0050133 S

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 643857

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Jim G. Field, Data Assessment and Interpretation, R2-12, 376-3753	[] Yes [X] No	12/17/98
	6. Project Title/No./Work Order No. Tank 241-AX-102	7. Bldg./Sys./Fac. No. 241-AX-102	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-472, Rev. 0-C	10. Related ECN No(s). ECNs: 623838, 625689, 640678	11. Related PO No. N/A

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

13a. Description of Change

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

The document has been totally revised to include the results of recent sampling to address technical issues associated with the waste, and to update the best basis standard inventory.

JAN 1999 RECEIVED EDMC

14a. Justification (mark one)

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

14b. Justification Details

Changes required to incorporate new sampling data.

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

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): ECN-643857

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

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

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

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

Document Number/Revision	Document Number/Revision	Document Number Revision
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	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. J.G. Field	J G Field	12/18/98	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	12/18/98	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J.W. Cammann	JW Cammann	12/18/98	Other		
R.J. Cash	J G Field for per telecon	12/21/98	DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

Tank Characterization Report for Single-Shell Tank 241-AX-102

Jim G. Field
Lockheed Martin Hanford Corp., Richland, WA 99352
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-AX-102. This report supports the requirements of the Tri-Party Agreement Milestone M-44-15C.

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Tank Characterization Report for Single-Shell Tank 241-AX-102

J. G. Field
S. R. Wilmarth
Lockheed Martin Hanford Corp.

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LIST OF TERMS

ANOVA	analysis of variance
B	B Plant high-level waste from cesium/strontium recovery
Btu/hr	British thermal units per hour
CC	concentrated complexed
Ci	curie
Ci/g	curies per gram
Ci/L	curies per liter
CI	confidence interval
cm	centimeter
CN	cyanide
CZE	capillary zone electrophoresis
DQO	data quality objective
DSC	differential scanning calorimetry
DW	dry weight
ft	feet
ft^2	square feet
g	gram
g/cc	grams per cubic centimeter
g/L	grams per liter
g/mL	grams per milliliter
g/mole	grams-mole
EDTA	ethylenediaminetetraacetic acid
HDW	Hanford defined waste
HEDTA	n(2-hyroxyethyl)eththylenediaminetriacetic acid
HHF	hydrostatic head fluid
IC	ion chromatography
ICP	inductively coupled plasma
in.	inch
J/g	joules per gram
K	degrees kelvin
kg	kilogram
kgal	kilogallon
kL	kiloliter

LIST OF TERMS (Continued)

kW	kilowatt
LFL	lower flammability limit
lb/gal	pounds per gallon
LL	lower limit
m	meter
m^2	square meters
M	moles per liter
mg	milligram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mm	millimeter
n/a	not applicable
NA	not analyzed
NF	not found
n/r	not reported
PHMC	Project Hanford Management Contractor
PL	low-level waste from PUREX process
ppm	parts per million
ppmv	parts per million by volume
PRSST	propagating reactive system screening tool
PUREX	Plutonium-Uranium Extraction (Facility)
QC	quality control
REML	restricted maximum likelihood method
RGS	retained gas sample
RPD	relative percent difference
SAP	sampling and analysis plan
SMM	supernatant mixing model
SMMA1	Supernatant Mixing Model Saltcake from the 242-A-Evaporator
SpG	specific gravity
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model

LIST OF TERMS (Continued)

TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
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
µg C/g	micrograms of carbon per gram
µCi/L	microcuries per liter
µg/g	micrograms per gram

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1.0 INTRODUCTION

A major function of the Tank Waste Remediation System (TWRS) is to characterize waste in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis and other available information about a tank are compiled and maintained in a tank characterization report (TCR). This report and its appendices serve as the TCR for single-shell tank 241-AX-102.

The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-AX-102 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 shows the best-basis inventory estimate, Section 4.0 makes recommendations about the safety status of the tank and additional sampling needs. The appendices contain supporting data and information. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1997), Milestone M-44-15c, change request M-44-97-03 to "issue characterization deliverables consistent with the Waste Information Requirements Document developed for FY 1999" (Adams et al. 1998).

1.1 SCOPE

The characterization information in this report originated from sample analyses and known historical sources. Samples were obtained and assessed to fulfill requirements for tank-specific issues discussed in Section 2.0 of this report. Other information was used to support conclusions derived from these results.

Appendix A contains historical information for tank 241-AX-102, including surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model. Appendix B summarizes recent sampling events (see Table 1-1), sample data obtained before 1989, and sampling results. Appendix C provides 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-AX-102 and its respective waste types.

Table 1-1. Summary of Recent Sampling.

Sample/Date[1]	Phase	Location	Segmentation	Recovery
Vapor sample (6/27/95)	Gas	Tank headspace, Riser 9E, 6.1 m (20 ft) below top of riser	n/a	n/a
Auger (2/10,14/95)	Solid/liquid	Riser 3A Riser 9E	n/a	1.97 g, ~ 10% 34.5 g, ~ 100% based on expected sample length (see Rice [1995])
Surface finger trap grab (2/11/98)	Solid/liquid	Riser 9G	Composite	Three sample bottles: full, 2/3 full and 3/4 full.

Notes:

n/a = not applicable

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

1.2 TANK BACKGROUND

Tank 241-AX-102 is located in the AX Tank Farm in the 200 East Area of the Hanford Site. The tank went into service in 1965 and was initially used as a Plutonium-Uranium Extraction Facility (PUREX) high-level waste receiver. From 1969 through 1975, tank 241-AX-102 was used to store high-activity waste from B Plant. Other wastes routed to tank 241-AX-102 until its deactivation in 1980 include evaporator feed, evaporator slurry, complexant, and concentrated complexant wastes (Brevick et al 1997).

In 1988, tank 241-AX-102 was declared an assumed leaker. Approximately 12 kL (3 kgal) are estimated to have leaked from the tank. The supernatant in the tank was pumped and the tank was interim stabilized by September 1988 (Hanlon 1998).

Table 1-2 gives an overall description of tank 241-AX-102. The tank has a maximum storage capacity of 3,785 kL (1,000 kgal), and presently contains an estimated 114 kL (30 kgal) of complexant concentrate waste. The tank is on the Watch List for the organics issue (Public Law 101-510).

Table 1-2. Description of Tank 241-AX-102. (2 sheets)

TANK DESCRIPTION	
Type	Single-shell
Constructed	1964-1965
In service	1963-1964
Diameter	22.9 m (75 ft)
Operating depth	9.91 m (32.5 ft)
Capacity	3,785 kL (1,000 kgal
Bottom shape	Flat
Ventilation	Passive
TANK STATUS (October 1, 1998)	
Waste classification	Concentrated complexant waste
Total waste volume[1]	114 kL (30 kgal)
Supernatant volume	0 kL (0 kgal)
Saltcake volume	87.1 kL (23 kgal)
Sludge volume	26.5 kL (7 kgal)
Drainable interstitial liquid volume	0 kL (0 kgal)
Waste surface level (10/1/98)	18.07 cm (11.05 in.)
Temperature (10/1/97 to 10/1/98)	21.9 °C (71.4 °F) to 26.3 °C (79.3 °F)
Integrity	Assumed leaker
Watch List	Organic
Flammable gas facility group	3
SAMPLING DATES	
Auger samples	February 1995
Grab samples	February 1998
Vapor samples	June 1995

Table 1-2. Description of Tank 241-AX-102. (2 sheets)

SERVICE STATUS	
Declared inactive	1980
Interim stabilization	September 1988
Intrusion prevention	December 1982

Note:

[1]Not the same as Hanlon (1998); total waste volume is based on ENRAF[1] surface level measurements, tank photos and sample results. The ENRAF™ gauge was installed in September 1998.

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

2.0 RESPONSE TO TECHNICAL ISSUES

Technical issues required by Brown et al. (1997) and addressed by sampling events include:

- **Safety screening**: Does the waste pose or contribute to any recognized potential safety problems?

- **Organic complexants**: Does the possibility exist for a point source ignition in the waste followed by a propagation of the reaction in the solid/liquid phase of the waste?

- **Organic solvents**: Does an organic solvent pool exist that may cause a fire or ignition of organic solvents in entrained waste solids?

Two auger samples were taken during February 1995 to support safety screening requirements. Samples were taken in accordance with the *Tank 241-AX-102 Tank Characterization Plan* (Schreiber 1995) and are reported in Rice (1995). Vapor samples were taken in June 1995 to address vapor flammability (Clauss et al. 1995). In 1997, archive auger samples from the February 1995 sampling event were analyzed in support of the organic complexant issue. Results are reported in Esch (1998). Because archive samples were totally consumed, three grab samples were taken in February 1998 for additional organic analyses (Field 1998). Results for the grab samples are reported in Esch (1998).

Historical samples include: grab samples taken in 1980 and 1988 and sludge samples taken in 1974 and 1977.

Appendix B describes the sample events and presents analytical results.

2.1 SAFETY SCREENING

The data needed to screen the waste in tank 241-AX-102 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 below.

2.1.1 Exothermic Conditions

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to ensure that there are not sufficient exothermic constituents (organic or ferrocyanide) in tank 241-AX-102 to pose a safety hazard. The safety screening data quality objective (DQO) requires that the waste sample profile be tested for energetics every 24 cm (9.5 in.) to determine whether the energetics exceeded the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry weight basis.

For 1995 auger samples, analytical results were greater than 480 J/g (dry weight basis), indicating that some fuel content is present in the waste material of tank 241-AX-102. Because the differential scanning calorimetry (DSC) notification limit was exceeded for the tank 241-AX-102 auger samples, total organic carbon (TOC) secondary analysis was performed. Auger samples also exceeded the TOC notification limit, ranging from 4.8 to 6.4 percent (wet weight) by the persulfate method. However, the 95 percent lower confidence interval on the mean for moisture content was 19.7 percent. This moisture content minimizes the potential for a propagating reaction in the tank.

2.1.2 Flammable Gas

Headspace sample measurements were taken from riser 9E before the June 1995 vapor sample event. The concentration of flammable gas in the tank headspace was less than 0.33 percent of the lower flammability limit (LFL), below the safety limit of 25 percent of the LFL. Data for the June 1995 vapor samples are presented in Appendix B.

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/g instead of g/L, the 1 g/L limit is converted into units of μCi/g by assuming that all alpha decay originates from ^{239}Pu. The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all alpha is from ^{239}Pu for a density of 1.5 g/L, this equates to 41 μCi/g. The gross alpha results were 1.27 μCi/g and 1.21 μCi/g. The maximum 95 percent confidence limit for total alpha (dry weight) was less 1.75 μCi/g. Therefore, total alpha is not a concern for this tank. Appendix C contains the method used to calculate confidence limits.

2.2 ORGANIC COMPLEXANTS

The data required to support the organic complexants issue are documented in *Memorandum of Understanding for the Organic Complexant Safety Issue Data Requirements* (Schreiber 1997). Energetics by DSC, TOC by furnace oxidation, thermogravimetric analysis for sample moisture, and propagating reactive system screening tool (PRSST) tests were conducted to address the organic complexants issue. Verification analyses by ion chromatography (IC) and capillary zone electrophoresis (CZE) were also performed.

Because auger samples failed the TOC and DSC screening, grab samples for propagation testing were taken in 1998. Dried samples were tested with the PRSST. None of the dried samples exhibited propagating exothermic reactions. The CZE tests showed that ethylene-diamine-tetraacetic acid (EDTA) and n(2-hydroxyethyl)ethylenediaminetriacetic acid (HEDTA) were present in waste samples.

To assess the safety margin between the waste fuel concentration and the concentration required for propagation, dried waste samples were spiked with additional fuel (sodium HEDTA) and reanalyzed at zero percent moisture using the PRSST. The tests showed that additional fuel was required for the samples to propagate. The TOC dry weight of samples used for propagation tests was 4.8 percent (6.3 percent with sodium HEDTA added). As a result of propagation tests, tank 241-AX-102 is classified as "safe" for the organic complexants safety issue (Meacham et al. 1998). Additional detail on grab sample results is included in Appendix B.

The organic complexant safety issue is expected to be closed in 1999.

2.3 ORGANIC SOLVENTS SAFETY SCREENING

The data required to support the organic solvent screening issue are documented in *Data Quality Objective to Support Resolution of the Organic Solvent Safety Issue* (Meacham et al. 1997). The DQO requires that tank headspace samples be analyzed for total nonmethane organic compounds to determine whether the organic extractant pool in the tank is a hazard. The purpose of this assessment is to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur.

Vapor samples taken in June 1995 showed that the concentration of total nonmethane organic hydrocarbon in tank 241-AX-102 was 10.86 mg/m^3, with an estimated organic solvent pool size of 0.92 m^2 (Huckaby and Sklarew 1997). This is near the limit of 1 m^2. However, the Organic Program has determined that even if an organic solvent pool does exist, the consequences of a fire or ignition of organic solvents is below risk evaluation guidelines for all of the tanks (Brown et al. 1998). The organic solvent safety issue is expected to be closed in 1999.

2.4 OTHER TECHNICAL ISSUES

2.4.1 Hazardous Vapor Screening

Vapor samples were taken to address *Data Quality Objective for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995). However, hazardous vapor screening is no longer an issue because headspace vapor (sniff) tests are required for the safety screening DQO (Dukelow et al. 1995), and the toxicity issue was closed for all tanks (Hewitt 1996).

2.4.2 Tank Waste Heat Load

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load based on the sample events was not possible because radionuclide analyses were not required. However, the heat load estimate based on the tank process history was 1.33 kW (4,540 Btu/hr) (Agnew et al. 1997) and the heat load estimate based on the tank headspace temperature was 2.16 kW (7,385 Btu/hr) (Kummerer 1995). Both of these estimates are well below the limit of 11.7 kW (40,000 Btu/hr) that separates high- and low-heat-load tanks (Smith 1986).

2.5 SUMMARY

The results of all analyses performed to address potential safety issues showed that primary analyte(s) exceeded safety decision threshold limits for TOC and DSC. However, PRSST analyses concluded that the potential for a propagating reaction is low. Therefore, although tank 241-AX-102 is on the Watch List for organics, the tank is classified as safe for the organic complexants issue. Total alpha results were below notification limits.

Vapor analyses were used to address the flammable gas safety screening issue and the organic solvents issue. The concentration of flammable gas in the tank headspace was 0.3 percent of the LFL, below the notification limit of 25 percent of the LFL. The organic pool size for this tank was estimated to be 0.92 m^2. This is near the limit of 1 m^2. However, the Organic Program has determined that even if an organic solvent pool does exist, the consequences of a fire or ignition of organic solvents is below risk evaluation guidelines for all of the tanks (Brown et al. 1998). The organic solvent safety issue is expected to be closed in 1999.

Table 2-1. Summary of Technical Issues.

Issue	Sub-issue	Result
Safety screening	Energetics	Exotherms exceeded 480 J/g. Moisture content was >17 percent. Tests with PRSST showed no progagation.
	Flammable gas	Vapor measurement reported 0.33 percent of LFL.
	Criticality	All analyses below 41μCi/g total alpha. The 95percent confidence limit was 1.75 μCi/g.
Organic complexants	Safety categorization (Safe)	Results for TOC and DSC exceeded notification limits, but no propagation in PRSST tests.
Organic solvents	Solvent pool size	Organic pool size estimate 0.92 m^2, near the 1 m^2 limit.

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3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, and 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 them into a form suitable for long-term storage/disposal.

Chemical and radiological inventory information is generally derived using three approaches: 1) component inventories are estimated using the results of sample analyses, 2) component inventories are predicted using the Hanford defined waste (HDW) model based on process knowledge and historical information, or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

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

- Limited analytical results for 1998 grab sample composite and 1995 auger saltcake samples (Appendix B).
- Analytical results for 1974 data (Horton 1974) and 1977 (Starr 1977) sludge data.
- Adjusted HDW model inventory estimates (Agnew et al. 1997)
- Inventory estimates based on sample results for tanks with similar process histories.

Tables 3-1 and 3-2 list the best-basis inventory of nonradioactive and radioactive components in tank 241-AX-102 as determined from consideration of both sample results, independent assessment values, HDW model values and use of a 114 kL (30 kgal) tank waste volume.

