity and the sum of the activities of the beta-emitting radionuclides. This comparison was only possible with the tank 241-AW-106 data set because total beta was not analyzed on tank 241-AP-101 grab samples. The sum of the activities of the individual beta emitters was calculated as follows:

$$\text{sum of beta emitters} = 2 * {}^{89/90}\text{Sr} + {}^{137}\text{Cs}$$

The $^{89/90}$Sr activity is multiplied by 2 because of its beta-emitting daughter product, ^{90}Y. Table B3-2 shows there is close agreement between the two methods.

Table B3-2. Comparison of Total Beta Activity with the Sum of the Activities of the Individual Beta Emitters.

Analyte	Tank 241-AW-106 Overall Mean (μCi/mL)	Beta Activity (μCi/mL)
$^{89/90}$Sr	0.0990	0.198
^{137}Cs	127	127
Sum of beta-emitter activities		127.2
Measured total beta activity		119

B3.3.2 Mass and Charge Balances

The principle objective in performing mass and charge balances is to determine whether measurements are consistent. Separate mass and charge balances were calculated for the tank 241-AP-101 grab sampling data set and the data set formed from the combination of the tank 241-AW-106 grab sample and evaporator slurry sample results. All analytes, which were present in detectable quantities and were listed in Section B3.4, were used in calculating the balances for tank 241-AP-101. All analytical results were converted from μg/mL to μg/g using the specific gravity mean of 1.31. The analytes present in concentrations above 100 μg/mL were used in calculating the balances for tank 241-AW-106 waste. All analytical results were first converted from μg/mL to μg/g using the specific gravity mean of 1.26.

Table B3-3 shows cation mass and charge balance information. Because all waste in tank 241-AP-101 is supernatant, the aluminum was assumed to be present as the aluminate ion. All positive charge was attributed to sodium. The anionic analytes listed in Table B3-4 were assumed to be present as sodium salts and were expected to balance the positive charge. The concentrations of cationic species in Table B3-3, the anionic species in Table B3-4, 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.

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

The total analyte concentrations calculated from the above equation for tank 241-AP-101 is 363,000 μg/g (wet weight). The mean weight percent water obtained from TGA is 58.2 percent or 582,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 945,000 μg/g, or 94.5 percent (see Table B3-5).

The total analyte concentrations calculated from the above equation for the tank 241-AW-106 data set is 279,000 μg/g (wet weight). The mean weight percent water obtained from TGA is 68.9 percent or 689,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 968,000 μg/g or 96.8 percent (see Table B3-5).

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of these two values. To derive the results shown in the equations, all concentrations must first be converted to a μg/g basis.

Total cations = $[Na^+]/23.0$
= 5,520 μeq/g (tank 241-AP-101)
= 3,870 μeq/g (tank 241-AW-106)

Total anions = $[AlO_2^-]/59.0 + [C_2H_3O_2^-]/59.0 + [Cl^-]/35.5 + [CO_3^{2-}]/30.0 + [F^-]/19.0 + [OH^-]/17.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 + [PO_4^{3-}]/31.7 + [SO_4^{2-}]/48.0$
= 6,010 μeq/g (tank 241-AP-101)
= 5,000 μeq/g (tank 241-AW-106)

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.92 for tank 241-AP-101 and 0.77 for tank 241-AW-106.

Table B3-3. Cation Mass and Charge Data.

Analyte	Concentration (wet weight)	Assumed Species	Concentration of Assumed Species	Charge
	μg/g		μg/g	μeq/g
Tank 241-AP-101				
Sodium	127,000	Na^+	127,000	5,520
Total			127,000	5,520
Tank 241-AW-106				
Sodium	88,900	Na^+	88,900	3,800
Total			88,900	3,870

Table B3-4. Anion Mass and Charge Data. (2 sheets)

Analyte	Concentration (wet weight)	Assumed Species	Concentration of Assumed Species	Charge
	μg/g		μg/g	μeq/g
Tank 241-AP-101				
Aluminum	9,240	AlO_2^-	20,200	342
Chloride	1,550	Cl^-	1,550	43.7
Fluoride	1,590	F^-	1,590	83.7
Hydroxide	37,700	OH^-	37,700	2,220
Nitrate	118,000	NO_3^-	118,000	1,900
Nitrite	31,800	NO_2^-	31,800	691

Table B3-4. Anion Mass and Charge Data. (2 sheets)

Analyte	Concentration (wet weight) µg/g	Assumed Species	Concentration of Assumed Species µg/g	Charge µeq/g
Tank 241-AP-101 (Cont'd)				
Phosphate	693	PO_4^{3-}	693	21.9
Sulfate	1,990	SO_4^{2-}	1,990	41.5
TIC	3,470	CO_3^{2-}	17,400	580
TOC	2,050	$C_2H_3O_2^-$	5,040	85.4
Total			236,000	6,010
Tank 241-AW-106				
Aluminum	3,920	AlO_2^-	8,570	145
Chloride	1,060	Cl^-	1,060	29.9
Fluoride	2,630	F^-	2,630	138
Hydroxide	23,500	OH^-	23,500	1,380
Nitrate	74,800	NO_3^-	74,800	1,210
Nitrite	30,900	NO_2^-	30,900	672
Phosphate	1,240	PO_4^{3-}	1,240	39.2
Sulfate	4,480	SO_4^{2-}	4,480	93.3
TIC	6,890	CO_3^{2-}	34,500	1,150
TOC	3,420	$C_2H_3O_2^-$	8,410	143
Total			190,000	5,000

Table B3-5. Mass Balance Totals. (2 sheets)

Totals	Concentrations µg/g
Tank 241-AP-101	
Total from Table B3-3	127,000
Total from Table B3-4	236,000
Water	582,000
Grand total	945,000

Table B3-5. Mass Balance Totals. (2 sheets)

Totals	Concentrations μg/g
Tank 241-AW-106	
Total from Table B3-3	88,900
Total from Table B3-4	190,000
Water	689,000
Grand total	968,000

In summary, the above calculations for the tank 241-AP-101 data yield reasonable (close to 1.00 for charge balance and 100 percent for mass balance) mass and charge balance values, indicating the analytical results are generally consistent. For tank 241-AW-106 data, the mass balance value is reasonably close to 100 percent; however, there is a significant deviation in the charge balance value. The anionic charge was about a third larger than the cationic charge.

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The following statistical evaluation was performed using 1) the analytical data generated from tank 241-AP-101 grab samples and 2) the analytical data generated from a grab sample (supernatant only) obtained from tank 241-AW-106 and an evaporator slurry sample. Tank 241-AP-101 grab samples were obtained November 1995 from two risers (riser 1 at 210° and riser 1 at 330°), each at three different depths.