Sampling results were chosen as the best basis for those analytes for which analytical values were available. The engineering inventory was calculated using adjusted HDW model results if

no sample based information was available. The inventory values reported in Tables 3-1 and 3-2 are subject to change. Refer to the Tank Characterization Database (LMHC 1998) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1998), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. These computer models are described in Kupfer et al. 1998, Section 6.1 and in Watrous and Wootan 1997. Model-generated values for radionuclides in any of Hanford Site's 177 tanks are reported in the Hanford defined waste (Rev. 4 model) results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result, if available.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AX-102. (Effective October 1, 1998) (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	3,260	M/E	AN tanks and adjusted HDW
Bi	21.3	M/E	AN tanks and adjusted HDW
Ca	285	S/E	AN tanks and 1974 sludge sample
Cl	124	M/E	AN tanks and adjusted HDW
TIC as CO_3	11,400	S/M	1995 and 1998 saltcake samples
Cr	143	M/E	AN tanks and adjusted HDW
F	34.2	S/M	1995 and 1998 saltcake samples and adjusted HDW
Fe	4,060	S/E	AN tanks and 1974 sludge sample
Hg	0	E	Simpson (1998)
K	178	M/E	AN tanks and adjusted HDW
La	0	E	No process history of La

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AX-102. (Effective October 1, 1998) (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Mn	370	S/E	AN tanks and 1974 sludge sample
Na	28,500	M/E	AN tanks and adjusted HDW
Ni	211	M/E	AN tanks and adjusted HDW
NO_2	5,080	S/M	1995 and 1998 saltcake samples and adjusted HDW
NO_3	34,600	S/M	1995 and 1998 saltcake samples and adjusted HDW
OH_{TOTAL}	9,150	C	Calculated from charge balance
Pb	34.7	M/E	AN tanks and adjusted HDW
PO_4	317	S/M	1995 and 1998 saltcake samples and adjusted HDW
Si	1,110	S/E	AN tanks and 1974 sludge sample
SO_4	638	S/M	1995 and 1998 saltcake samples and adjusted HDW
Sr	2.60	M/E	AN tanks and adjusted HDW
TOC	7,190	S/M	1995 and 1998 saltcake samples and adjusted HDW
U_{TOTAL}	249	S/E	AN tanks and 1974 sludge sample
Zr	72.4	M/E	AN tanks and adjusted HDW

Notes:

TIC = total inorganic carbon

[1]S = sample based. M = Hanford defined waste model (Agnew et al. 1997a). E = engineering assessment-based. and C = calculated by charge balance: includes oxides as hydroxides. not including CO_3. NO_2. NO_3. PO_4. SO_4. and SiO_3.

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994. (Effective October 1, 1998) (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	22.7	M/E	
^{14}C	3.80	M/E	
^{59}Ni	3.30	M/E	
^{60}Co	405	M/E	HDW model SMM and 1977 sludge data
^{63}Ni	341	M/E	
^{79}Se	12.0	M/E	
^{90}Sr	3.10E+05	S/E	AN tank saltcake and 1977 sludge data
^{90}Y	3.10E+05	S/E	Referenced to ^{90}Sr
^{93m}Nb	34.8	M/E	
^{93}Zr	52.3	M/E	
^{99}Tc	27.8	M/E	
^{106}Ru	1.41	M/E	
^{113m}Cd	262	M/E	
^{125}Sb	4,730	M/E	HDW model SMM and 1977 sludge data
^{126}Sn	19.0	M/E	
^{129}I	0.0536	M/E	
^{134}Cs	0.384	M/E	
^{137m}Ba	44,100	S/E	Referenced to ^{137}Cs
^{137}Cs	46,600	S/E	AN tank saltcake and 1977 sludge data
^{151}Sm	34,700	M/E	
^{152}Eu	49.9	M/E	HDW model SMM and 1977 sludge data
^{154}Eu	60.9	M/E	HDW model SMM and 1977 sludge data
^{155}Eu	1,750	M/E	
^{226}Ra	0.000533	M/E	
^{227}Ac	0.00255	M/E	
^{228}Ra	0.0248	M/E	
^{229}Th	0.000578	M/E	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994. (Effective October 1, 1998) (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{231}Pa	0.000443	M/E	
^{232}U	0.118	S/E/M	Based on 1977 data and AN tank U_{TOTAL} and HDW model isotopic ratios
^{233}U	0.451	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{234}U	0.0927	S/E/M	Based on 1977 data and AN tank U_{TOTAL} and HDW model isotopic ratios
^{235}U	0.00371	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{236}U	0.00303	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{237}Np	0.0967	M/E	
^{238}Pu	21.3	M/E	Based on 1995/1998 saltcake total alpha. 1974 total Pu and HDW model ratios.
^{238}U	0.0831	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{239}Pu	78.2	S/M/E	Based on 1995/1998 saltcake total alpha. 1977 total Pu and HDW model ratios.
^{240}Pu	58.2	S/M/E	Based on 1995/1998 saltcake total alpha. 1977 total Pu and HDW model ratios.
^{241}Am	1.330	M	
^{241}Pu	1.470	S/M/E	Based on 1995/1998 saltcake total alpha. 1977 total Pu and HDW model ratios.
^{242}Cm	1.79	M	HDW model adjusted to 114 kL volume.
^{242}Pu	0.0104	S/M/E	Based on 1995/1998 saltcake total alpha. 1977 total Pu and HDW model ratios.

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994. (Effective October 1, 1998) (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{243}Am	0.148	M	
^{243}Cm	0.218	M	
^{244}Cm	8.96	M	

Note:

[1]S = sample-based, M = Hanford defined waste model-based (Agnew et al. 1997), and E = engineering assessment-based.

4.0 RECOMMENDATIONS

The results of analyses performed to address the safety screening DQO showed that total alpha and flammable gas analyses did not exceed safety decision threshold limits. The TOC and DSC results exceeded the notification limits for energetics and the organic complexants issue. However, the moisture content in the tank is greater than 17 percent, and no propagation was observed in PRSST tests. As a result, energetics is not a problem, and the tank is classified as "safe" for the organic complexants issue. Vapor samples showed that the estimated organic pool size was near the safety limit of 1 m^2. However, the Organic Program has determined that even if an organic solvent pool does exist, the consequences of a fire or ignition of organic solvents is below risk evaluation guidelines for all of the tanks (Brown et al. 1998). The organic solvents issue is expected to be closed in 1999.

Table 4-1 summarizes the Project Hanford Management Contractor (PHMC) TWRS Program review status and acceptance of the sampling and analysis results reported in this tank characterization report. All issues required to be addressed by sampling and analysis are listed in column 1 of Table 4-1. Column 2 indicates by "yes" or "no" whether issue requirements were met by the sampling and analyses performed. Column 3 indicates concurrence and acceptance by the program in PHMC/TWRS that is responsible for the applicable issue. A "yes" in column 3 indicates that no additional sampling or analyses are needed. Conversely, "no" indicates additional sampling or analyses may be needed to satisfy issue requirements.

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

Issue	Sampling and Analyses Performed	TWRS/PHMC Program Acceptance
Safety screening DQO	Yes	Yes
Organic complexants memorandum of understanding[1]	Yes	Yes
Organic solvents DQO[1]	Yes	Yes

Note:

[1]The organic complexants and organic solvents issues are expected to be closed in 1999.

Table 4-2 summarizes the status of PHMC/TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. Column 1 lists the

different evaluations performed in this report. Column 2 shows whether issue evaluations have been completed or are in progress. Column 3 indicates concurrence and acceptance with the evaluation by the program in PHMC/TWRS that is responsible for the applicable issue. A "yes" indicates that the evaluation is completed and meets all issue requirements.

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

Issue	Evaluation Performed	TWRS/PHMC Program Acceptance
Safety screening DQO	Yes	Yes
Organic complexants memorandum of understanding[1]	Yes	Yes
Organic solvents DQO[1]	Yes	Yes

Note:

[1]The organic complexants and organic solvents issues are expected to be closed in 1999.

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-AX-102 based on historical information. For this report, historical information includes information about the fill history, waste types, surveillance, or tank modeling data. This information is necessary for providing a balanced assessment of sampling and analytical results.

This appendix contains the following information.

- **Section A1.0**: Current tank status, including the current waste levels and the tank stabilization and isolation status
- **Section A2.0**: Tank design information
- **Section A3.0**: Process knowledge about the tank, the waste transfer history, and the estimated tank contents based on modeling data
- **Section A4.0**: Surveillance data for tank 241-AX-102, including surface-level readings, temperatures, and a description of the waste surface based on photographs
- **Section A5.0**: Appendix A references

A1.0 CURRENT TANK STATUS

As of October 1, 1998, tank 241-AX-102 contained an estimated 114 kL (30 kgal) of complexant concentrate waste based on ENRAF™ tank level measurements. This differs from the Hanlon (1998) value of 148 kL (39 kgal), which was based on earlier, manual tape measurements (Section A4.1). Table A1-1 shows the volumes of the waste phases in the tank. The tank is classified as an assumed leaker and is on the Watch List for the organic issue. No unreviewed safety questions are associated with tank 241-AX-102 at this time. All tank monitoring instruments are in compliance with documented standards (Hanlon 1998).

Tank 241-AX-102 is passively ventilated and was removed from service in 1980. In 1988, the tank was declared to be an assumed leaker, with an approximate volume of 12 kL (3 kgal) estimated to have leaked from the tank.

Table A1-1. Tank Contents Status Summary.

Waste Type	kL (kgal)
Total waste[1]	114 (30)
Supernatant	0 (0)
Sludge[2]	26.5 (7)
Saltcake[1]	87.1 (23)
Drainable interstitial liquid	0 (0)
Drainable liquid remaining	0 (0)
Pumpable liquid remaining	0 (0)

Notes:

[1]Based on tank surface level measurements, October 1, 1998.

[2]Hanlon (1998)

A2.0 TANK DESIGN AND BACKGROUND

The AX Tank Farm was constructed from 1963 to 1964 in the 200 East Area of the Hanford Site. The AX Tank Farm contains four 100 series tanks. These tanks have a capacity of 3,785 kL (1,000 kgal) and a diameter of 23 m (75 ft). The 241-AX Tank Farm was designed for boiling or self-concentrating waste (for a 5- to 10- year boiling period) with a maximum fluid temperature of 121 °C (250 °F) (Leach and Stahl 1997). Because the tanks are designed specifically for boiling waste, airlift circulators were installed to control waste temperatures.

The single-shell tanks in the 241-AX Tank Farm are constructed of 30-cm (1-ft)-thick reinforced concrete with a 6.4- mm (1/4- in.) mild carbon steel liner on the bottom and sides and a 38-cm (1.25-ft)-thick domed concrete top. They have a flat bottom with a 15- cm (6- in.) radius knuckle and a 9.91-m (32.5-ft) operating depth. A grid of drain slots exists below the tank liner of each tank. There are no cascade overflow lines between the tanks in the 241-AX Tank Farm. The tanks are covered with approximately 1.83m (6 ft) of overburden (Brevick et al. 1997).

Tank 241-AX-102 went into service in 1965. Instruments access tank 241-AX-102 through risers and monitor the temperature, liquid level, sludge level, and other bulk tank characteristics. The locations of these risers are depicted in Figure A2-1, and Table A2-1 describes the risers. A diagram of single-shell tank 241-AX-102 is presented in Figure A2-2. For more information about the AX Tank Farm and single-shell tanks, refer to WHC-SD-WM-TI-648, *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

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

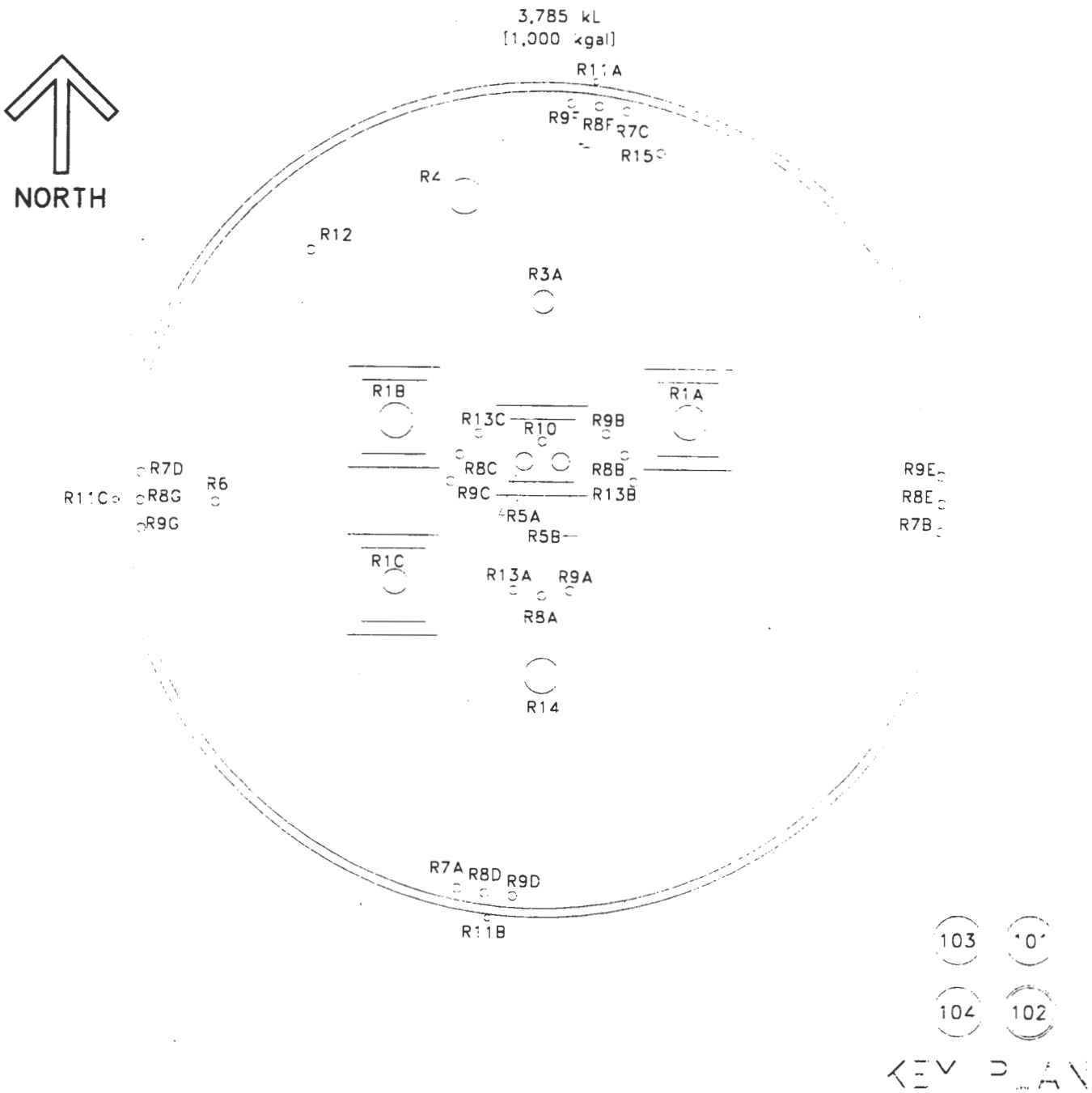


Table A2-1. Tank 241-AX-102 Risers. (2 sheets)

Number	Diameter (in.)	Description and Comments
R1A	34	Sludge sluice. weather covered
R1B	34	Pump pit. weather covered
R1C	12	Pump pit. weather covered
R3A*	16	Observation port B-222. benchmark
R4	20	Vapor outlet. below grade
R5A	12	Salt well screen. weather covered
R5B	12	Pump access. weather covered
R6	4	Tank pressure. below grade
R7A	4	Temperature probe
R7B	4	Temperature probe
R7C	4	Temperature probe. benchmark
R7D	4	Temperature probe
R8A	6	Dry well
R8B	6	Dry well
R8C	6	Dry well
R8D	6	Dry well
R8E	6	Dry well
R8F	6	Dry well
R8G	6	Dry well
R9A*	6	Sludge measurement port
R9B	6	Level indicator (Food Instrument Corporation)
R9C	6	Temperature probe
R9D	6	Liquid level reel
R9E*	6	Air filter
R9F*	6	Flange
R9G*	6	Sludge measurement port
R10	4	Distributor pit 02A drain. weather covered
R11A	7.75	Structural thermocouple. below grade
R11B	7.75	Structural thermocouple. below grade
R11C	7.75	Structural thermocouple. below grade
R12	4	Leak detection pit drain. below grade