A mean concentration and the associated variability were calculated for each analyte for both data sets (tank 241-AP-101 and tank 241-AW-106). A two-sided 95 percent confidence interval for the mean concentration was also 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 percent confidence interval for the mean are

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

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

B3.4.1 Mean Concentrations

B3.4.1.1 Tank 241-AP-101 Data Set. The statistics for the first data set were based on analytical data from the November 1995 sampling event of tank 241-AP-101. The data were statistically evaluated using two models. The first model used a nested analysis of variance (ANOVA) where the data were identified by a grab sample within riser. The second model used one-way ANOVA where the data were identified by one variable (the grab sample). The ANOVA 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 (or detected) values.

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

- The upper value of the "less-than" (for example, 3.5 for <3.5) was used to represent all "less-than" analytical values in the first computation. This produces a bias of unknown magnitude in the mean analyte concentration and the variance associated with the mean; the mean analyte concentration is biased high. The extension ".w" was added to the analyte name in the tables to distinguish which analyte was statistically analyzed using "less-than" values.

- The "less-than" values were deleted in the second computation. Deleting data produces unbalanced data sets which complicates the statistical analysis and decreases the number of degrees of freedom. Deleting data also produces a bias of unknown magnitude in the mean analyte concentration and the variance associated with the mean. The extension ".wo" was added to the analyte name in the tables to distinguish which analyte was statistically analyzed with the "less-than" values deleted.

Table B3-6 shows the mean concentration estimates and the two-sided 95 percent confidence interval for the mean concentration (nested ANOVA) and Table B3-7 (one-way ANOVA) for analytes with at least 50 percent of the reported data as quantitative values. For some analytes, the lower limit of the 95 percent confidence interval was a negative value caused by 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 analytes in Table B3-6 where $\hat{\sigma}_{riser}$ is not significantly different from zero are marked with a "*." The mean concentrations and the variances of the mean concentrations calculated using the two statistical models (one-way ANOVA and nested ANOVA) are not significantly different for these analytes.

Table B3-8 lists the analytes that had less than 50 percent of the reported data as quantitative values. Table B3-8 shows the largest value observed from the six analytical results.

Table B3-6. Tank 241-AP-101 Summary Statistics Mean Concentrations (Nested Analysis of Variance).

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
%Water.tga[1]	wt%	58.2	0.770	1	48.5	68.0
Al.icp.a[1]	μg/mL	12,100	367	1	7,460	16,800
^{241}Am.w	μCi/mL	3.25E-04	2.39E-05	1	2.05E-05	6.28E-04
^{241}Am.wo[1]	μCi/mL	3.04E-04	3.69E-06	1	2.57E-04	3.50E-04
Cl^-.ic[1]	μg/mL	2,030	35.1	1	1,590	2,480
^{137}Cs.gea[1]	μCi/mL	188	6.58	1	105	272
DSC.exo.dry[1]	J/g dry	65.0	58.4	1	0.00	807
DSC.exo.wet[1]	J/g wet	28.0	25.4	1	0.00	351
F^-.ic[1]	μg/mL	2,080	318	1	0.00	6,120
NO_2^-.ic[1]	μg/mL	41,700	1,120	1	27,400	56,000
NO_3^-.ic[1]	μg/mL	1.54E+05	5,660	1	82,200	2.26E+05
Na.icp.a[1]	μg/mL	1.66E+05	4,170	1	1.12E+05	2.18E+05
OH^{-1}	μg/mL	49,400	1,570	1	29,400	69,400
PO_4^{3-}.ic.w[1]	μg/mL	908	113	1	0.00	2,340
$^{239/240}$Pu[1]	μCi/mL	1.64E-04	5.92E-06	1	8.84E-05	2.39E-04
SO_4^{2-}.ic[1]	μg/mL	2,610	346	1	0.00	7,010
SpG[1]	---	1.31	0.0126	1	1.15	1.47
$^{89/90}$Sr[1]	μCi/mL	0.155	0.0125	1	0.00	0.314
TIC[1]	μg/mL	4,550	328	1	371	8,720
TOC	μg/mL	2,680	518	1	0.00	9,260
pH	unitless	13.9	0.0467	1	13.3	14.5

Note:

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

Table B3-7. Tank 241-AP-101 Summary Statistics Mean Concentrations (One-Way Analysis of Variance).

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
%Water.tga	wt%	58.2	0.770	5	56.3	60.2
Al.icp.a	μg/mL	12,100	362	5	11,200	13,000
^{241}Am.wo	μCi/mL	3.03E-04	2.97E-06	4	2.95E-04	3.11E-04
Cl^-.ic	μg/mL	2,030	35.1	5	1,940	2,120
^{137}Cs.gea	μCi/mL	188	6.58	5	171	205
DSC.exo.dry	J/g dry	65.0	58.4	5	0.00	215
DSC.exo.wet	J/g wet	28.0	25.4	5	0.00	93.3
F^-.ic	μg/mL	2,080	290	5	1,340	2,830
NO_2^-.ic	μg/mL	41,700	1,120	5	38,800	44,600
NO_3^-.ic	μg/mL	1.54E+05	5,660	5	1.39E+05	1.69E+05
Na.icp.a	μg/mL	1.66E+05	4,090	5	1.55E+05	1.76E+05
OH^-	μg/mL	49,400	1,570	5	45,400	53,500
PO_4^{3-}.ic.w	μg/mL	908	113	5	619	1,200
PO_4^{3-}.ic.wo	μg/mL	806	115	2	310	1,300
$^{239/240}$Pu	μCi/mL	1.64E-04	5.20E-06	5	1.50E-04	1.77E-04
SO_4^{2-}.ic	μg/mL	2,610	290	5	1,870	3,360
SpG	---	1.31	0.0126	5	1.27	1.34
$^{89/90}$Sr	μCi/mL	0.155	0.0125	5	0.123	0.187
TIC	μg/mL	4,550	279	5	3,830	5,260

Table B3-8. Tank 241-AP-101 Analytes with >50 Percent "Less-Than" Values.

Analyte	Unit	Result
Total Alpha	μCi/mL	<0.00341
^{60}Co.gea	μCi/mL	<0.0443
Fe.icp.a	μg/mL	<20

B.3.4.1.2 Tank 241-AW-106 Grab Sample, Evaporator Slurry Sample. The statistics for the second data set were based on analytical data from two 1995 sampling events: one grab sample (supernatant) from tank 241-AW-106 and one evaporator slurry sample (from Campaign 95-1). If duplicate analyses were performed, the data were statistically evaluated using one-way ANOVA. For the analytes without duplicate analyses, the mean and the standard deviation of the mean were calculated. The less-than values were treated the same way as for the first data set.

Table B3-9 gives mean concentration estimates and the two-sided 95 percent confidence interval for the mean concentration. For some analytes, the lower limit of the 95 percent confidence interval was a negative value caused nu 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. Table B3-10 lists the analytes that had 50 percent or less of the reported data as quantitative values. Table B3-10 also cites the largest value observed from the two (occasionally three) analytical results.