Table A2-1. Tank 241-AX-102 Risers.[1] (2 sheets)

Number	Diameter (in.)	Description and Comments
R13A	4	Temperature probe, weather covered
R13B	4	Temperature probe, weather covered
R13C	4	Temperature probe, weather covered
R14	42	Sludge sluice
R15	4	Future condensate, below grade
N1	4	Spare
A	4	Fill line sealed in diversion box 241-AX-152
B	4	Fill line sealed in diversion box 241-AX-152
C	4	Fill line sealed in diversion box 241-AX-152

Notes:

[1]Tran (1993), Alstad (1993), WHC (1986)

* risers tentatively available for sampling (Lipnicki 1997)

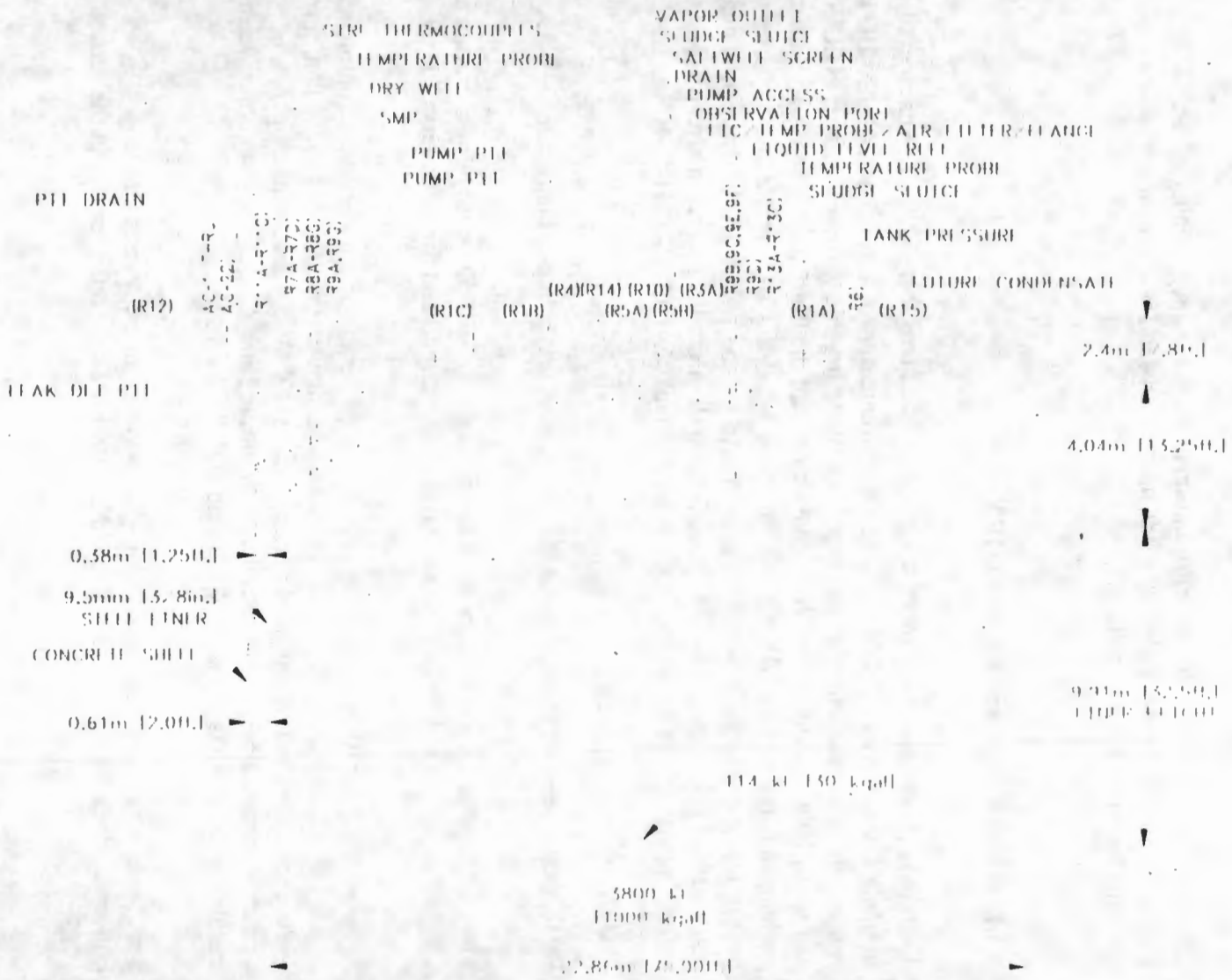


Figure A2-2. Tank 241-AX-102 Cross Section and Schematic.

A3.0 PROCESS KNOWLEDGE

The sections below: 1) provide information about the transfer history of tank 241-AX-102, 2) describe the process wastes that made up the transfers, and 3) estimate the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-AX-102 (Agnew et al. 1997b). In the last two quarters of 1965 and the first two quarters of 1966, tank 241-AX-102 received water from construction. The tank began receiving organic wash waste from PUREX in the third quarter of 1966 and continued to receive waste until the third quarter of 1967. Supernatant was exchanged between tank 241-AX-102 and tank 241-AX-101 from the fourth quarter of 1966 to the third quarter of 1967. Waste was transferred to tank 241-A-102 in the second quarter of 1967 and received from tanks 241-A-102 and 241-A-103 from the second quarter of 1967 to the second quarter of 1968. Waste was also sent to tanks 241-C-102, 241-C-105 and 241-TY-103 in 1968.

By the last quarter of 1968, most of the supernatant was pumped out of tank 241-AX-102.

The tank received B Plant waste from the first quarter of 1969 through the third quarter of 1975. The tank received some PUREX waste during the second and third quarters of 1969.

Between 1971 and 1976, numerous tank-to-tank supernatant transfers were completed. From 1976 to 1977, tank 241-AX-102 was sluiced and the waste was routed to B Plant. From 1977 to 1980, tank 241-AX-102 was used in conjunction with 242-A Evaporator operations primarily as a dilute complex receiver and complex concentrate storage tank, and evaporator waste was transferred between tank 241-AX-102 and tank 241-A-102.

Small waste transfers from tank 241-C-105 occurred in the second quarter of 1979 and a salt well liquor transfer was made to tank 241-AN-101 during salt well pumping in the second quarter of 1983.

Currently, the tank waste is classified as concentrated complexant waste. The tank was declared inactive in 1980, and intrusion prevention was completed in 1982. In 1988, the tank was declared an assumed leaker, with a volume of 12 kL (3 kgal) estimated to have leaked from the tank. The tank declared interim stabilized in September 1988.

Table A3-1 presents an estimate of the total volumes of the specific waste types that were added to the tank.

Table A3-1. Tank 241-AX-102 Major Transfers.[1] (2 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[2]	
				kL	kgal
Miscellaneous		Water	1965	1.374	363
PUREX		OWW	1966-1967	1.858	491
241-AX-101		Supernatant	1966-1967	2.854	754
	241-AX-101	Supernatant	1967	5.110	1.350
	241-A-102	Supernatant	1967	469	124
241-A-03/ 241-A-102		Supernatant	1967-1968	6.742	2.019
	C-102	Supernatant	1968	95	25
	241-C-105	Supernatant	1968-1969	6.518	1.722
	241-TY-103	Supernatant	1968	2.067	546
B Plant		B	1969-1975	16.646	4.398
PUREX		PL	1969	295	78
	241-A-106	Supernatant	1969-1973	3.233	12.237
244-AR Vault		Supernatant	1971	129	34
	241-AX-103	Supernatant	1973-1975	3.743	989
241-A-104		Supernatant	1974	178	47
241-AX-103		Supernatant	1974-1976	2.597	686
	241-AX-101	Supernatant	1975	526	139
	241-C-105	SRR	1975-1976	155	41

Table A3-1. Tank 241-AX-102 Major Transfers.[1] (2 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume[2]	
				kL	kgal
241-A-102		Evaporator waste	1977-1980	9,962	2,082
	241-A-102	Evaporator waste, residual	1976-1980	10,628	2,808
	241-AZ-102	Supernatant	1978	79.5	21
241-C-105		Supernatant	1979	238	63
	241-AN-101	Salt well liquor	1983	56.8	15

Notes:

B = B Plant high-level waste from cesium/strontium recovery process at B Plant
OWW = Organic wash waste
PL = Low-level waste from the PUREX process
PUREX = Plutonium-Uranium extraction (Facility)
SRR = Stronium Recover Waste

[1]Agnew et al (1997b)

[2]Because only major transfers are listed, the sum of these transfers will not equal the current 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: WSTRS, Rev. 4*, (Agnew et al. 1997b) is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4* (Agnew et al. 1997a) contains the Hanford defined waste (HDW) list, the supernatant mixing model (SMM), the tank layer model (TLM), and the historical tank content estimate (HTCE).

- The HDW list is comprised of approximately 50 waste types defined by concentration for major analytes compounds for sludge and supernatant layers.

- The TLM defines the solid layers in each tank using waste composition and waste transfer information.

- The SMM is a subroutine within the HDW-model that calculates the volume and composition of certain supernatant blends and concentrates.

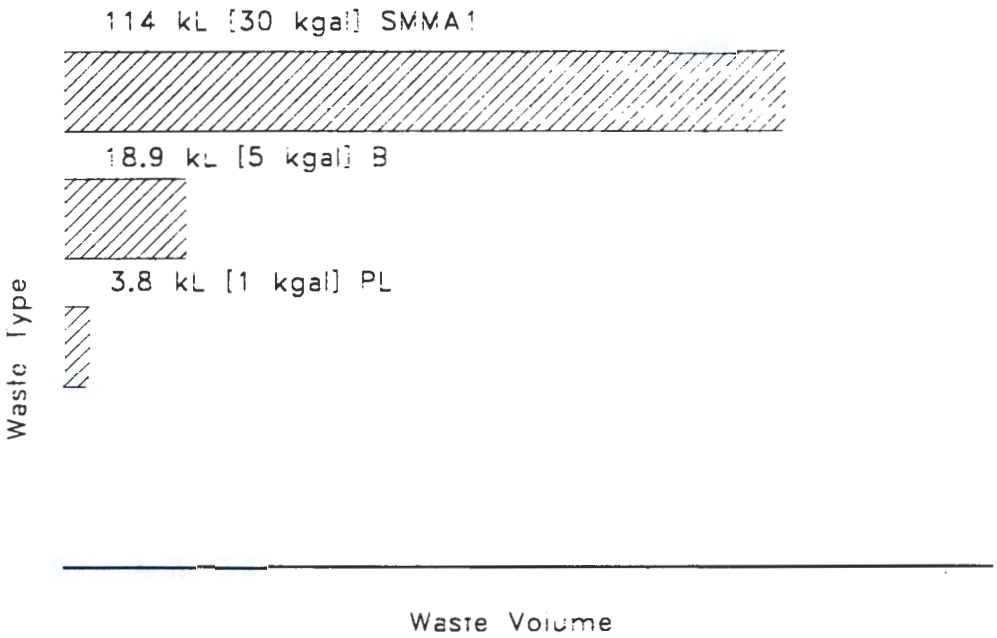
Using these records, the TLM defines the solid layers in each tank. The SMM uses information from the WSTRS, the TLM, and the HDW list to describe the supernatants and concentrates in each tank. Together the WSTRS, TLM, SMM, and HDW list determine the inventory estimate for each tank. These model predictions are considered estimates that require further evaluation using analytical data.

Based on Agnew et al. (1997a), tank 241-AX-102 contains 3 k gal of supernatant, 30 kgal of Supernatant Mixing Model Saltcake from the 242-A-Evaporator (SMMA 1), 5 kgal of B Plant high level (B) waste and 1 kgal of PUREX low level (PL) waste. Figure A3-1 is a graphical representation of the estimated waste type and volume for the tank layer. The historical tank content estimate model predicts that the SMMA1 saltcake layer contains greater than 1 weight percent of sodium, nitrate, nitrite, and hydroxide, and between 1 and 0.1 weight percent of aluminum, carbonate, phosphate, sulfate, chloride, HEDTA and glycolate. Cesium and strontium are predicted to be the primary radionuclides present.

The B and PL layers contain greater than one weight percent of sodium, aluminum, iron, hydroxide, nitrate carbonate and silicate. The B and PL layers are distinguished from the SMMA1 layer by higher levels of iron and silicate. No organic material expected to be present. The B and PL wastes also contain higher levels of strontium and total alpha radioactivity, and less cesium.

Table A3-2 shows the historical estimate of the expected waste constituents and their concentrations.

Figure A3-1. Tank Layer Model.



Note: The TLM value for SMMA1 differs from the current tank volume of 87.1 kL (23 kgal).

Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Physical Properties				**-95 CI**	**+95 CI**
Total waste	2.29E+05 (kg)	(39.0 kgal)	----	----	----
Heat load	1.33 (kW)	(4.54E+03 Btu/hr)	----	0.272	1.73
Bulk density[3]	1.55 (g/cc)	----	----	1.51	1.59
Water wt%[3]	38.1	----	----	36.2	40.3
TOC wt% C (wet)[3]	0.983	----	----	0.583	1.38
Chemical Constituents	***M***	**Ppm**	**Kg[4]**	**-95 CI (*M*)**	**+95 CI (*M*)**
Na^{+}	12.2	1.81E+05	4.15E+04	11.5	13.1
Al^{3+}	1.61	2.79E+04	6.39E+03	1.44	1.68
Fe^{3+} (total Fe)	0.211	7.59E+03	1.74E+03	8.30E-02	0.235
Cr^{3+}	0.111	3.72E+03	852	9.57E-02	0.119
Bi^{3+}	1.06E-03	142	32.6	9.88E-04	1.13E-03
La^{3+}	2.20E-05	1.97	0.452	1.61E-05	2.80E-05
Hg^{2+}	8.09E-06	1.05	0.239	7.72E-06	8.33E-06
Zr (as $ZrO(OH)_2$)	1.55E-04	9.08	2.08	1.42E-04	1.67E-04
Pb^{2+}	1.04E-03	138	31.7	8.56E-04	1.22E-03
Ni^{2+}	1.28E-02	483	111	7.35E-03	3.40E-02
Sr^{2+}	0	0	0	0	0
Mn^{4+}	3.68E-03	130	29.8	3.07E-03	4.29E-03
Ca^{2+}	6.52E-02	1.68E+03	386	3.65E-02	0.171
K^{+}	5.59E-02	1.41E+03	323	5.04E-02	6.47E-02
OH^{-}	9.45	1.04E+05	2.37E+04	8.65	9.84
NO_3^{-}	4.00	1.60E+05	3.66E+04	3.78	4.13
NO_2^{-}	2.14	6.35E+04	1.45E+04	1.85	2.41
CO_3^{2-}	0.447	1.73E+04	3.96E+03	0.414	0.553
PO_4^{3-}	7.84E-02	4.80E+03	1.10E+03	7.09E-02	8.61E-02
SO_4^{2-}	0.232	1.44E+04	3.29E+03	0.198	0.266
Si (as SiO_3^{2-})	0.223	4.04E+03	925	6.47E-02	0.650
F-	5.56E-02	681	156	4.96E-02	6.51E-02
Cl-	0.205	4.68E+03	1.07E+03	0.185	0.218

Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Chemical Constituents (Cont'd)	***M***	**Ppm**	**Kg[4]**	**-95 CI (*M*)**	**+95 CI (*M*)**
$C_6H_5O_7^{3-}$	2.78E-02	3.38E+03	775	2.59E-02	3.05E-02
$EDTA^{4-}$	2.28E-02	4.24E+03	971	7.45E-03	3.85E-02
$HEDTA^{3-}$	4.10E-02	7.24E+03	1.66E+03	1.02E-02	7.23E-02
$Glycolate^{-}$	9.43E-02	4.56E+03	1.04E+03	6.35E-02	0.126
$Acetate^{-}$	1.50E-02	571	131	1.22E-02	1.94E-02
$Oxalate^{2-}$	2.89E-05	1.64	0.375	2.57E-05	3.21E-05
DBP	2.06E-02	2.80E+03	640	1.80E-02	2.46E-02
Butanol	2.06E-02	986	226	1.80E-02	2.46E-02
NH^3	6.50E-02	712	163	5.51E-02	8.15E-02
$Fe(CN)_6^{4-}$	0	0	0	0	0
Radiological Constituents	**Ci/L**	**µCi/g**	**Ci[5]**	**-95 CI (Ci/L)**	**+95 CI (Ci/L)**
^{3}H	2.19E-04	0.141	32.4	1.41E-04	2.46E-04
^{14}C	3.45E-05	2.23E-02	5.10	1.82E-05	3.59E-05
^{59}Ni	1.06E-05	6.84E-03	1.57	1.83E-06	4.51E-05
^{63}Ni	1.09E-03	0.704	161	1.79E-04	4.67E-03
^{60}Co	4.48E-05	2.89E-02	6.61	2.61E-05	3.16E-04
^{79}Se	3.58E-05	2.31E-02	5.29	3.20E-06	7.18E-05
^{90}Sr	1.16	749	1.72E+05	0.101	1.56
^{90}Y	1.16	750	1.72E+05	0.101	1.56
^{93}Zr	1.58E-04	0.102	23.3	1.58E-05	3.38E-04
^{93m}Nb	1.06E-04	6.83E-02	15.6	1.13E-05	2.32E-04
^{99}Tc	2.55E-04	0.165	37.7	1.94E-04	3.17E-04
^{106}Ru	3.96E-06	2.55E-03	0.585	3.20E-06	4.05E-06
^{113m}Cd	7.95E-04	0.513	117	8.54E-05	1.87E-03
^{125}Sb	2.09E-04	0.134	30.8	1.28E-04	2.29E-04
^{126}Sn	5.65E-05	3.64E-02	8.35	4.84E-06	1.11E-04
^{129}I	4.93E-07	3.18E-04	7.28E-02	3.75E-07	6.13E-07
^{134}Cs	3.41E-06	2.20E-03	0.504	2.25E-06	4.60E-06
^{137}Cs	0.252	163	3.73E+04	0.230	0.278

Table A3-2. Historical Tank Inventory Estimate.[2] (4 sheets)

Radiological Constituents (Cont'd)	Ci/L	µCi/g	Ci[5]	-95 CI (Ci/L)	+95 CI (Ci/L)
^{137m}Ba	0.239	154	3.52E+04	0.203	0.260
^{151}Sm	0.105	67.9	1.55E+04	1.12E-02	0.231
^{152}Eu	1.43E-04	9.19E-02	21.1	1.41E-04	1.43E-04
^{154}Eu	1.12E-02	7.23	1.66E+03	6.24E-04	2.02E-02
^{155}Eu	6.95E-03	4.48	1.03E+03	6.87E-03	7.00E-03
^{226}Ra	1.58E-09	1.02E-06	2.34E-04	1.27E-10	2.70E-09
^{228}Ra	2.57E-07	1.66E-04	3.79E-02	9.51E-08	3.27E-07
^{227}Ac	7.70E-09	4.96E-06	1.14E-03	7.88E-10	1.42E-08
^{231}Pa	4.00E-09	2.58E-06	5.91E-04	2.96E-09	4.00E-08
^{229}Th	5.98E-09	3.85E-06	8.82E-04	2.24E-09	7.51E-09
^{232}Th	2.62E-08	1.69E-05	3.86E-03	6.15E-09	3.69E-08
^{232}U	8.51E-07	5.48E-04	0.126	6.22E-07	1.13E-06
^{233}U	3.26E-06	2.10E-03	0.482	2.38E-06	4.34E-06
^{234}U	6.71E-07	4.32E-04	9.90E-02	6.49E-07	6.88E-07
^{235}U	2.68E-08	1.73E-05	3.96E-03	2.59E-08	2.75E-08
^{236}U	2.19E-08	1.41E-05	3.23E-03	2.09E-08	2.25E-08
^{238}U	8.62E-07	5.55E-04	0.127	8.42E-07	8.87E-07
^{237}Np	8.99E-07	5.79E-04	0.133	7.00E-07	1.10E-06
^{238}Pu	4.11E-04	0.265	60.7	2.23E-04	4.33E-04
^{239}Pu	2.81E-03	1.81	415	1.54E-03	2.96E-03
^{240}Pu	1.00E-03	0.647	148	5.47E-04	1.06E-03
^{241}Pu	2.84E-02	18.3	4.20E+03	1.54E-02	3.00E-02
^{242}Pu	2.06E-07	1.32E-04	3.03E-02	1.12E-07	2.17E-07
^{241}Am	9.02E-03	5.81	1.33E+03	4.44E-03	9.56E-03
^{243}Am	1.00E-06	6.48E-04	0.148	4.93E-07	1.07E-06
^{242}Cm	1.21E-05	7.80E-03	1.79	1.20E-05	1.21E-05
^{243}Cm	1.48E-06	9.52E-04	0.218	1.47E-06	1.48E-06
^{244}Cm	6.07E-05	3.91E-02	8.96	4.54E-05	6.25E-05

Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Totals	M	µg/g	Kg	-95 CI (*M*)	+95 CI (*M*)
Pu	4.98E-02 (g/L)	----	7.35	2.72E-02	5.24E-02
U	7.57E-03	1.16E+03	266	7.31E-03	7.77E-03

Notes:

CI = confidence interval

SRR = Stronium Recovery Waste

Wt% = weight percent

[1]Agnew et al. (1997a)

[2]These predictions have not been validated and should be used with caution.

This is the volume average for density, mass average water weight percent, and TOC weight percent carbon.

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

[5]Differences exist among the inventories in this column and the inventories calculated from the two sets of concentrations.

A4.0 SURVEILLANCE DATA

Tank 241-AX-102 surveillance consists of surface-level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and leak detection well (dry well) monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity. Liquid-level measurements can indicate whether the tank has a major leak. Solid surface-level measurements can indicate physical changes in and consistencies of the solid layers of a tank. Dry wells located around the tank perimeter may show increased radioactivity caused by leaks.

A4.1 SURFACE-LEVEL READINGS

To determine the surface level of the waste, tank 241-AX-102 was equipped only with a manual tape until September 1998. Measurements of the surface level were made on a quarterly basis through riser 9D. Liquid waste volume was determined by a manual tape, solid waste volume was determined by a photographic evaluation and a sludge-level measurement device.

Using a metal tape, surface level measurements varied widely (38 cm [15 in.] to 23 cm [9 in.] between January 1990 and January 1995, see Figure A4-1). The variation in surface level measurements may be attributed to the tape contacting a small pipe or metal coil. Surface level measurements were steady at 24.1 cm (9.5 in.) from January 1995 to September 1998.

An ENRAF™ gauge was installed in the tank in September 1998. ENRAF™ measurements have been steady at 28.1 cm (11.05 in). Figures A4-1 and A4-2 show the surface level history from 1965 to the present. The surface level of the waste measured on October 1, 1998 was 28.1 cm (11.05 in.). This equates to a volume of 114 kL (30 kgal), and is the volume that was used for best-basis inventory estimates.

No liquid observation well is available for establishing the interstitial liquid level in the solids of tank 241-AX-102.

Eleven dry wells are associated with tank 241-AX-102. In 1975, one dry well was capped because it interfered with construction. A review of historical data from the remaining ten dry wells shows no apparent increase in activity, although one well has some anomalous readings. Tank 241-AX-102 also has a leak detection pit. This was one of the first leak detection pits used at the Hanford Site. Problems of false leak indications and erratic data have been noted since its construction. Assessment of tank integrity based on the available historic leak detection pit and dry well data for tank 241-AX-102 is inconclusive.

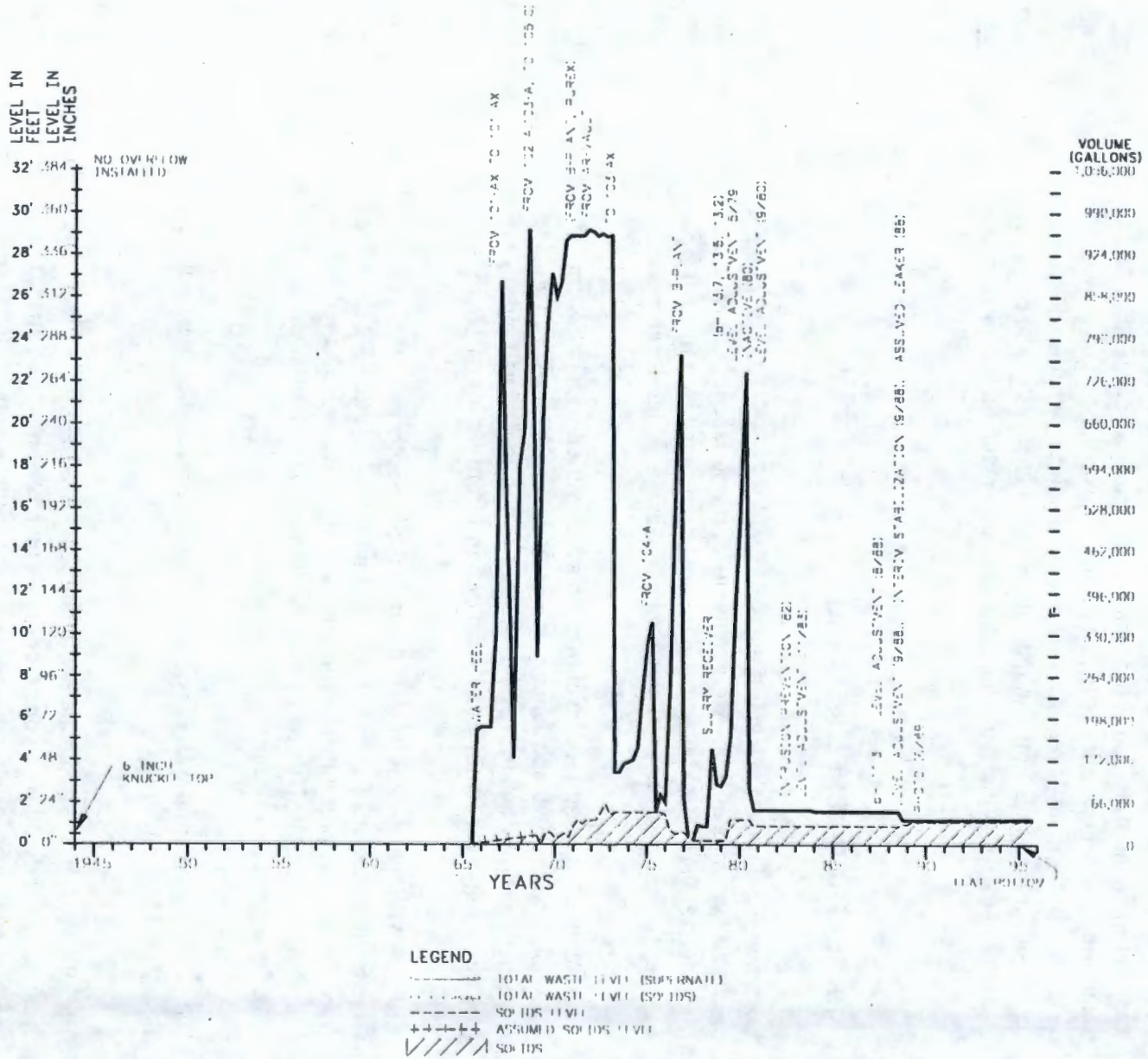
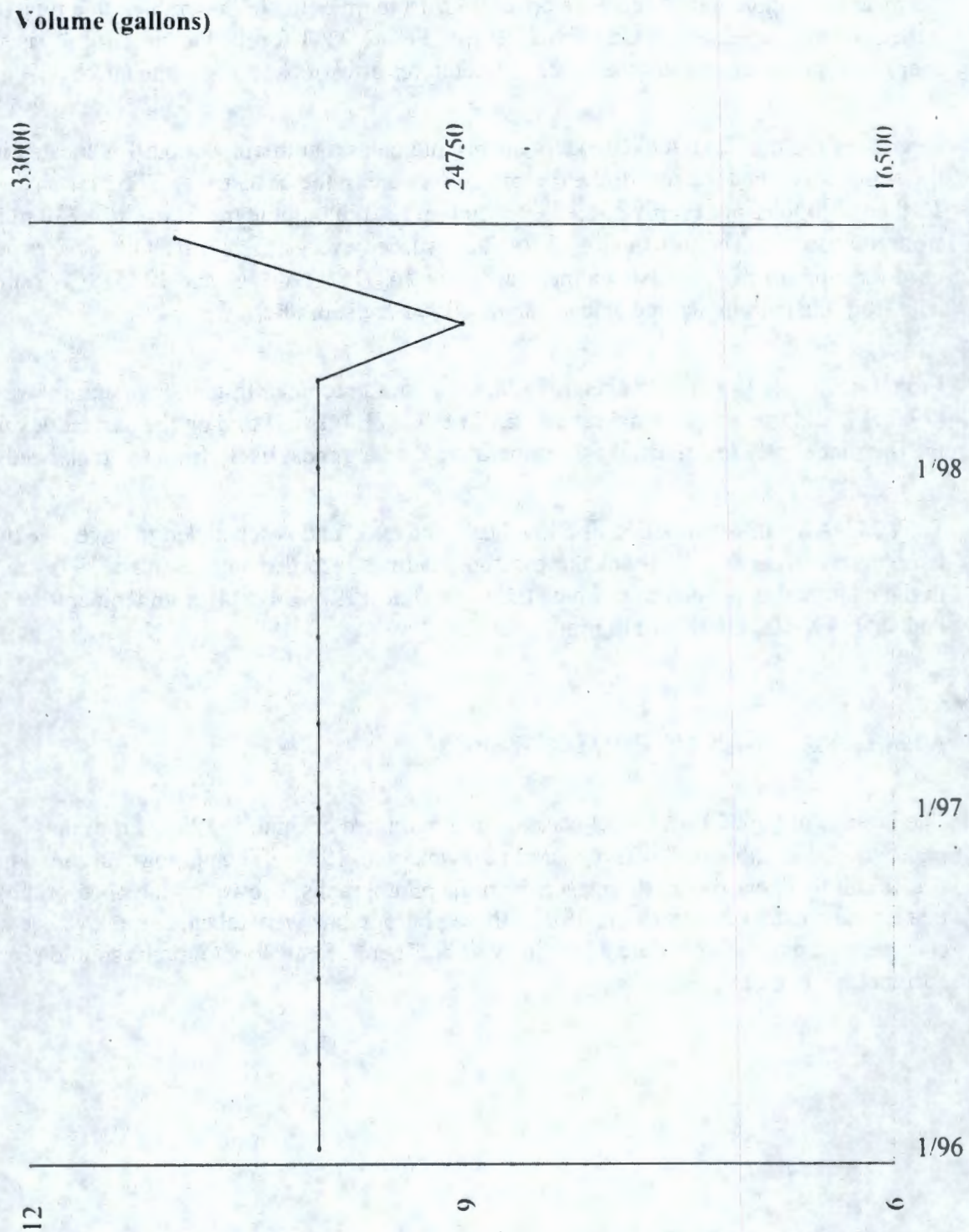


Figure A4-1. Tank 241-AX-102 Surface Level History.

Figure A4-2. Tank 241-AX-102 Current Surface Level Measurements.



A4.2 INTERNAL TANK TEMPERATURES

To measure in-tank temperatures, a probe with 18 thermocouples assembled in a pipe (termed a thermocouple tree) is located in riser 9C (see Figure A2-1 for the location of this riser). The thermocouple tree monitors the waste temperatures at various levels in the tank.