Table B3-9. Tank 241-AW-106 Summary Statistics - Mean Concentrations. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Al	μg/mL	4,940	350	1	493	9,390
OH^-	μg/mL	29,600	1,900	1	5,450	53,700
SpG	---	1.26	0.0470	1	0.665	1.86
TC	μg/mL	20,000	7,420	1	0.00	1.14E+05
TIC	μg/mL	8,680	380	1	3,850	13,500
TOC	μg/mL	4,310	992	1	0.00	16,900
pH	unitless	13.8	0.337	1	9.55	18.1
^{14}C	μCi/mL	1.55E-04	1.95E-05	1	0.00	4.02E-04
^{134}Cs	μCi/mL	0.266	0.0420	1	0.00	0.800
^{137}Cs	μCi/mL	127	15.0	1	0.00	318
F^-	μg/mL	3,310	565	1	0.00	10,500
Na	μg/mL	1.12E+05	8,500	1	3,500	2.20E+05
NO_2^-	μg/mL	38,900	1,600	1	18,600	59,200
NO_3^-	μg/mL	94,200	1,300	1	77,700	1.11E+05
PO_4^{3-}	μg/mL	1,560	370	1	0.00	6,260
$^{239/240}Pu$	μCi/mL	2.18E-04	8.00E-05	1	0.00	0.00123
SO_4^{2-}	μg/mL	5,650	135	1	3,930	7,360
^{79}Se	μCi/mL	1.05E-04	1.70E-05	1	0.00	3.20E-04

Table B3-9. Tank 241-AW-106 Summary Statistics - Mean Concentrations. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
$^{89/90}Sr$	μCi/mL	0.0990	0.0651	1	0.00	0.925
^{99}Tc	μCi/mL	0.0322	0.00305	1	0.00	0.0709
Total beta	μCi/mL	119	24.6	1	0.00	432
^{3}H	μCi/mL	0.00850	0.00280	1	0.00	0.0441
U	μg/mL	69.2	1.95	1	44.4	93.9
Analytes with Only 1 Analytical Result						
Cl^-	μg/mL	1,340	n/a	n/a	n/a	n/a
DSC	J/g dry	0.00	n/a	n/a	n/a	n/a
NH_3	μg/mL	2.94	n/a	n/a	n/a	n/a
%Water	wt%	68.9	n/a	n/a	n/a	n/a

Table B3-10. Tank 241-AW-106 Analytes with ≥50 Percent "Less-Than" Values.

Analyte	Unit	Result
^{241}Am	μCi/mL	<0.00109
$^{144}Ce/Pr$	μCi/mL	<0.351
^{60}Co	μCi/mL	<0.0184
$^{243/244}Cm$	μCi/mL	<0.00109
^{154}Eu	μCi/mL	<0.0446
^{155}Eu	μCi/mL	<0.158
Fe	μg/mL	<20.05
^{129}I	μCi/mL	<5.76E-05
^{94}Nb	μCi/mL	<0.0157
^{237}Np	μCi/mL	<2.06E-05
^{238}Pu	μCi/mL	<8.57E-05
^{226}Ra	μCi/mL	<1.48
$^{106}Ru/Rh$	μCi/mL	<1.17
Total alpha	μCi/mL	<0.0134

B3.4.2 Analysis of Variance Model

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

The data were statistically evaluated using two 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 k^{th} analytical result from the j^{th} grab sample from the i^{th} riser

μ = the grand mean

R_i = the effect of the i^{th} riser

S_{ij} = the effect of the j^{th} grab sample from the i^{th} riser

A_{ijk} = the effect of the k^{th} analytical result from the j^{th} grab sample from the i^{th} riser

a = the number of risers

b_i = the number of grab samples from the i^{th} riser

n_{ij} = the number of analytical results from the j^{th} grab sample from the i^{th} riser.

The variables R_i and S_{ij} are assumed to be random effects. These variables and 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[3] (Statistical Sciences 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 j^{th} analytical result from the i^{th} grab sample
μ	=	the grand mean
S_i	=	the effect of the i^{th} grab sample
A_{ij}	=	the effect of the j^{th} analytical result from the i^{th} grab sample
a	=	the number of grab samples
n_i	=	the number of analytical results from the i^{th} grab sample.

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

B3.4.3 Sampling Based Tank Inventory

The sampling based tank inventory for each analyte is calculated by multiplying the tank volume for liquids by the mean concentration. The liquid tank volume for tank 241-AP-101 at the time it was sampled in November 1995 was 2,790 kL (737 kgal). After the

[3]S-PLUS is a registered trademark of Statistical Science, Seattle, WA.

November 1995 sampling event, 1,160 kL (306 kgal) of liquid waste from tank 241-AW-106 was transferred to tank 241-AP-101. The sampling based tank inventory was calculated using

$$\text{Tk Inv} = aX + bY$$

where a is the volume for tank 241-AP-101, X is the mean concentration for tank 241-AP-101 (nested ANOVA model), b is the volume for the waste transferred from tank 241-AW-106, and Y is the mean concentration for tank 241-AW-106.

The variance for the sampling based tank inventory was calculated using

$$\text{Var(Tk Inv)} = a^2\text{Var}(X) + b^2\text{Var}(Y)$$

where a, b, X, and Y are defined as above.

The lower and upper limits for the sampling based tank inventory were calculated using

$$\text{Tk Inv} \pm t_{(1,0.025)} \times \text{Std(Tk Inv)}$$

where Std(Tk Inv) is the square root of Var(Tk Inv).

The degrees of freedom associated with the variance of tank 241-AP-101 data were used in determining the lower and upper limits for tank inventory. Table B3-11 shows the tank inventory and upper and lower limits for analytes having concentration data for tanks 241-AP-101 and 241-AW-106.

For analytes with less than 50 percent of the data reported as quantitative values, the tank inventory was calculated by multiplying the tank volume by the concentration listed in Tables B3-8 and B3-10. Values for the lower limit and the upper limit are not possible.

Table B3-11. Analytical-Based Inventory for Tank 241-AP-101.

Analyte		LL (kg or Ci)	UL (kg or Ci)
%Water[2]	3.40E+06 kg	3.15E+06	3.64E+06
Al	4.09E+04 kg	2.64E+04	5.54E+04
^{241}Am.w[2]	<2.47E+00 Ci	7.77E-01	4.17E+00
^{241}Am.wo[2]	<2.41E+00 Ci	2.14E+00	2.69E+00
Cl^-.ic[2]	7.59E+03 kg	6.28E+03	8.91E+03
^{137}Cs.gea	7.08E+05 Ci	3.48E+05	1.07E+06
F^-.ic	1.06E+04 kg	0.00E+00	2.58E+04
NO_2^-.ic	1.72E+05 kg	1.23E+05	2.22E+05
NO_3^-.ic	5.65E+05 kg	3.63E+05	7.67E+05
Na.icp.a	6.22E+05 kg	4.07E+05	8.36E+05
OH^-	1.80E+05 kg	1.15E+05	2.46E+05
PO_4^{3-}.ic.w	4.78E+03 kg	0.00E+00	1.26E+04
$^{239/240}$Pu	7.70E-01 Ci	0.00E+00	2.25E+00
SO_4^{2-}.ic	1.54E+04 kg	2.89E+03	2.79E+04
$^{89/90}$Sr	5.76E+02 kg	0.00E+00	1.84E+03
TIC	2.52E+04 kg	1.16E+04	3.87E+04
TOC	1.37E+04 kg	0.00E+00	3.95E+04
Total alpha	<2.88E+01 Ci	n/a	n/a
^{60}Co.gea	<1.50E+02 Ci	n/a	n/a
Fe.icp.a	<8.46E+01 kg	n/a	n/a

Notes:

[1]The mean concentrations and the associated variabilities listed in Table B3-6 and Table 3-8 were used for the first data set (tank 241-AP-101). The mean concentrations and the associated variabilities listed in Tables B3-9 and B3-10 were used for the second data set (tank 241-AW-106 grab sample and the evaporator slurry sample).

[2]The variability associated with the tank 241-AP-101 data was used to estimate the variability associated with the tank 241-AW-106 data.

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APPENDIX C

STATISTICS FOR SAFETY SCREENING DATA QUALITY OBJECTIVE

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APPENDIX C

STATISTICS FOR SAFETY SCREENING DATA QUALITY OBJECTIVE

C1.0 STATISTICAL ANALYSIS: CONFIDENCE LEVELS

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, the results of computing one-sided confidence limits are reported for tank 241-AP-101. The data are from the November 1995 sampling event for tank 241-AP-101, the 1995 sampling event for tank 241-AW-106, and the evaporator slurry sample.

Confidence intervals were computed for each grab sample using the analytical data. The 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 these grab samples (per sample number), *df* equals the number of observations minus one.

Table C1-1 lists the upper limit of the 95 percent confidence interval for each sample number based on the exothermic DSC results (dry weight). Each confidence interval can be used to make the following statement. If the upper limit of the exotherm for the sample is less than 480 J/g (dry basis), reject the null hypothesis that exotherm is greater than or equal to 480 J/g dry at the 0.05 level of significance. For seven of eight grab samples, the upper limit is less than 480 J/g on a dry weight basis. The upper limit for sample S95T003730 (four analytical results of 0, 877, 0, 0) is greater than 480 J/g on a dry basis. However, if one result is considered to be an outlier and is deleted from the statistical analysis, the upper limit is not greater than 480 J/g dry. Therefore, the hypothesis that DSC results are greater than 480 J/g dry is rejected for seven of eight grab samples. The hypothesis that DSC results are greater than 480 J/g dry is rejected for the eighth sample if one analytical result is declared an outlier, as was concluded in Section 2.1.1. Therefore, the confidence interval is below the safety action limit for all valid samples.

Because all analytical results for total alpha were less-than values, confidence intervals are not possible. The largest nondetect value was <0.00341 μCi/mL which is less than the total alpha limit of 61.5 μCi/mL. Table C1-2 lists the data. The $^{239/240}$Pu data were used to evaluate the plutonium limit of 1 g/L. The $^{239/240}$Pu data were transformed to g/L by assuming that all the plutonium is ^{239}Pu and using the specific activity of 0.062 Ci/g to convert from curies to grams. Table C1-3 lists the sample numbers and the upper limit of the 95 percent confidence intervals. Each confidence interval can be used to make the following statement. If the upper limit is less than 1 g/L, reject the null hypothesis that the $^{239/240}$Pu is greater than or equal to 1 g/L at the 0.05 level of significance. The upper limit was less than 1 g/L for six of eight grab samples. Thus, the hypothesis that the plutonium results are greater than 1 g/L is rejected for six of eight grab samples. An upper limit is not possible for the remaining two grab samples because duplicate analyses were not performed. However, the Pu concentrations (g/L) are orders of magnitude below the limit (1 g/L).

Table C1-1. Summary Statistics - Differential Scanning Calorimetry.

Sample Number	Sample Description	$\hat{\mu}$ (J/g dry)	$\hat{\sigma}_{\hat{\mu}}$ (J/g dry)^2	UL (J/g dry)
S95T003721	Tank 241-AP-101, riser 1 at 210°, 516 in. elevation	0.00	0.00	0.00
S95T003722	Tank 241-AP-101, riser 1 at 210°, 383 in. elevation	0.00	0.00	0.00
S95T003723	Tank 241-AP-101, riser 1 at 210°, 640 in. elevation	0.00	0.00	0.00
S95T003728	Tank 241-AP-101, riser 1 at 330°, 383 in. elevation	48.7	48.7	356
S95T003729	Tank 241-AP-101, riser 1 at 330°, 516 in. elevation	0.00	0.00	0.00
S95T003730	Tank 241-AP-101, riser 1 at 330°, 640 in. elevation	175 0.00[1]	175 0.00[1]	549 0.00[1]
S95T002016	Tank 241-AW-106 riser 16B, 6AW-95-1	0.00	0.00	0.00
T2270	Evaporator slurry sample	0.00	0.00	0.00

Note:
[1]Outlier deleted.

Table C1-2. Total Alpha Data.

Sample Number	Sample Description	Analytical Results (μCi/mL)
S95T003731	Tank 241-AP-101, riser 1 at 210°, 516 in. elevation	<0.00159 <0.00341
S95T003732	Tank 241-AP-101, riser 1 at 210°, 383 in. elevation	<0.00311 <0.00251
S95T003733	Tank 241-AP-101, riser 1 at 210°, 640 in. elevation	<0.00341 <0.00189
S95T003735	Tank 241-AP-101, riser 1 at 330°, 383 in. elevation	<0.00256 <0.00256
S95T003736	Tank 241-AP-101, riser 1 at 330°, 516 in. elevation	<0.00225 <0.00256
S95T003737	Tank 241-AP-101, riser 1 at 330°, 640 in. elevation	<0.00287 <0.00287
S95T002016	Tank 241-AW-106 riser 16B, 6AW-95-1	<0.0134
T2270	Evaporator slurry sample	<0.00299

Table C1-3. Summary Statistics - $^{239/240}Pu$.