Review of the tank 241-AX-102 level history indicates that thermocouple 1 is located in or near the solids level, and the rest of the thermocouples are in the headspace. The first 12 thermocouples are evenly spaced every 0.6 m (2 ft) along the tree starting at 330 mm (13 in.) from the bottom. Thermocouples 13 to 18 are spaced every 1.2 m (4 ft). Other risers previously used for monitoring the waste temperature were 7A-7D, 11A-11C, and 13A-13C. Temperature data from the tank in-service date to January 1991 are sporadic.

From October 1, 1997 to October 1, 1998, the highest recorded in-tank temperature was 26.3 °C (79.3 °F), and the lowest temperature was 21.9 °C (71.4 °F). Based on the surface-level data and the thermocouple elevations, these temperature data are most likely from the tank headspace.

Tank 241-AX-102 is classified as a low heat-load tank, and is scheduled to have weekly in-tank temperature data taken.[2] In-tank temperature readings recorded since January 1975 are available in the historical tank content estimate (Brevick et al. 1997). Weekly high temperature plots for tank 241-AX-102 are shown in Figure A4-3.

A4.3 TANK 241-AX-102 PHOTOGRAPHS

The interior of tank 241-AX-102 was last photographed on June 5, 1989. From these photographs, a "montage" was prepared (Brevick et al. 1997). The photographs are dark, and it is difficult to assess the waste surface from the photographs. However, the photographs indicate that no supernatant is in the tank. Since these photographs were taken, there have been no changes in the tank that would affect the waste. Therefore, the photographs should represent the current tank contents.

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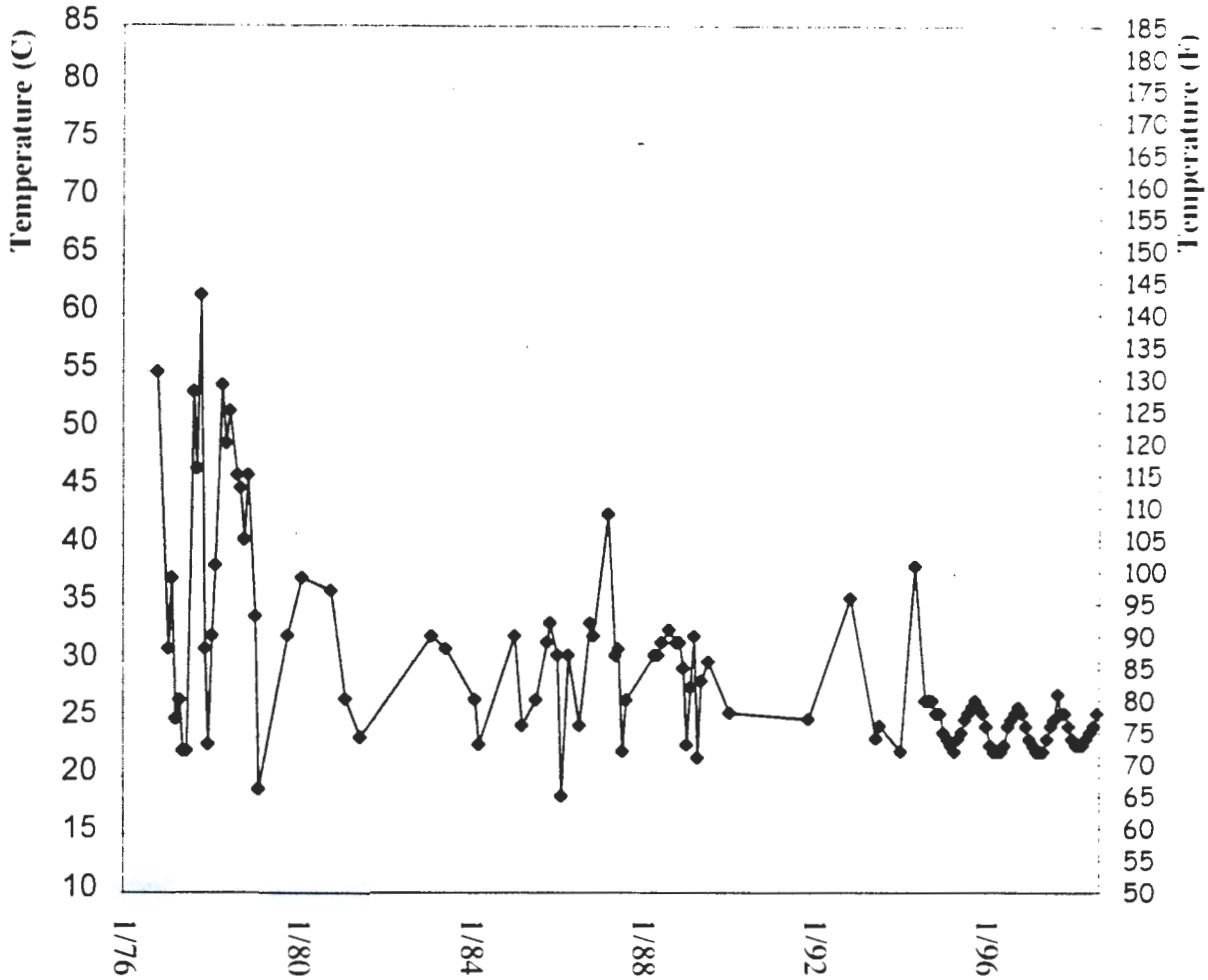
[2]Normally, low heat-load tanks are scheduled for semiannual temperature monitoring in January and July. However, because tank 241-AX-102 is an Organic Watch List tank, the in-tank temperature is monitored weekly.

Figure A4-3. Tank 241-AX-102 High Temperature Plot.



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APPENDIX B

SAMPLING OF TANK 241-AX-102

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APPENDIX B
SAMPLING OF TANK 241-AX-102

Appendix B provides sampling and analysis information for each known sampling event for tank 241-AX-102 and assesses sample results. It includes the following information.

- **Section B1.0**: Tank Sampling Overview
- **Section B2.0**: Sampling Events
- **Section B3.0**: Assessment of Characterization Results
- **Section B4.0**: Appendix B References

B1.0 TANK SAMPLING OVERVIEW

Sampling of tank 241-AX-102 includes: grab sampling performed in 1998, auger sampling performed in 1995, vapor sampling performed in 1995, liquid grab sampling performed in 1988 and 1980, and sludge sampling performed in 1974 and 1977.

The 1998 grab samples were obtained in support of the organic complexants issue (Schreiber 1997b). The 1995 auger and vapor samples satisfy requirements of *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), the organic solvents DQO (Meacham et al. 1997), and partial requirements for the organic complexants issue (Schreiber 1997b). The requirement of obtaining two vertical profiles was satisfied by the 1995 auger sampling event. The other six sampling events are useful from a historic perspective, and 1974 and 1977 grab sample data were used to estimate the best-basis sludge inventory. No attempt to assess DQOs was made using the historical data. For discussions of the sampling and analysis procedures, refer to *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

B2.0 SAMPLING EVENTS

This section describes sampling events. Tables B2-10 through B2-61 show analytical results. Table B2-1 summarizes the sampling and analytical requirements for applicable issues.

Table B2-1. Integrated Data Quality Objective Requirements for Tank 241-AX-102.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Auger sample	Safety screening - Energetics - Moisture content - Total alpha - Flammable gas Dukelow et al. (1995) Organic complexants[2] Schreiber (1997b)	Core samples from a minimum of two risers separated radically to the maximum extent possible. Combustible gas measurement	Flammability, energetics, moisture, total alpha activity, density, anions, cations, radionuclides, TOC, separable organics, physical properties
Grab sampling[2]	Organic complexants Schreiber (1997b)	Grab samples	Energetics, moisture, PRSST, TOC, CZE
Vapor sampling	Organic solvents Meacham et al. (1997)	Steel canisters, triple sorbent traps, sorbent trap systems	Flammable gas, organic vapors, permanent gases

Notes:

[1]Brown et al. (1997)

[2]Archive auger samples were used to address this issue. Grab samples were required to provide enough material for PRSST and CZE tests.

B2.1 1998 GRAB SAMPLING EVENT

B2.1.1 1998 Grab Sample Handling

Three surface finger trap grab samples were collected from riser 9G of tank 241-AX-102 on February 11, 1998. This is a special sampler, previously used for C-201, C-202 samples. It was designed as a type of "scoop" to obtain solids samples where the sample depth is minimal, waste is dry and/or samples are otherwise difficult to obtain. The three samples were composited, subsampled and analyzed in accordance with *Tank 241-AX-102 Grab Sampling and Analysis Plan* (Field 1998). Samples were analyzed at the 222-S Laboratory. Before subsampling, the composite sample was blended with a mechanical blade homogenizer in an attempt to break up all of the large chunks of material.

B2.1.2 1998 Grab Sample Analysis

The homogenized composite sample was split into three portions for PRSST testing, equilibrium moisture studies using CZE, and archive material. Table B2-2 contains sample receipt and appearance information. The grab samples were dried before testing, and some of the dried samples were spiked using Na_3HEDTA to increase the TOC concentration to 5 or 6 percent. Tests were also performed on non-dried subsamples to compare TOC, moisture and exothermic energy of the grab samples with 1995 auger sample results.

A water digest of the solids was performed for the IC, CZE, and furnace oxidation TOC analyses. The DSC, themogravimetric analysis (TGA) and persulfate oxidation TOC analyses were performed directly on the solids. The primary anions of interest were nitrite and nitrate. All other anions and total inorganic (TIC) analyses were considered opportunistic.

Table B2-3 lists the approved analytical procedures used for reported analyses for the 1998 grab samples and the 1995 auger samples. Table B2-4 summarizes the 1998 grab sample sample portions, sample numbers, and analyses performed on each sample.

Table B2-2. Receipt and Appearance Information for Tank 241-AX-102 Grab Samples.[1]

Sample Number	Date Received	Sampling Depth (in.)	% Settled Solids	Sample Description
102AX-98-1	2/11/98	642	100	Bottle 3/4 full. Crumbly, moist, dark brown solids; no organic layer.
102AX-98-2	2/11/98	642	100	Bottle full. Crumbly, moist dark brown solids at bottom of jar. Dark brown solids at top were more moist with consistency of soft mud; no organic layer.
102AX-98-3	2/11/98	642	100	Bottle 2/3 full. Crumbly, slightly moist, dark brown solids; no organic layer.

Note:

[1]Esch (1998a). Sample depth is measured from the top of the riser to the mouth of the sample bottle.

Table B2-3. Analytical Procedures.[1,2]

Analysis	Method	Procedure Number
Energetics	DSC	LA-514-114
Percent water	TGA	LA-514-114
Total alpha activity	Alpha proportional counter	LA-508-101
Bulk density	Direct	LO-160-103
EDTA, HEDTA	CZE	LA-533-113
Cyanide	Cyanide by Speciation	LA-695-102
Anions and organic acids	IC	LA-533-115 (organic acids) LA-533-105 (anions)
Total organic carbon	Furnace oxidation	LA-344-105
TOC/TIC	Persulfate	LA-342-100
PRSST	PRSST	LT-510-103
OH	Water digestion hydroxide	LA-211-102

Notes:

[1]Esch (1998a)

[2]Rice (1995)

Table B2-4. Tank 241-AX-102 Sample Analysis Summary.

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
9G	102AX-98-1	Composite dried	S98T000738	TIC/TOC, DSC/TGA
	102AX-98-2		S98T000739	IC, Furnace oxidation, CZE
	102AX-98-3		S98T000896	TIC/TOC, DSC/TGA
			S98T000897	IC, Furnace oxidation, CZE
			S98T001093	IC, CZE
		Composite dried, 6% spike	S98T001160	TIC/TOC, DSC/TGA
			S98T001161	Furnace oxidation
		Composite dried, 5% spike	S98T001185	TIC/TOC, DSC/TGA
			S98T001222	TIC/TOC, DSC/TGA
			S98T001223	Furnace oxidation
			S98T001224	Furnace oxidation
		Composite "as-is"	S98T001315	TIC/TOC, DSC/TGA
			S98T001316	IC, CZE

B2.1.3 1998 Grab Sample Analytical Results

The 1998 grab samples were obtained primarily for PRSST and CZE tests. Analyses for DSC/TGA and TIC/TOC were also performed. Except as noted in Table B2-4, samples were dried before the analysis. Some samples were also spiked with Na_3HEDTA to increase the TOC to 5 or 6 percent. Propagation occurred only in the sample spiked to 6 percent. Spiked sample results are not included in the data tables in this tank characterization report , but are available in Bechtold and Beck (1998). Table B2-5 lists analytical tables for percent water, energetics, and IC analytical results associated with this tank. These results are documented in Esch (1998). Tests by PRSST showed that there was no propogation in the samples or the spiked samples.

Table B2-5. Analytical Tables.

Analysis	Table Number
IC	B2-10 to 23
CZE	B2-24,25
Energetics by DSC	B2-26
Percent water by TGA	B2-27
TOC by furnace oxidation	B2-28
TIC	B2-29
TOC by persulfate	B2-30

The quality control (QC) parameters assessed in conjunction with tank 241-AX-102 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. The QC criteria are specified in the sampling and analysis plan (Field 1998). Sample and duplicate pairs, in which any QC parameter was outside these limits, are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, e, or f as follows.

- "a" indicates 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.
- "f" indicates blank contamination.

In the analytical tables in this section, the "mean" is the average of the result and duplicate value. All values, including those below the detection level (denoted by "<") were averaged. If both sample and duplicate values were nondetected, or if one value was detected while the other was not, the mean is expressed as a nondetected value. If both values were detected, the mean is expressed as a detected value.

B2.1.3.1 Thermogravimetric Analysis (TGA). The first transition in each sample began at the lower temperature limit of the analysis (30 °C [86 °F]) and was complete at approximately 120 °C (248 °F). In this region, the observed decreases in weight are mainly due to the loss of bulk and interstitial water in the samples. The second transition occurred between 200 and

490 °C (392 and 914 °F). The phenomena demonstrated in this region could be attributed to the loss of covalently bound water molecules or the dehydration of compounds such as aluminum hydroxide.

Sample results ranged from 22.53 to 37.24 percent for air dried samples and from 36.70 to 44.58 percent for "as-is" samples.

B2.1.3.2 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the sample is heated at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically. Exothermic behavior was noted in all of the DSC analyses conducted. Wet weight results ranged from 378 to 607 J/g for dried samples and from 148 to 168 J/g for "as-is" samples.

B2.1.3.3 Total Organic Carbon. Both the persulfate oxidation and furnace oxidation methods were used to determine TOC content on dried samples. Only persulfate oxidation was performed on the "as-is" sample. Total organic carbon results for dry non-spiked samples ranged from 42,900 to 51,700 μg C/g using the furnace oxidation method and from 24,200 to 53,200 μg C/g for the persulfate method. TOC results for the "as-is" sample ranged from 48,600 to 55,300 μg C/g.

B2.1.3.4 Anions. Ion chromatography analysis was performed on all samples to quantitate inorganic anions and acetate, glycolate, formate, oxalate, citrate, nitrilotriacetate , and iminodiacetate . The organic acid results are reported as free-base (anionic) concentrations. Primary anions of interest were nitrite and nitrate. All others are considered opportunistic. No correlations were observed between results for dried samples and "as-is" samples.

B2.1.3.5 Capillary Zone Electrophoresis (CZE). Capillary zone electrophoresis was performed for EDTA and HEDTA analyses. Samples were analyzed in duplicate. Both HEDTA and EDTA were detected in the "as-is" and partially dried samples at approximately five times the detection limit. Only EDTA was detected in the dried samples. The absence of HEDTA may be attributed to drying or may be the result of sample variability.

B2.1.3.6 Propagating Reactive System Screening Tool. Tests were conducted on March 10, 1998. All samples were dried prior to analysis. Test results showed that none of the samples propagated. Propagation occurred only in the sample spiked to 6 weight percent TOC (Bechtold and Beck 1998).

B2.2 1995 AUGER SAMPLE EVENT

In February 1995, two auger samples were obtained from tank 241-AX-102 (sample 95-AUG-006 from riser 3A and sample 95-AUG-007 from riser 9E), in accordance with the tank characterization plan (Schreiber 1995). Each auger sample obtained from tank 241-AX-102 had 9 flutes; flute 1 is defined as beginning at the auger shaft, and flute 9 is defined as ending at the auger tip. Table B2-6 describes the samples recovered (Rice 1995).

B2.2.1 1995 Auger Sample Handling

The samples were extruded and analyzed at the 222-S Laboratory. Less material was recovered from riser 3A than from riser 9E. Because of a "coiled up wire on the auger stem," it was "difficult to remove the sleeve" from the riser 9E auger sample (Rice 1995).

Refer to Table B2-6 for information about extrusion dates and masses recovered for each sample.

Little drainable liquid was present in either sample. Most likely much of the liquid drained back into the tank as the auger was lifted from the waste surface to the riser flange.

In 1997, additional analyses were determined to be needed for the organic complexants issue. As a result, archive material from the 1995 auger sample was used to conduct additional tests (Schreiber 1997a). However, because the amount of archive material was insufficient, grab samples were needed for PRSST tests (Section 2.1).

Table B2-6. Tank 241-AX-102 Subsampling Scheme and Sample Description.[1]

Sample Number	Riser Number	Date Extruded	Sample Mass (g)	Sample Description
95-AUG-006	3A	3/1/95	1.97	Dark brown solids distributed as a thin layer or film. No drainable liquid.
95-AUG-007	9E	3/1/95	34.5	Dark brown solids distributed as a thin layer or film.
			2	Drainable liquid

Note:

Rice (1995)

B2.2.2 Sample Analysis

Radionuclide analyses were conducted using fused sludge samples dissolved in acid. The fusions were performed in nickel crucibles with potassium hydroxide. The DSC and TGA analyses were performed on small (5 to 20 mg) quantities of the solid waste. Because of the small sample size, the reproducibility of the results was affected by the sample heterogeneity.

Table B2-3 lists the approved analytical procedures used for reported analyses. Table B2-7 summarizes the sample portions, sample numbers, and analyses performed on each sample. Additional information on analytical methods can be obtained from *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

Table B2-7. Tank 241-AX-102 Sample Analysis Summary.

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
3A	95AUG006	Whole	S95T000203	TIC/TOC, TGA, DSC
			S95T000204	Alpha
9E	95AUG007	Whole	S95T000206	TIC/TOC, TGA, Speciation (CN), DSC
			S95T000208	Alpha
			S95T000593	OH, IC
			S97T001244	IC, Furnace oxidation, CZE

B2.2.3 Analytical Results

This section summarizes the sampling and analytical results associated with the August 1995 sampling and analysis of tank 241-AX-102. Table B2-8 lists the tables containing total alpha activity, percent water, energetics, and IC analytical results associated with this tank. These results are documented in Rice (1995) and Esch (1998b).

Table B2-8. Analytical Tables.

Analysis	Table Number
IC	B2-31 to 45
CZE	B2-46, 47
Energetics by DSC	B2-48, 49
Percent water by TGA	B2-50
Total alpha	B2-51
TOC by furnace oxidation	B2-52
Hydroxide	B2-53
TOC	B2-54
TOC by persulfate	B2-55

The QC parameters assessed in conjunction with tank 241-AX-102 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. The QC criteria are specified in the sampling and analysis plan (Schreiber 1995). Sample and duplicate pairs in which any QC parameter was outside these limits are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, e, or f as follows.

- "a" indicates 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.
- "f" indicates blank contamination.

In the analytical tables in this section, the "mean" is the average of the result and duplicate value. All values, including those below the detection level (denoted by "<") were averaged. If both sample and duplicate values were nondetected, or if one value was detected while the other was not, the mean is expressed as a nondetected value. If both values were detected, the mean is expressed as a detected value.

B2.2.3.1 Total Alpha. Analyses for total alpha activity were performed on the samples recovered from tank 241-AX-102. The samples were prepared by fusion digestion. Two fusions

were prepared for each sample (for duplicate results). Each fused dilution was analyzed twice, and the results were averaged and reported as one value. Results ranged from 1.15 to 1.35 μCi/g.

B2.2.3.2 Total Organic Carbon. High TOC values were obtained using persulfate coulometry and by furnace oxidation for the archive samples. The average value for the 95-AUG-006 sample was 57,300 μg C/g and the average value for sample 95-AUG-007 was 55,800 μg C/g. Both values exceeded the notification limit. The average archive sample result was 37,800 μg C/g , which is 2 weight percent less than previously reported results. The difference may be attributed to water soluble organic carbon being analyzed from the archive samples and direct solid measurements in previous samples.

B2.2.3.3 Cyanide. Cyanide analyses were required because the DSC results exceeded the notification limit. The average cyanide result was 26.3 μg/g.

B2.2.3.4 Hydroxide. Hydroxide analyses were required because the energy equivalent of the TOC analysis was greater than 125 percent of the DSC value. No free hydroxide above the detection limit was observed.

B2.2.3.5 Anions - Nitrite and Nitrate. The primary analytes were nitrate and nitrite with average values of 17,200 μg/g and 40,700 μg/g respectively. Fluoride and bromide were below detection limits. Chloride, formate, sulfate and phosphate were all detected. Only one sample was analyzed, the other had insufficient sample.

B2.2.3.6 Thermogravimetric Analysis. Thermogravimetric analysis measures the mass of a sample as its temperature is increased at a constant rate. Nitrogen is passed over the sample during heating to remove any released gases. A decrease in the weight of a sample during TGA 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 TGA sample weight loss up to a certain temperature (typically 150 to 200 °C [300 to 390 °F]) is caused by water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well.

Water content values ranged from 28.0 to 33.3 percent.

B2.2.3.7 Differential Scanning Calorimetry. In a DSC analysis, heat absorbed or emitted by a substance is measured while the sample is heated at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically.

Exotherms were observed in all of the samples. Dry weight exotherms ranged from 416 to 494 J/g, exceeding the notification limit of 481 J/g.

B2.2.3.8 Capillary Zone Electrophoresis. CZE analysis was performed to determine HEDTA and EDTA. The average value for HEDTA was 1,500 μg/g, and the average value for EDTA was 3,070 μg/g.

B2.3 JUNE 1995 VAPOR SAMPLING EVENT

Before the June 1995 vapor sampling event, a vapor phase measurement was taken. The LFL was 0 percent, ammonia was 25 ppm, oxygen content was 20.9 percent, and TOC was 3 ppm (Caprio 1995).

Headspace vapor samples were taken from riser 9E on June 27, 1995. Sample collection and analysis were performed in accordance with the Homi (1995). Air from the headspace was withdrawn via a 7.9-m long heated sampling probe and transferred through a heated tube assembly to a vapor sampling system manifold. These measurements support the hazardous vapor safety screening DQO (Osborne and Buckley 1995) and the organic solvents DQO (Meacham et al. 1997). The percent LFL for headspace samples was determined for the safety screening flammability issue (Dukelow et al. 1995).

The total percent LFL, as determined from hydrogen, carbon monoxide, methane and ammonia results, was <0.33. Average results for analytes measured are shown in Table B2-9 (Claus et al. 1995) and additional results are in Huckaby and Bratzel (1995).

Table B2-9. Results of June 27, 1995 Headspace Vapor Sample Measurements.[1] (2 sheets)

Category	Sample Medium	Analyte	Concentration	Units
Inorganic analytes	Sorbent traps	NH_3	34 ± 3	ppmv
		NO_2	0.08	ppmv
		NO	0.18 ± 0.03	ppmv
		H_2O	13.4 ± 0.6	mg/L
Permanent gases	SUMMA[2] canister	H_2	<98	ppmv
		CH_4	<12	ppmv
		CO_2	704	ppmv
		CO	<12	ppmv
		N_2O	50	ppmv

Table B2-9. Results of June 27, 1995 Headspace Vapor Sample Measurements.[1] (2 sheets)

Category	Sample Medium	Analyte	Concentration	Units
Volatile organics[1]	SUMMA™ canister	Methyl alcohol	4.01	mg/m^3
		Trichlorofluoromethane	2.49	mg/m^3
		3-Heptanone	1.17	mg/m^3
Semi-volatile organics[3]	Sorbent traps	Trichlorofluoromethane	1.54	mg/m^3
		3-Heptanone	1.28	mg/m^3
		1-Butanol	0.52	mg/m^3

Notes:

[1]Clauss et al. (1995)

[2]SUMMA is a trademark of Molectrics, Inc., Cleveland, Ohio.

[2]Results are at standard temperature and pressure (760 torr, 273 K). Total nonmethane hydrocarbons calculations in Section 2.3 for organic solvent pool size estimates are based on "in-tank" conditions.

B2.4 HISTORICAL SAMPLING EVENTS

Historical sample results follow. The historical data have not been validated and should be used with caution.

B2.4.1 August 1988 Sampling Event

In August 1988, a sample was taken from tank 241-AX-102 as part of a response to indications that this tank was leaking. One 100-mL sample was taken through riser 3A (Eacker 1988). The sample depth was not specified. Weiss (1988) identifies the sample as "a sample of the residual supernatant liquid in the tank." The sample was a dark brown liquid with no solids. Most likely the sample was obtained using a bottle on a string. Aliquots of the sample were taken and submitted to Analytical Chemistry Services Laboratories for component analysis. Sample results are given in Weiss (1988) and include metal, anion, and radionuclide data (Table B2-56).

B2.4.2 February 1980 Sampling Event

In 1980, samples were taken from tank 241-AX-102. The exact date that the samples were taken is not clear, but results of analyses conducted on them were reported in February 1980 (Delegard 1980a). Little information is available about this sampling event, but most likely a bottle on a string was used. Sample results include metal, anion, and physical data and are reported in Delegard (1980a) (Table B2-57). A boildown test was performed and viscosities were also reported.

B2.4.3 January 1980 Sampling Event

In 1980, tank 241-AX-102 waste was sampled and analyzed. The exact date and reason for sampling are not clear, but the data were most likely collected in support of evaporator operations. Results were reported in January 1980 (Delegard 1980b). Little information is available about this sampling event, but most likely a bottle on a string was used. Sample results include metal, anion, and physical data and are reported in Delegard (1980b) (Table B2-58). A boildown test was performed and boiling point was also reported.

B2.4.4 February July 1977 Sampling Event

In 1977, a series of six samples was taken from tank 241-AX-102. These samples were taken from the residual sludge that remained in tank 241-AX-102 following sluicing. Exact dates when the samples were obtained are not clear; however, the samples were obtained to provide data to estimate heat output from the sludge remaining in the tank. Little information is available about these sampling events, but most likely they were using a bottle on a string. Sample results include primarily radionuclide data and are reported in Starr (1977) (Table B2-59).

B2.4.5 January 1977 Sampling Event

In January 1977, two memos were issued identifying analytical data from sampling of tank 241-AX-102 waste. The data were from samples taken as the tank was sluiced and transferred through the 244-AR vault to B Plant during 1976. Only $^{89/90}Sr$ data were obtained. Results ranged from 0.2 to 141.0 Ci/L (Buckingham 1977a and 1977b).

B2.4.6 August 1974 Sampling Event

In 1974, a sample was taken from the sludge of tank 241-AX-102. The data were reported in Horton (1974). The sample was most likely taken using a bottle on a string. Sample results included metal, radionuclide, and physical data. This data represented the sludge concentrations before sluicing and was used as the primary basis to estimate the inventory for chemical analytes in tank 241-AX-102 sludge. Sludge sample composition results and inventory calculations are presented in Appendix D.

1998 GRAB SAMPLE DATA TABLES

Table B2-10. Tank 241-AX-102 Analytical Results: Bromide (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	<1,010	<1,010	<1,010
S98T001316		Grab composite	<970	<969	<969

Table B2-11. Tank 241-AX-102 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	687	863	775[QC:e]
S98T001316		Grab composite	583	677	630

Table B2-12. Tank 241-AX-102 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	1,240	1,300	1,270
S98T001316		Grab composite	<241	244	<242

Table B2-13. Tank 241-AX-102 Analytical Results: Formate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	4,950	6,200	5,570[QC:e]
S98T001316		Grab composite	5,480	5,890	5,680

Table B2-14. Tank 241-AX-102 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	3.48E+05	1.58E+05	2.53E+05[QC:e]
S98T001316		Grab composite	2.60E+05	2.07E+05	2.33E+05[QC:e]

Table B2-15. Tank 241-AX-102 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	32,100	37,600	34,800
S98T001316		Grab composite	30,400	31,200	30,800

Table B2-16. Tank 241-AX-102 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	2,110	3,080	2,590[QC:e]
S98T001316		Grab composite	2,350	2,420	2,380

Table B2-17. Tank 241-AX-102 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	6,020	5,470	5,740
S98T001316		Grab composite	4,150	4,510	4,330

Table B2-18. Tank 241-AX-102 Analytical Results: Acetate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	< 162	< 161	< 161
S98T001316		Grab composite	1,810	1,870	1,840

Table B2-19. Tank 241-AX-102 Analytical Results: Citrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	2,930	2,640	2,780
S98T001316		Grab composite	2,300	2,670	2,480

Table B2-20. Tank 241-AX-102 Analytical Results: Glycolate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	8,180	8,200	8,190
S98T001316		Grab composite	5,960	6,420	6,190

Table B2-21. Tank 241-AX-102 Analytical Results: Iminodiacetic Acid (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	<1,130	<1,130	<1,130
S98T001316		Grab composite	<1,090	<1,090	<1,090

Table B2-22. Tank 241-AX-102 Analytical Results: Nitrilotriacetic Acid (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	<804	<798	<801
S98T001316		Grab composite	<772	<772	<772

Table B2-23. Tank 241-AX-102 Analytical Results: Oxalate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	15,200	16,400	15,800
S98T001316		Grab composite	16,500	17,300	16,900

Table B2-24. Tank 241-AX-102 Analytical Results: EDTA (CZE).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	5,620	5,530	5,580
S98T001316		Grab composite	4,430	5,110	4,770

Table B2-25. Tank 241-AX-102 Analytical Results: HEDTA (CZE).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	1,780	668	1,220
S98T001316		Grab composite	954	1,610	1,280

Table B2-26. Tank 241-AX-102 Analytical Results: Exotherm (DSC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**J/g**	**J/g**	**J/g**
S98T001315	Riser 9G	Grab composite	148	168	158

Table B2-27. Tank 241-AX-102 Analytical Results: Percent Water (TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**%**	**%**	**%**
S98T001315	Riser 9G	Grab composite	44.6	36.7	40.6

Table B2-28. Tank 241-AX-102 Analytical Results: Total Organic Carbon (Furnace Oxidation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S98T000739	Riser 9G	Dried grab composite	42,900	45,500	44,200

Table B2-29. Tank 241-AX-102 Analytical Results: Total Inorganic Carbon (TIC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**µg/g**	**µg/g**	**µg/g**
S98T001315	Riser 9G	Grab composite	15,500	14,800	15,200

Table B2-30. Tank 241-AX-102 Analytical Results: Total Organic Carbon (TOC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**µg/g**	**µg/g**	**µg/g**
S98T001315	Riser 9G	Grab composite	55,300	48,600	52,000

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Table B2-31. Tank 241-AX-102 Analytical Results: Bromide (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	<1,030	<1,030	<1,030

Table B2-32. Tank 241-AX-102 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	745	781	763

Table B2-33. Tank 241-AX-102 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	<256	307	<282

Table B2-34. Tank 241-AX-102 Analytical Results: Formate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	4,440	5,110	4,780

Table B2-35. Tank 241-AX-102 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S95T000593	Riser 9E	Whole	1.72E+05	1.72E+05	1.72E+05[QC:c]
S97T001244		Whole	3.06E+05	3.15E+05	3.10E+05

Table B2-36. Tank 241-AX-102 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S95T000593	Riser 9E	Whole	40,100	41,300	40,700[QC:c]
S97T001244		Whole	32,900	34,000	33,500

Table B2-37. Tank 241-AX-102 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	1,820	1,290	1,560

Table B2-38. Tank 241-AX-102 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	3,910	4,080	3,990[QC:b]

Table B2-39. Tank 241-AX-102 Analytical Results: Cyanide.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**µg/g**	**µg/g**	**µg/g**
S95T000206	Riser 9E	Whole	26.8	25.7	26.3