Sample Number	Sample Description	$\hat{\mu}$ (g/L)	$\hat{\sigma}_{\bar{x}}$ $(g/L)^2$	UL (g/L)
S95T003731	Tank 241-AP-101, riser 1 at 210°, 516 in. elevation	2.51E-06	8.06E-09	2.56E-06
S95T003732	Tank 241-AP-101, riser 1 at 210°, 383 in. elevation	2.67E-06	2.42E-08	2.82E-06
S95T003733	Tank 241-AP-101, riser 1 at 210°, 640 in. elevation	2.45E-06	1.13E-07	3.16E-06
S95T003735	Tank 241-AP-101, riser 1 at 330°, 383 in. elevation	2.45E-06	9.68E-08	3.06E-06
S95T003736	Tank 241-AP-101, riser 1 at 330°, 516 in. elevation	2.80E-06	2.02E-07	4.07E-06
S95T003737	Tank 241-AP-101, riser 1 at 330°, 640 in. elevation	2.95E-06	6.45E-08	3.36E-06
S95T002016	Tank 241-AW-106 riser 16B, 6AW-95-1	2.23E-06	n/a	n/a
T2270	Evaporator slurry sample	4.81E-06	n/a	n/a

C2.0 APPENDIX C REFERENCES

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APPENDIX D

RESULTS OF THE EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-AP-101

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APPENDIX D

RESULTS OF THE EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-AP-101

The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-AP-101.

Expected Waste Type

Double-Shell Slurry Feed (DSSF).

D1.0 CHEMICAL INFORMATION SOURCES

Available composition information for tank 241-AP-101 waste is as follows.

- The validation summary for tank 241-AP-101 (Miller 1993) provides characterization results from the July 1993 "bottle-on-a-string" sampling event at a time when 4,016 kL (1,061 kgal) of dilute noncomplexed waste was in the tank.

- Beginning in October 1994, the contents of tank 241-AP-108 were transferred to tank 241-AP-101. Characterization results from the June 1994 grab sampling event for tank 241-AP-108 (Miller 1994, Table 14) were used to provide a composition for this waste.

- In August 1995, 2,498 kL (660 kgal) of waste from tank 241-AP-105 were transferred to tank 241-AP-101. The composition for this waste was taken from the characterization results of the March 1993 "bottle-on-a-string" sampling event given in the TCR for tank 241-AP-105 (De Lorenzo et al. 1994, Table 5-6).

- The final report for grab samples taken in November 1995 (Esch 1996, Table 1 provides characterization results for tank 241-AP-101 after it received DSSF from tanks 241-AP-105 and 241-AP-108.

- The *242-A Evaporator Campaign 95-1 Post Run Document* (Guthrie 1996, Table 10) and the final report for the August 1995 tank 241-AW-106 grab samples (Esch 1995) provided characterization results for the 1,158 kL (306 kgal) of DSSF transferred from tank 241-AW-106 to tank 241-AP-101 in March 1996.

- The HDW model document (Agnew et al. 1996) provides tank content estimates derived from the Los Alamos National Laboratory model, in terms of component concentrations and inventories. A complete list of data sources used in this evaluation is in this section.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The HDW model (Agnew et al. 1996) provides composition estimates for waste in tank 241-AP-101 on January 1, 1994. Because tank contents have changed since that time, no comparisons between the HDW estimate and sampling data were attempted.

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents was performed to identify potential errors and/or missing information that would influence the sample-based inventories and to estimate the current inventory in tank 241-AP-101 from sample data of contributing wastes and transfer records.

D3.1 CONTRIBUTING WASTE TYPES

At the beginning of 1994, tank 241-AP-101 contained 4,012 kL (1,060 kgal) of dilute noncomplexed waste. In a succession of alternating transfers beginning in August 1994, waste from tank 241-AP-101 was transferred to other tanks as evaporator feed and waste from tank 241-AP-108 was transferred to tank 241-AP-101. At the conclusion of the transfers, tank 241-AP-101 contained only 295 kL (78 kgal) of dilute noncomplexed waste.

This volume remained unchanged until August 1995 when 2,498 kL (660 kgal) of DSSF from tank 241-AP-105 was sent to tank 241-AP-101. Seven months later, in March 1996, another 1,158 kL (306 kgal) of DSSF from the 242-A Evaporator Campaign 95-1 was added to tank 241-AP-101. This DSSF was stored in tank 241-AW-106 before it was transferred to tank 241-AP-101. Another transfer from tank 241-AW-106 (280 kL [74 kgal]) was made in January 1997. Since of March 1997, the waste in tank 241-AP-101 has remained unchanged.

D3.2 EVALUATION OF HISTORICAL DATA

The last sampling event for tank 241-AP-101 ended November 13, 1995, approximately four months before the last transfer of DSSF from Campaign 95-1. The November 1995 data was compared to a composition derived from sample data and historical transfer information that dated back to the July 1993 sampling event. A best-basis estimate was derived for the waste by combining the reconciled November 1995 data with composition and volume information for the Campaign 95-1 DSSF (from the Campaign 95-1 post run document [Guthrie 1996] and grab sampling results from tank 241-AW-106 [Esch 1995]).

Table D3-1 shows the chronology of transfers associated with tank 241-AP-101 dating back to January 1, 1994. Analytical data for tank 241-AP-105 were taken from De Lorenzo et al. (1994), and analytical data for tank 241-AP-108 were taken from Miller (1994). Data for the DSSF from Campaign 95-1 were taken from Guthrie (1996) and Esch (1995). These data represent the waste at the time of transfer. Using these compositions and the transfer history through November 1995, a historical estimate of the contents in November 1995 was derived to compare with the analytical results of the November 1995 sampling event.

Table D3-1. Chronology of Transfers for Tank 241-AP-101 as of January 31, 1997.[1]

Date[2]	Source	Destination	Volume Change kL (kgal)	Final 241-AP-101 Volume kL (kgal)
1/1/94	n/a	n/a	n/a	4,012 (1,060)
8/11/94	241-AP-101	241-AW-102	-2,816 (744)	1,196 (316)
10/7/94	241-AP-108	241-AP-101	1,075 (284)	2,271 (600)
10/8/94	241-AP-101	241-AW-102	-1,707 (451)	564 (149)
1/20/95	241-AP-108	241-AP-101	2,896 (765)	3,460 (914)
1/22/95	241-AP-101	241-AP-107	-3,164 (836)	295 (78)
8/27/95	241-AP-105	241-AP-101	2,498 (660)	2,790 (737)
3/4/96	241-AW-106	241-AP-101	1,158 (306)	3,944 (1,042)
1/9/97	241-AW-106	241-AP-101	280 (74)	4,224 (1,116)

Notes:

[1]Because minor level fluctuations are not shown, volumes may not add up exactly.

[2]Dates are in the mm/dd/yy format.