Table B2-40. Tank 241-AX-102 Analytical Results: Acetate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	<165	<165	<165

Table B2-41. Tank 241-AX-102 Analytical Results: Citrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	4,420	5,750	5,090

Table B2-42. Tank 241-AX-102 Analytical Results: Glycolate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	6,970	8,430	7,700

Table B2-43. Tank 241-AX-102 Analytical Results: Iminodiacetic Acid (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	<6,140	<6,150	<6,150

Table B2-44. Tank 241-AX-102 Analytical Results: Nitrilotriacetic Acid (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	<1,040	<1,040	<1,040

Table B2-45. Tank 241-AX-102 Analytical Results: Oxalate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	17,900	18,000	17,900

Table B2-46. Tank 241-AX-102 Analytical Results: EDTA (CZE).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	2,940	3,200	3,070

Table B2-47. Tank 241-AX-102 Analytical Results: HEDTA (CZE).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	1,310	1,680	1,500

Table B2-48. Tank 241-AX-102 Analytical Results: Exotherm (DSC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**J/g**	**J/g**	**J/g**
S95T000203	Riser 3A	Whole	352	348	350
S95T000206	Riser 9E	Whole	282	330	306

Table B2-49. Tank 241-AX-102 Analytical Results: Exotherms – Calculated Dry Weight (DSC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**J/g DW**	**J/g DW**	**J/g DW**
S95T000203	Riser 3A	Whole	494	488	491
S95T000206	Riser 9E	Whole	416	487	452

Note:

DW = dry weight

Table B2-50. Tank 241-AX-102 Analytical Results: Percent Water (TGA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**%**	**%**	**%**
S95T000203	Riser 3A	Whole	29.6	28	28.8
S95T000206	Riser 9E	Whole	31.1	33.3	32.2

Table B2-51. Tank 241-AX-102 Analytical Results: Total Alpha.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
S95T000204	Riser 3A	Whole	1.2	1.35	1.27[QC:c,e]
S95T000208	Riser 9E	Whole	1.27	1.15	1.21[QC:c]

Table B2-52. Tank 241-AX-102 Analytical Results: Total Organic Carbon (Furnace Oxidation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S97T001244	Riser 9E	Whole	34,900	40,600	37,800

Table B2-53. Tank 241-AX-102 Analytical Results: Hydroxide (OH).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S95T000593	Riser 9E	Whole	<1,660	<1,660	<1,660

Table B2-54. Tank 241-AX-102 Analytical Results: Total Inorganic Carbon (TIC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**µg/g**	**µg/g**	**µg/g**
S95T000203	Riser 3A	Whole	16,800	16,300	16,600[QC:d]
S95T000206	Riser 9E	Whole	18,700	15,300	17,000

Table B2-55. Tank 241-AX-102 Analytical Results: Total Organic Carbon (TOC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Average
Solids			**µg/g**	**µg/g**	**µg/g**
S95T000203	Riser 3A	Whole	61,200	53,400	57,300[QC:d,e]
S95T000206	Riser 9E	Whole	63,500	48,100	55,800[QC:e]

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Table B2-56 August 1988 Liquid Sample Results.[1] (2 sheets)

Component	Value
Am	1,000 µCi/L
Pu	97 µCi/L
^{137}Cs	3.5E+05 µCi/L
^{60}Co	710 µCi/L
^{154}Eu	3,500 µCi/L
^{155}Eu	4,700 µCi/L
^{90}Sr	1.7E+05 µCi/L
PH	11.3
NO_3	3.7 *M*
NO_2	1.4 *M*
CO_3	0.98 *M*
PO_4	<.056 *M*
NH_4	0.028 *M*
TOC	36.8 g/L
Ag	<0.004 *M*
Al	0.006 *M*
B	0.002 *M*
Ba	<0.0001 *M*
Bi	<0.0004 *M*
Ca	0.014 *M*
Ce	0.0009 *M*
Cd	<0.0004 *M*
Co	<0.0006 *M*
Cr	0.004 *M*
Cu	0.0006 *M*
Fe	0.033 *M*
K	0.002 *M*
La	0.0004 *M*
Li	<0.002 *M*
Mg	0.0005 *M*
Mn	0.011 *M*

Table B2-56 August 1988 Liquid Sample Results.[1] (2 sheets)

Component	Value
Mo	0.0004 *M*
Na	7.32 *M*
Nd	0.001 *M*
Ni	0.009 *M*
Pb	0.002 *M*
Pd	0.0006 *M*
P	0.023 *M*
Si	0.0009 *M*
Sn	<0.001 *M*
Sr	<0.0003 *M*
Ta	<0.0003 *M*
Ti	0.00007 *M*
Zn	0.0013 *M*
Zr	0.0016 *M*

Note:

[1]Weiss (1988). These pre-1989 data have not been validated, and should be used with caution.

Table B2-57. February 1980 Liquid Sample Results.[1]

	Sample # 7700		**Sample # 7701**	
Component	***M***	**Wt%**	***M***	**Wt%**
$NaAlO_2$	0.070	0.53	0.147	1.13
NaOH	0.329	1.21	0.172	0.64
$NaNO_3$	0.725	5.66	0.717	5.69
$NaNO_2$	0.267	1.69	0.268	1.73
Na_3PO_4	0.0142	0.22	0.0138	0.21
Na_2SO_4	0.187	2.44	0.164	2.17
NaF	0.0074	0.03	0.0074	0.03
Na_2CO_3	0.490	4.77	0.52	5.15
TOC (g/L)	--	--	9.75	0.91
H_2O		87.62		87.25
Total		104.17		104.91
Sp G (g/mL)	1.088		1.071	

Notes:

SpG = specific gravity

[1]Delegard (1980a). These pre-1989 data have not been validated, and should be used with caution.

Table B2-58. January 1980 Analyses of Feed and Product Slurry.[1]

	Feed Liquor		Product Liquor		Product Solid
Component	**M**	**Wt%**	**M**	**Wt%**	**Wt%**
$NaAlO_2$	0.0371	0.27	0.215	1.26	0
NaOH	0.572	2.06	<0.5	<1.42[2]	>31.4
$NaNO_2$	0.443	2.75	1.98	9.73	3.5
$NaNO_3$	0.865	6.61	4.12	24.94	11.2
Na_2CO_3	0.490	4.67	0.95	7.17	40.9
Na_3PO_4	0.100	1.47	0.0488	0.57	3.7
Fe_2O_3	0.0060	0.09	0.0308	0.35	2.4
TOC	16.1 g/L	1.45	68.5 g/L	4.88	0
H_2O	--	84.4	--	53.62	0
Total	--	103.8	--	103.94	93.1
SpG (g/mL)	1.113	--	1.404	--	--

Notes:

SpG = specific gravity

[1]Delegard (1980b). These pre-1989 data have not been validatedand should be used with caution.

[2]Comparison of feed and product liquor analyses (product of boildown; not Tank samples), especially aluminum, show a concentration factor of about five. This is consistant with the 77 percent waste volume reduction. Because it is unlikely that NaOH precipitated through concentration, the product liquor hydroxide analysis is undoubtedly low, while the product solid NaOH percentage is high.

Table B2-59. February through July 1977 Sludge Samples.[1] (2 sheets)

Analyte	#1	#2	#3039	#3040	#4095	#5403	Units
Pu	7.0×10^{-2}	7.2×10^{-2}	6.0×10^{-2}	1.9×10^{-1}	5.5×10^{-2}	7.9×10^{-2}	g/ L
$^{89+90}Sr$	6.5×10^{6}	1.5×10^{7}	1.4×10^{7}	2.2×10^{7}	2.7×10^{7}	1.5×10^{7}	µCi/L
^{137}Cs	1.6×10^{6}	3.3×10^{5}	5.5×10^{3}	4.9×10^{5}	4.8×10^{5}	1.0×10^{6}	µCi/L
^{60}Co	1.4×10^{5}	NF	NF	NF	NF	NF	µCi/L
^{125}Sb	9.3×10^{5}	6.7×10^{5}	4.8×10^{5}	6.8×10^{5}	3.6×10^{5}	7.3×10^{7}	µCi/L
^{144}Ce	1.3×10^{6}	1.8×10^{5}	9.0×10^{5}	2.1×10^{6}	NF	2.3×10^{6}	µCi/L
^{155}Eu	5.4×10^{5}	8.9×10^{5}	4.6×10^{5}	8.8×10^{5}	NF	NF	µCi/L
^{154}Eu	NF	NF	NF	NF	NF	3.9×10^{-1}	µCi/L
U	NA	1.7×10^{-6}	3.0×10^{-4}	8.1×10^{-4}	1.3×10^{-2}	1.0×10^{-2}	lb/gal
Si	NA	NA	NA	NA	NA	0.86	*M*

Notes:

NF - not found

NA - not analyzed

[1]Starr (1977). These pre-1989 data have not been validated and should be used with caution.

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

This section discusses the overall quality and consistency of the current sampling results for tank 241-AX-102. This section also evaluates sampling and analysis factors that may impact data interpretation. These factors are used to assess overall data quality and consistency and to identify limitations in data use.

B3.1 FIELD OBSERVATIONS

The most notable observation regarding the auger samples obtained from tank 241-AX-102 during the 1995 sampling event was the low recovery. Only a thin coating was obtained both on the auger from riser 3A and the auger from riser 9E. This low recovery led to only a limited

number of analyses on the sample obtained from riser 3A. A greater quantity of material was available from the auger taken from riser 9E, and this comprised the bulk of the secondary analyses for this tank. Low recovery makes it difficult to draw conclusions about the relationship between the analytical results and the bulk tank contents.

During extrusion of the sample taken from riser 9E, a coiled-up wire on the auger stem made it difficult to remove the sleeve from the auger (Rice 1995). This problem may have interfered with sample acquisition and retention, but it is difficult to ascertain any effects it may have had. The grab sample was taken using a special sampling device (finger trap grab sampler) to scoop material from the waste surface. No problems were encountered during sampling.

B3.2 QUALITY CONTROL ASSESSMENT

The usual QC assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All pertinent QC tests were conducted on 1995 auger samples and 1998 grab samples, allowing a full assessment regarding the accuracy and precision of the data. Schreiber (1995) and Field (1998) established specific criteria for the 1995 and 1998 sample events. Criteria for analyzing archive samples were specified in Schreiber (1997a and 1998) and Sasaki (1997). Sample and duplicate pairs with one or more QC results outside the specified criteria were identified by footnotes in the data summary tables.

The standard and spike recovery results provide an estimate of 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. The precision is estimated by the relative percent difference, which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100.

In the 1995 auger samples, only one standard was found to not be acceptable (i.e., 100 $\pm$ 10 percent). This one exception was the cyanide result from the auger sample of riser 9E. A potential biasing of the cyanide result from riser 9E is signified by a 121.3 percent standard recovery. However, this high standard recovery is of little consequence, because the analytical results were approximately three orders of magnitude below the cyanide notification limit. All other grab sample and auger sample analyses met QC requirements.

Analytical preparation blanks were analyzed for total alpha activity, TOC , cyanide, and anions. All preparation blanks were below the respective detection limits, indicating that there was no sample contamination.

In general, the analytical results agree well with most of the analytes within the RPD criterion specified in the Safety Screening DQO (Dukelow et al .1995). RPD values exceeded limits for some TOC values. Sample incompatibilities were also noted for the TOC method used.

In some samples, systematic variability was apparent because of spike recovery results outside the range of 90 to 110 percent. The quality control results for the sample analyses are footnoted in the data summary tables. In general, the data for the 1995 and 1997 sample events appeared to be consistent and quality control observations mentioned here should not affect the utility of the data.

B3.3 DATA CONSISTENCY CHECKS

The ability to assess the overall consistency or trends of the data for the grab or auger samples is limited because of the limited quantity of sample material recovered and because inductively coupled plasma (ICP) analyses were not conducted. Two data consistency checks were made for the 1995 auger data.

However, mass and charge balance calculations were not possible, given the limited data.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the 1995 auger sample and 1998 grab sample results from two analytical methods. Agreement between the two methods strengthens the credibility of both results, but poor agreement brings the reliability of the data into question.

B3.3.1.1 Comparison of DSC and TOC Analyses. The dry weight TOC and equivalent TOC energetics are presented in Table B3-1.

If the exotherms detected by the DSC analyses were produced exclusively from oxidation of the organic carbon present in the samples, then knowing the form of the molecule(s) in which the organic carbon is contained allows for calculation of the exothermic heat of reaction for the compound(s). Organic compounds known to have been transferred to Hanford Site wastes, and the resultant heats of reaction (assuming reaction to completion) for each of these compounds are presented in Table B3-2.

Table B3-1. Combination of Total Organic Carbon, Differential Scanning Calorimetry, and Thermogravimetric Analysis Data.

Analyte	1995 Auger Results	1998 Grab Results
Dry weight TOC (μg C/g)[1]		
Furnace oxidation	54,400	44,200 (dried sample)
Persulfate	81,400	87,500
TOC Equivalent (J/g)[2]		
Furnace oxidation	204	166
Persulfate	305	328
Dry weight DSC (J/g)	472	266

Notes:

[1]To convert from a wet basis to a dry basis use: wet basis ÷ (1 - (wt% H_2O)/100) = dry basis

[2]Conversion: 200 J/4.5 g = 1 percent TOC (dry weight)

Table B3-2. Theoretical Energy from Oxidation of Organic Carbon by $NaNO_3$ (2 sheets)

Molecular Form Containing Organic Carbon[1]				Energy that would be Produced in Tank 241-AX-102 from 56,600 μg C/g of Waste (J/g) (Wet Basis)[3]
Fuel	Molecular Weight (g/mole)	C atoms/ Molecule	Enthalpy (J/g)[2]	
Na_3 HEDTA	340	10	11,000	1,760
Na_4 EDTA	380	10	8,800	1,580
Na_3 Citrate	258	6	6,840	1,390
$NaCH_3C00$	82	2	7,940	1,540
TBP	266	12	17,200	1,800

Table B3-2. Theoretical Energy from Oxidation of Organic Carbon by $NaNO_3$ (2 sheets)

Molecular Form Containing Organic Carbon[1]				Energy that would be Produced in Tank 241-AX-102 from 56,600 µg C/g of Waste (J/g) (Wet Basis)[3]
Fuel	**Molecular Weight (g/mole)**	**C atoms/ Molecule**	**Enthalpy (J/g)[2]**	
Na DBP	200	8	21,100	2,490
$Na_2NiFE(CN)_6$	n/a	n/a	9,510	n/a

Notes:

n/a = Not applicable

DBP = Ditbutyl phosphate

TBP = tributyl phosphate

[1]Theoretical data (Burger 1993)

[2]Values are energy per gram of fuel.

[3]Values are energy per gram of wet waste and calculated assuming all carbon detected is in the indicated fuel form.

Most compounds that were originally transferred to storage in the waste tanks at the Hanford Site no longer exist in their original form. Further, most chemical reactions will not proceed to completion. Consequently, it is not possible to discern if the DSC results are from TOC. It is possible that the DSC results from the 1995 analysis event are produced from combustion of $NaNO_3$ with a less energetic form of TOC than shown in Table B3-2, or that $NaNO_3$ is not the only oxidant.

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

A nested analysis of variance (ANOVA) model was fit to the 1995 auger composite data and 1998 grab sample solids composite data. Dried sample results and results for spiked samples were not used in model calculations. Mean values, and 95 percent confidence intervals on the mean, were determined from the ANOVA. Four variance components were used in the calculations. The variance components represent concentration differences between risers, segments, laboratory samples, and analytical replicates. The model is:

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

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

where

Y_{ijkm}	=	concentration from the mth analytical result of the kth sample of the jth segment of the ith riser
μ	=	the mean
R_i	=	the effect of the ith riser
S_{ij}	=	the effect of the jth segment from the ith riser
L_{ijk}	=	the effect of the kth sample from the jth segment of the ith riser
A_{ijkm}	=	the analytical error
a	=	the number of risers
b_i	=	the number of segments from the ith riser
c_{ij}	=	the number of samples from the jth segment of the ith riser
n_{ijk}	=	the number of analytical results from the jk^{th} sample.