Table D3-2 shows the analytical results from the November 1995 sampling of tank 241-AP-101. Three samples were taken from each of two risers at depths of 678 cm (267 in.), 340 cm (134 in.), and 25 cm (10 in.) from the tank bottom for a total of six samples. The transfer history indicates that 2,498 kL (660 kgal) of DSSF and 295 kL (78 kgal) of dilute noncomplexed waste were in the tank suggesting the possibility the waste was stratified. Therefore, it was assumed that samples 95-2 and 95-4 taken from the top of the waste represent the smaller dilute noncomplexed portion of the waste, and the remaining samples represent the DSSF portion. Results obtained from using this assumption differ little from results obtained if the waste is assumed to have been homogenous as indicated in Table D3-3.

Table D3-2. Results of November 1995 Sampling of Tank 241-AP-101. (2 sheets)

Analyte	Riser 1 SW			
	95-2	95-1	95-3	Top/ Bottom[1]
	μg/mL	μg/mL	μg/mL	
TOC	2,100	2,060	2,340	0.90
TIC	5,360	4,960	4,300	1.25
Percent water	60.47%	58.91%	56.82%	1.06
Specific gravity	1.295	1.285	1.34	0.97
pH	13.87	13.77	13.86	1.00
OH^-	42,200	49,200	53,900	0.78
Al	11,000	11,600	12,600	0.87
Fe	n/a	n/a	n/a	---
Na	1.53E+05	1.59E+05	1.72E+05	0.89
SO_4^{2-}	3,520	3,220	2,140	1.64
PO_4^{3-}	<1,210	<1,210	<613	---
NO_3^-	1.47E+05	1.50E+05	1.81E+05	0.81
NO_2^-	38,700	40,500	46,800	0.83
F^-	2,700	2,450	2,050	1.32
Cl^-	1,910	1,980	2,140	0.89
Units	μCi/mL	μCi/mL	μCi/mL	
^{90}Sr	0.152	0.134	0.163	0.93
$^{239/240}Pu$	1.66E-04	1.55E-04	1.52E-04	1.09
^{137}Cs	173	182	196	0.88
^{60}Co	n/a	n/a	n/a	---
^{241}Am	2.98E-04	3.00E-04	3.04E-04	0.98

Table D3-2. Results of November 1995 Sampling of Tank 241-AP-101. (2 sheets)

Analyte	Riser 1 SW			
	95-2	95-1	95-3	Top/ Bottom[1]
	μg/mL	μg/mL	μg/mL	
TOC	2,100	2,060	2,340	0.90
Analyte	Riser 1 NW			
	95-4	95-5	95-6	Top/ Bottom
	μg/mL	μg/mL	μg/mL	
TOC	3,360	3,240	3,000	1.12
TIC	5,070	3,760	3,820	1.33
Percent water	60.29%	56.50%	56.47%	1.07
SpG	1.275	1.295	1.350	0.94
pH	13.95	13.91	13.93	1.00
OH	50,700	50,100	50,300	1.01
Al	11,500	13,300	12,700	0.91
Fe	n/a	n/a	n/a	---
Na	1.58E+05	1.77E+05	1.74E+05	0.90
SO_4	2,940	2,120	1,740	1.69
PO_4	1,010	617	787	1.28
NO_3	1.56E+05	1.46E+05	1.44E+05	1.08
NO_2	42,000	41,800	40,600	1.03
F	2,820	1,320	1,150	2.45
Cl	2,120	2,010	2,020	1.05
Units	μCi/mL	μCi/mL	μCi/mL	
^{90}Sr	0.184	0.190	0.109	1.69
$^{239/240}Pu$	1.52E-04	1.73E-04	1.83E-04	0.83
^{137}Cs	170	212	198	0.86
^{60}Co	n/a	n/a	n/a	---
^{241}Am	n/a	n/a	n/a	---

Note:

[1]Ratio of upper sample (95-2 or 95-4) to lower sample (95-3 or 95-6). Similar ratios might indicate stratification.

Table D3-3. Composition of Tank 241-AP-101 as of November 1995: Homogeneity Versus Stratification.

Analyte	If Contents Were Homogenous (*M*)	If Contents Were Stratified (*M*)
TOC (g/L)	2.65	2.66
CO_3	0.378	0.360
OH	2.91	2.97
Al	0.449	0.460
Fe	n/r	n/r
Na	7.19	7.34
SO_4	0.0272	0.0250
PO_4	0.00854	0.00775
NO_3	2.48	2.50
NO_2	0.907	0.918
F	0.110	0.0974
Cl	0.0573	0.0574
Units	Ci/L	Ci/L
^{90}Sr	1.63E-04	1.58E-04
$^{239/240}Pu$	1.64E-07	1.65E-07
^{137}Cs	0.197	0.203
^{241}Am	3.01E-07	3.02E-07

Note:
n/r = not repored

Table D3-4 compares the historical estimate to the results of the November 1995 sampling event (assuming waste stratification). Overall, agreement is excellent agreement. The largest disparities were phosphate and plutonium. Because of the low plutonium concentrations, the 68 percent difference for this analyte is deemed acceptable. The phosphate disparity needs to be addressed.

The bulk of the phosphate in the historical estimate comes from tank 241-AP-105. The IC results for phosphate were chosen from De Lorenzo et al. (1994). If the ICP results for phosphorus were used instead, the resulting disparity would be decreased from 45 to 24 percent. The November 1995 analytical results are assumed to be the better basis for phosphate.

Table D3-4. Estimated and Analytical Compositions for Waste in Tank 241-AP-101 as of November 1995. (2 sheets)

Analyte	Historical Estimate *M*	Analytical Result *M*	Analytical Estimate
Ag	1.15E-06	n/r	
$Al(OH)_4$	0.388	0.460	0.84
As	1.09E-05	n/r	
B	0.00177	n/r	
Ba	4.17E-06	n/r	
Ca	0.00149	n/r	
Cd	1.42E-05	n/r	
$Cr(OH)_4$	0.00322	n/r	
Fe	1.07E-04	n/r	
K	0.709	n/r	
Mg	3.35E-04	n/r	
Na	6.51	7.34	0.89
Ni	1.66E-04	n/r	
Pb	2.33E-05	n/r	
Se	1.60E-06	n/r	
Si	0.00462	n/r	
Ti	1.19E-12	n/r	
U g/L	0.0390	n/r	
Zn	8.05E-04	n/r	
CO_3	0.336	0.360	0.93
CL	0.0597	0.0574	1.04
F	0.0718	0.0974	0.74
SO_4	0.0227	0.0250	0.91
NO_3	2.38	2.50	0.95
NO_2	0.941	0.918	1.03
PO_4	0.00424	0.00775	0.55
OH	2.84	2.97	0.96
TOC (g/L)	2.46	2.66	0.92

Table D3-4. Estimated and Analytical Compositions for Waste in Tank 241-AP-101 as of November 1995. (2 sheets)

Analyte	Historical Estimate	Analytical Result	Analytical Estimate
	M	M	
	Ci/L	Ci/L	
^{14}C	1.95E-07	n/r	
^{90}Sr	2.02E-04	1.58E-04	1.28
^{90}Y	2.02E-04	1.58E-04	1.28
^{99}Tc	6.28E-05	n/r	
^{137}Cs	2.13E-01	2.03E-01	1.05
^{137}Ba	2.02E-01	1.93E-01	1.05
^{154}Eu	5.32E-09	n/r	
^{238}U	1.31E-08	n/r	
^{237}Np	2.81E-07	n/r	
^{239}Pu	1.13E-07	1.65E-07	0.68
^{241}Pu	1.77E-07	n/r	
^{241}Am	3.63E-07	3.02E-07	1.20

The November 1995 sample analysis did not include a large number of components that are in the historical estimate. For these components, the historical estimate is used as the basis. Table D3-5 shows the best-basis inventory for waste in tank 241-AP-101 before the final transfer of DSSF from Campaign 95-1.

Table D3-5. Estimated and Analytical Inventories for Waste in Tank 241-AP-101 as of November 1995. (2 sheets)

Analyte	Pre-Campaign 95-1 Inventory[1]
	kg
Al	34,700
B	0.00177
Ca	237
Cr	662
Fe	23.5
K	1.09E+05
Na	4.71E+05
Ni	38.5
Pb	19.0
Si	512
U	154
CO_3	60,300
CL	5,680
F	5,160
SO_4	6,700
NO_3	4.33E+05
NO_2	1.18E+05
PO_4	2,050
OH	1.41E+05
TOC	7,420

Table D3-5. Estimated and Analytical Inventories for Waste in Tank 241-AP-101 as of November 1995. (2 sheets)

Analyte	Pre-Campaign 95-1 Inventory[1]
Units	Ci
^{14}C	1.95E-07
^{90}Sr	564
^{90}Y	564
^{99}Tc	175
^{137}Cs	5.67E+05
^{137}Ba	5.39E+05
^{154}Eu	0.0149
^{238}U	0.0518
^{237}Np	0.785
^{239}Pu	0.461
^{241}Pu	0.494
^{241}Am	0.844

Note:

[1]This is the inventory before addition of 1,158 kL (306 kgal) of DSSF from tank 241-AW-106 in March 1996 (Campaign 95-1).

Once the waste composition for November 1995 was established, it was necessary to estimate a current composition for tank 241-AP-101 by "adding" the 1,438 kL (380 kgal) of DSSF that was produced in Campaign 95-1 and stored in tank 241-AW-106 before it was transferred to tank 241-AP-101. The concentration estimates for the additional portion were derived by combining the results from a sample of the 242-A Evaporator slurry and the results from an August 1995 grab sampling of tank 241-AW-106. The combining was done as discussed in Section B3.4. Table D3-6 shows the concentration estimates for the additional portion.

Table D3-6. Concentration Estimates for Waste Received from Tank 241-AW-106 in March 1996 and January 1997.

Analyte	Concentration	Inventory
	μg/mL	kg
Al	4,940	5,720
Na	1.12E+05	1.30E+05
F	3,310	3,830
NO_2	38,900	45,000
NO_3	94,200	1.09E+05
PO_4	1,560	1,810
SO_4	5,650	6,540
OH	29,600	34,300
TOC	4,310	4,990
	μCi/mL	Ci
^{14}C	1.55E-04	0.180
^{90}Sr	0.0990	115
^{90}Y	0.0990	115
^{99}Tc	0.0322	37.3
^{137}Cs	127	1.47E+05
^{137}Ba	121	1.40E+05
$^{239/240}Pu$	2.18E-04	0.252

In combining the November 1995 basis with the DSSF from Campaign 95-1, component inventories in the November 1995 basis that were not included in the Campaign 95-1 data were assumed to be the total inventories for the tank. This introduces considerable uncertainty for these components, but in the absence of other data, the result of this analysis is the best-basis for the tank.

D4.0 DEFINE THE BEST BASIS AND ESTABLISH COMPONENT INVENTORIES

The sample-based data should serve as the basis for the best estimate inventory for tank 241-AP-101 for the following reasons:

1. Although no individual samples of the waste are currently stored in tank 241-AP-101, data from the tank samples taken in November 1995 and data from the waste produced in Evaporator Campaign 95-1 can be combined to describe waste currently in tank 241-AP-101.

2. The HDW model estimate is outdated because of a large number of waste transfers that have occurred subsequent to the model development.

Tables D4-1 and D4-2 show best-basis inventory estimates for tank 241-AP-101. Radionuclide values are decayed to January 1, 1994.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-101 as of September 30, 1996. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	40,400	S	
Ca	237	S	Campaign 95-1 data not available.
Cl	5,680	S	
TIC as CO_3^{2-}	1.13E+05	S	
Cr	662	S	Campaign 95-1 data not available.
F	8,990	S	
Fe	23.5	S	
K	1.09E+05	S	Campaign 95-1 data not available.
Na	6.01E+05	S	
Ni	38.5	S	Campaign 95-1 data not available.
NO_2^-	1.63E+05	S	
NO_3^-	5.42E+05	S	
OH^-	1.75E+05	S	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-101 as of September 30, 1996. (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Pb	19.0	S	Campaign 95-1 data not available.
PO_4	4,280	S	45 percent disparity between historical and analytical results.
Si	512	S	Campaign 95-1 data not available.
SO_4	13,400	S	
TOC	12,400	S	
U_{TOTAL}	191	S	

Note:
[1]S = sample-based, M = HDW model-based, E = engineering assessment-based

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-101 as of September 30, 1996 (Decayed to January 1, 1994).

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{14}C	0.744	S	
^{90}Sr	679	S	
^{90}Y	679	S	
^{99}Tc	212	S	
^{137}Cs	7.14E+05	S	
^{137m}Ba	6.78E+05	S	
^{154}Eu	210		
^{237}Np	1.11	S	Campaign 95-1 data not available.
^{238}U	0.0518	S	Campaign 95-1 data not available.
$^{239/240}Pu$	0.713	S	
^{241}Am	0.843	S	

Note:
[1]S = sample-based, M = HDW model-based, E = engineering assessment-based

D5.0 APPENDIX D REFERENCES

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

De Lorenzo, D. S., L. C. Amato, A. T. DiCenso, K. W. Johnson, and R. H. Stephens, 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-105*, WHC-SD-WM-ER-360, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Esch, R. A., 1995, *60-Day Waste Compatibility Safety Issue and Final Results for Tank 241-AW-106, Grab Samples 6AW-95-1, 6AW-95-2, and 6AW-95-3*, WHC-SD-WM-DP-147, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Esch, R. A., 1996, *Final Report for Tank 241-AP-101 Grab Samples 1AP-95-1 & 1AP-95-2 & 1AP-95-3 & 1AP-95-4 & 1AP-95-5 & 1AP-95-6*, WHC-SD-WM-DP-161, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Guthrie, M. D., 1996, *242-A Campaign 95-1 Post Run Document*, WHC-SD-WM-PE-055, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1993, *Validation Summary for Double-Shell Tank 241-AP-101*, WHC-SD-WM-DP-051, Addendum 1, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Miller, G. L., 1994, *Analysis and Characterization of Double-Shell Tank 241-AP-108*, WHC-SD-WM-DP-065, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AP-101

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AP-101

Appendix E is a bibliography of information that supports the characterization of tank 241-AP-101. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-AP-101 and its respective waste types.

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

I. NON-ANALYTICAL DATA

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

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

- IIa. Sampling of tank 241-AP-101
- IIb. Sampling of 242-A Evaporator Streams
- IIc. Sampling of Similar Waste Types

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

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

This bibliography is broken down into the appropriate sections and has an annotation at the end of each reference describing the information source. Whenever possible, a reference is provided for information sources. A majority of the information listed below is available in the Tank Characterization Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign 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, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4,* LA-UR-96-3680, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains waste type summaries and primary chemical compound/analyte and radionuclide estimates for liquids and solids based on campaign information.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1997, *Waste Tank Status and Transaction Record Summary for the Southeast Quadrant, (WSTRS), Rev. 4,* LA-UR-97-311 Los Alamos National Laboratory, Los Alamos, New Mexico.

- Contains spreadsheets showing available data on tank additions and transfers.

Koreski, G. M., and J. Strode, 1994, *Operational Waste Volume Projection,* WHC-SD-WM-ER-029, Rev. 20, Westinghouse Hanford Company, Richland, Washington.

- Includes spreadsheets detailing double-shell tank waste transfers.

Ic. Surveillance/Tank Configuration

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

- Summarizes tank farm historical information including the following: historical analytical results, surveillance level data and graphs, riser configurations, tank photographs, inventory estimates, and layering model data.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending January 31, 1997,* WHC-EP-0182-106, Lockheed Martin Hanford Company, Richland, Washington.

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

KEH, 1982, "Plan Tank Penetrations 241-AP-101 and 103," Drawing H-2-90538, Rev. 1, Kaiser Engineers Hanford Company, Richland, Washington.

- Shows a top down view of riser locations.

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

- Details tank design, designed use, construction, and equipment information.

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

- Assesses riser locations for each tank; not all tanks are included or completed.

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

- A compilation of riser information for double-shell tanks. Includes above ground plan views, riser sizes and elevations, and tank reference drawing numbers.

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

- Unvalidated compilation of thermocouple information for all tanks. Includes source document references.

WHC, 1994, "Piping Plan Tank 101," Drawing H-2-90553, Rev. 4, Westinghouse Hanford Company, Richland, Washington.

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

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- Requests analysis of two samples taken to determine whether tank 241-AP-101 was within tank corrosion control specififications.

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

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- Details sampling and analysis procedures for the November 1995 grab sampling.

Homi, C. S., 1995, *Tank 241-Ap-101 Tank Characterization Plan,* WHC-SD-WM-TP-417, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Describes safety and operational issues for which samples are necessary.

Jones, J. M., 1995, *Compatibility Grab Sampling and Analysis Plan,* WHC-SD-WM-TSAP-037, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Details the plan which serves as the contractual agreement for the Characterization Program, Sampling Operations, and the 222-S Laboratory. The plan provides guidance for the sampling and analysis of samples for waste compatibility purposes.

Le, E. Q., 1995, *242-A Evaporator Sample Schedule for Campaign 95-1,* FSS-T-630-00001, Rev. B-5, Westinghouse Hanford Company, Richland, Washington.

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Schreiber, R. D., 1995, *Letter of Instruction for Tank 241-Ap-101 Grab Samples*, (internal memorandum 71520-95-107 to A. D. Rice, March 15), Westinghouse Hanford Company, Richland, Washington.

- Describes analyses needed on two grab samples to determine whether the tank was within corrosion control specifications.

Ie. Data Quality Objectives and Customers of Characterization Data

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

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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.

- Establishes the process for assessing waste compatibility for transfers into and within the double-shell tank system.

If. Other - Nondocumented or Electronic Sources

Koreski, G. M., 1997, *Operational Waste Volume Projection Historical Database*, Lockheed Martin Hanford Corporation, Richland, Washington.

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

Lockheed Martin Services, 1997, SACS: Surveillance Analysis Computer System. In: SYBASE/Visual Basic [Mainframe]. Available: HLAN, Lockheed Martin Services, Richland, WA; or Tank Waste Information Network System, Pacific Northwest National Laboratory, Richland, Washington.

- Contains 200 Area tank surveillance data from the Computer Automated Surveillance System and the Tank Monitoring and Control System.

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

IIa. Sampling of Tank 241-AP-101

Esch, R. A., 1996, *Final Report for Tank 241-AP-101, Grab Samples 2AP-95-1, 2AP-95-2, 2AP-95-3, 2AP-95-4, 2AP-95-5, and 2AP-95-6,* WHC-SD-WM-DP-161, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Shows the analytical results from the November 1995 grab sampling.

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IIb. Sampling of Evaporator Waste Streams

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- Summarizes the results of 242-A Evaporator Campaign 94-2.

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- Contains organic speciation data for tanks 241-AP-101 and 241-AP-107.

IIc. Sampling of Similar Waste Types

De Lorenzo, D. S., L. C. Amato, A. T. DiCenso, K. W. Johnson, and R. H. Stephens, 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-105*, WHC-SD-WM-ER-360, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Describes and characterizes the waste in tank 241-AP-105 based on the March 1993 grab sampling.

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- Shows the results from the August 1995 grab sampling of tank 241-AW-106.

Miller, G. L., 1994, *Analysis and Characterization of Double-Shell Tank 241-AP-108*, WHC-SD-WM-DP-065, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Shows sampling and analytical data for tank 241-AP-108.

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, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 4*, LA-UR-96-3680, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

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

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IIIb. Compendium of Data From Other Sources Physical and Chemical

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- Gives solubility ranges used for key chemical and radionuclide components based on supernatant sample analysis.

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- Summarizes tank farm historical information including the following: historical analytical results, surveillance level data and graphs, riser configurations, tank photographs, inventory estimates, and layering model data.

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.

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

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- Summarizes tank farm historical information including the following: historical analytical results, surveillance level data and graphs, riser configurations, tank photographs, inventory estimates, and layering model data.

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

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- Contains tank inventories generated in support of safety analyses.

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- Contain a collection of internal memorandums and letters concerning tank or process sampling. Includes all process aids documents from 1969 to 1993.

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