The variables R_i, S_{ij}, and L_{ijk} are random effects. These variables, as well as A_{ijkm}, are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(R)$, $\sigma^2(S)$, $\sigma^2(L)$ and $\sigma^2(A)$, respectively.

The restricted maximum likelihood method (REML) was used to estimate the mean concentration and standard deviation of the mean for all analytes that had 50 percent or more of their reported values greater than the detection limit. The mean value and standard deviation of the mean were used to calculate the 95 percent confidence intervals. The following table gives the mean, degrees of freedom, and confidence interval for each constituent.

Some analytes had results that were below the detection limit. In these cases, the value of the detection limit was used for nondetected results. For analytes with a majority of results below the detection limit, a simple average is all that is reported.

The lower (LL) and upper (UL) limits, of a two-sided 95 percent confidence interval on the mean were calculated using the following equation:

$$LL(95\%) = \hat{\mu} - t_{(df,\ 0.025)} \times \hat{\sigma}(\hat{\mu}),$$
$$UL(95\%) = \hat{\mu} + t_{(df,\ 0.025)} \times \hat{\sigma}(\hat{\mu}).$$

In this equation, $\hat{\mu}$ is the REML estimate of the mean concentration, $\hat{\sigma}(\hat{\mu})$ is the REML estimate of the standard deviation of the mean, and $t_{(df,\ 0.025)}$ is the quantile from Student's t distribution with *df* degrees of freedom. The degrees of freedom equals the number of risers with data minus one. In cases where the lower limit of the confidence interval was negative, it is reported as zero.

Table B3-3. Tank 241-AX-102 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Sample Data. (Reference Date - October 9, 1998) (2 sheets)

Analyte	Method	Mean	*df*	LL	UL	Units
Acetate*	IC:W	1.00E+03	1	0.00E+00	1.16E+04	µg/g
Bromide*	IC:W	<1.00E+03	n/a	n/a	n/a	µg/g
Chloride	IC:W	6.96E+02	1	0.00E+00	1.54E+03	µg/g
Citrate	IC:W	3.78E+03	1	0.00E+00	2.03E+04	µg/g
Fluoride*	IC:W	2.62E+02	1	1.25E+01	5.11E+02	µg/g
Formate	IC:W	5.23E+03	1	0.00E+00	1.10E+04	µg/g
Glycolate	IC:W	6.95E+03	1	0.00E+00	1.65E+04	µg/g
Gross alpha	Alpha:F	1.24E+00	1	6.90E-01	1.79E+00	µCi/g

Table B3-3. Tank 241-AX-102 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Sample Data. (Reference Date - October 9, 1998) (2 sheets)

Analyte	Method	Mean	*df*	LL	UL	Units
Hydroxide*	OH:W	<1.66E+03	n/a	n/a	n/a	µg/g
IDA (Iminodiacetic acid)*	IC:W	<3.62E+03	n/a	n/a	n/a	µg/g
Cyanide	Speciation (CN)	2.63E+01	1	1.93E+01	3.32E+01	µg/g
EDTA	CZE:W	3.12E+03	1	0.00E+00	2.41E+04	µg/g
HEDTA	CZE:W	9.69E+02	1	0.00E+00	5.41E+03	µg/g
Nitrate	IC:W	2.39E+05	2	6.63E+04	4.11E+05	µg/g
Nitrite	IC:W	3.50E+04	2	2.22E+04	4.77E+04	µg/g
Nitrilotriacetic acid*	IC:W	<8.52E+02	n/a	n/a	n/a	µg/g
Oxalate	IC:W	1.74E+04	1	1.09E+04	2.39E+04	µg/g
Percent water	DSC/TGA	3.39E+01	2	1.87E+01	4.90E+01	%
Phosphate	IC:W	1.97E+03	1	0.00E+00	7.22E+03	µg/g
Sulfate	IC:W	4.16E+03	1	2.02E+03	6.31E+03	µg/g
Total inorganic carbon	TIC/TOC	1.62E+04	2	1.38E+04	1.87E+04	µg/g
Total organic carbon	Furnace oxidation:W	3.78E+04	1	1.54E+03	7.40E+04	µg/g
Total organic carbon	TIC/TOC	5.50E+04	2	4.39E+04	6.62E+04	µg/g

Notes:

W = water digest

F = fusion

*A less than value was used in the calculation.

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

Appendix C documents the results of the analyses and statistical and numerical manipulations required by the DQOs applicable for tank 241-AX-102. The analyses required for tank 241-AX-102 are reported as follows.

- **Section C1.0**: Statistical analysis and numerical manipulations supporting the safety screening DQO (Dukelow et al. 1995)
- **Section C2.0**: Appendix C references.

C1.0 STATISTICS FOR THE SAFETY SCREENING DATA QUALITY OBJECTIVE

The safety screening DQO (Dukelow et al. 1995) defines decision limits in terms of one-sided 95 percent confidence intervals. The safety screening DQO limits are 41 µCi/g for gross alpha and 480 Joules/g for DSC. Confidence intervals were calculated for the mean values from each laboratory sample. Table C1-1 has the Gross Alpha results. The DSC results are in Table C1-2.

The upper limit (UL) of a one-sided 95 percent confidence interval on the mean is

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

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\mu}$ 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. The degrees of freedom equals the number of samples minus one.

For sample numbers with at least one value above the detection limit, the upper limit of a 95 percent confidence interval is given in Table C1-1. Each confidence interval can be used to make the following statement. If the upper limit is less than 41 µCi/g (61.5 µCi/mL for drainable liquid), then one would reject the null hypothesis that the alpha is greater than or equal to 41 µCi/g (61.5 µCi/mL for drainable liquid) at the 0.05 level of significance.

All four of the gross alpha results were above the detection limit. The UL closest to the threshold was 1.75 μCi/g for the auger sample from riser 9E. This is well below the limit of 41 Ci/g.

Table C1-1. 95 Percent Upper Confidence Limits for Gross Alpha.

Lab Sample ID	Description	$\hat{\mu}$	*df*	UL	Units
S95T000204	Riser 3A	1.27E+00	1	1.75e+00	μCi/g
S95T000208	Riser 9E	1.21E+00	1	1.59e+00	μCi/g

Six of the DSC results had an exothermic reaction. For each laboratory sample identification number, a 95 percent upper confidence limit is given in Table C1-2. All results are expressed on a dry weight (DW) basis. Each confidence interval can be used to make the following statement. If the upper limit is less than 480 J/g, then one would reject the null hypothesis that DSC is greater than or equal to 480 J/g at the 0.05 level of significance. The maximum upper limit to a 95 percent confidence interval on the mean for DSC was 675 J/g DW, for the auger sample from riser 9E, and above the threshold limit of 480 J/g.

Table C1-2. 95 Percent Upper Confidence Limits for DSC.

Lab Sample ID	Description	$\hat{\mu}$	*df*	UL	Units
S95T000203	Riser 3A	4.91E+02	1	5.10E+02	J/g DW
S95T000206	Riser 9E	4.52E+02	1	6.75E+02	J/g DW
S98T001315	Grab	2.67E+02	1	3.71E+02	J/g DW

Although DSC and TOC values were high, reactive system screening tool results showed that there was no propagating reaction.

C2.0 APPENDIX C REFERENCES

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-AX-102

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-AX-102

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

- Limited analytical results for 1998 grab sample composite and 1995 auger saltcake samples (Appendix B)
- Analytical results for 1974 and 1977 sludge data
- Inventory estimates generated by HDW model (Agnew et al. 1997)
- Inventory estimates based on sample results for tanks with similar process histories.

The evaluation results support using analytical data for tank 241-AX-102, when available for saltcake inventory estimates. Saltcake chemical inventory estimates are based on results from the tank-specific assessment process and supplemented by predictions of the HDW model. Sludge inventory estimates are based on 1974 sample results for tank 241-AX-102 and supplemented by HDW model estimates adjusted for water losses attributed to evaporation.

The following sections establish a best-basis inventory estimate for chemical and radionuclide components in tank 241-AX-102. A complete list of data sources used in inventory evaluations is provided at the end of this appendix.

D1.0 CHEMICAL INFORMATION SOURCES

Tank 241-AX-102 has undergone eight sampling and analysis events. One sludge sample was taken in 1974, as the tank was being prepared for sluicing (Horton 1974). The tank then contained 189 kL (50 kgal) of sludge derived primarily from B Plant waste (Agnew et al. 1997). The sample was analyzed for percent water, density, radionuclides, and a few metals. After being sluiced in 1976/1977, the tank contained a heel of approximately 26 kL (7 kgal) of sludge. Six samples of the remaining sludge were analyzed for radionuclide content only (Table B2-59).

After it was sluiced, the tank was used as both a feed and slurry storage tank for the 242-A Evaporator-Crystallizer (1977 to 1980). The evaporator was processing complexed waste during that time. Analytical results for two liquid grab samples taken in early 1980 show the composition of the evaporator feed solution in the tank at that time (Appendix B). These results provide no quantitative estimates of the solids deposited on top of the sludge heel, but they do indicate the type of waste that was being stored in the tank.

In 1988, the tank was declared a leaker, and a liquid grab sample was taken to establish the composition of the liquid to be pumped out of the tank by salt well pumping (Appendix B). This sample contained no solids, but analysis of the liquid firmly identifies the waste as concentrated complexed (CC) waste (waste having a total organic carbon concentration over 10 g/L at the aluminate phase boundary). The composition of the solids deposited during the evaporator operations (approximately 98 kL) can be assumed to be similar in composition to the solids deposited by CC wastes in double-shell tanks 241-AN-107 and 241-AN-102, where the solids have been analyzed (Herting 1994a and 1996).

Two auger samples were taken from the waste surface in February 1995, and grab samples were taken in February 1998, to support the safety screening and organic complexants safety issues. Limited analyses were obtained from these samples (Appendix B).

The HDW model report (Agnew et al. 1997) provides tank content estimates derived from process flowsheets and waste volume records.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Hanlon (1998) estimates that tank 241-AX-102 contains 26.5 kL (7 kgal) of sludge, 110 kL (29 kgal) of saltcake, and 11.0 kL (3 kgal) of supernatant liquid. These values are based on the surface level measurements and tank photographs taken at the time the tank was pumped in 1988. More recent photographs and tank samples indicate that no supernatant liquid in the tank.

Surface level measurements using a metal tape varied widely from 38 cm (15 in.) to 23 cm (9 in.) between 1990 and January 1995, but tended to gradually decrease (Figure A4-1). The variation in measurements may have been caused by contact with a small pipe or metal coil observed in the tank. Surface level measurements were steady at 24.1 cm (9.5 in.) from January 1995 to September 1998. An ENRAF™ gauge was installed in the tank in September, 1998. ENRAF™ measurements have been steady at 28.1 cm (11.05 in.). This equates to a volume of 114 kL (30 kgal), and is the volume that was used for best-basis inventory estimates.

The Hanlon (1998) value of 26.5 kL (7 kgal) was used for sludge inventory estimates. The saltcake volume (87 kL [23 kgal]) was determined by subtracting the sludge volume from the total tank waste volume.

Tables D2-1 and D2-2 list the HDW model predictions for inventories of various analytes in tank 241-AX-102 waste. Normally previous best-basis values are also presented in this table. These were not presented because many of the previous best-basis values were based on the HDW model. HDW values were based on a total tank volume of (39 kgal). The chemical species are reported without charge designation in accordance with the best-basis inventory convention.

Table D2-1. Hanford Defined Waste Inventory Estimates for Nonradioactive Components in Tank 241-AX-102. (2 sheets)

Analyte	HDW Model[1] (kg)	Analyte	HDW Model[1] (kg)
Density (g/mL)	1.55	Ni	111
Heat load (kW)	1.33	NO_2	14,500
Al	6,390	NO_3	36,600
Bi	32.6	OH	23,700
Ca	386	Pb	31.7
Cl	1,070	PO_4	1,100

Table D2-1. Hanford Defined Waste Inventory Estimates for Nonradioactive Components in Tank 241-AX-102. (2 sheets)

Analyte	HDW Model[1] (kg)	Analyte	HDW Model[1] (kg)
TIC as CO_3	3,960	Si	925
Cr	852	$SO_4^=$	3,290
F	156	Sr	0
Fe	1,740	U_{TOTAL}	266
Hg	0.239	Zr	2.08
K	323	EDTA	971
La	0.452	NH_3	163
Mn	29.8	Pu	7.35
Na	41,500	Volume (kL)	148

Notes:

HDW = Hanford Defined Waste
[1]Agnew et al. (1997)

Table D2-2. Hanford Defined Waste Model Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994.

Analyte	HDW Model (Ci)[1]	Analyte	HDW Model (Ci)[1]
^{3}H	32.4	^{226}Ra	2.34 E-04
^{14}C	5.10	^{227}Ac	0.00114
^{59}Ni	1.57	^{228}Ra	0.0379
^{60}Co	6.61	^{229}Th	8.82E-04
^{63}Ni	161	^{231}Pa	5.91E-04
^{79}Se	5.29	^{232}Th	0.00386
^{90}Sr	172,000	^{232}U	0.126
^{90}Y	172,000	^{233}U	0.482
^{93m}Nb	15.6	^{234}U	0.0990
^{93}Zr	23.3	^{235}U	0.00396
^{99}Tc	37.7	^{236}U	0.00323
^{106}Ru	0.585	^{237}Np	0.133
^{113m}Cd	117	^{238}Pu	60.7
^{125}Sb	30.8	^{238}U	0.127
^{126}Sn	8.35	^{239}Pu	415
^{129}I	0.0728	^{240}Pu	148
^{134}Cs	0.504	^{241}Am	1,330
^{137m}Ba	35,200	^{241}Pu	4,200
^{137}Cs	37,300	^{242}Cm	1.79
^{151}Sm	15,500	^{242}Pu	0.0303
^{152}Eu	21.1	^{243}Am	0.148
^{154}Eu	1,660	^{243}Cm	0.218
^{155}Eu	1,030	^{244}Cm	8.96

Notes:

HDW = Hanford Defined Waste
[1]Agnew et al. (1997)

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would have an effect upon the HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

There is general agreement among various sources that tank 241-AX-102 contains two layers of waste The bottom layer referred to as sludge and the top layer as saltcake. Each layer is discussed separately below.

D3.1.1 Sludge Layer

The HDW model (Agnew et al. 1997) predicts that the sludge layer is composed of 3.8 kL (1 kgal) of PUREX low-level waste sludge (PL) and 19 kL (5 kgal) of B Plant waste (B) from cesium/strontium extraction operations. The overall composition of the sludge layer as predicted by the HDW model is shown in Tables D3-1 and D3-2.

One grab sample of sludge was taken in 1974 in preparation for sluicing the sludge from the tank (Horton 1974). Six more samples were taken after the sluicing was completed, but analyses were limited to a few radionuclides. The ^{137}Cs and ^{90}Sr activities reported for the before-sluicing sample were within the range of activities reported in the six post-sluicing samples, so the chemical analyses from the pre-sluicing sample are believed to be representative of the heel left after sluicing. Where available, post sluicing analytical results (Starr 1977) were used as the best-basis for radionuclides in the sludge layer. These analyses are shown in Tables D3-1 and D3-2, column 3.

Table D3-1. Comparison of Tank 241-AX-102 Hanford Defined Waste Model Sludge Layer Chemical Concentration Estimates with Sampling Data. (2 sheets)

Analyte	HDW Model Composition[1]	1974 Sampling Data Composition[2]	Adjusted HDW Model Estimate[3]
Al (μg/g)	21,400	nr	36,300
Bi (μg/g)	0	nr	0
Ca (μg/g)	8,020	5,070	13,600
Cl (μg/g)	469	nr	795
CO_3 (μg/g)	12,000	nr	20,400
Cr (μg/g)	95.6	nr	162
F (μg/g)	0	nr	0
Fe (μg/g)	57,300	90,600	90,600
Hg (μg/g)	0	nr	0
K (μg/g)	113	nr	192
La (μg/g)	0	nr	0
Mn (μg/g)	0	7,600	0
Na (μg/g)	63,200	nr	107,200
Ni (μg/g)	2,370	nr	4,020
NO_2 (μg/g)	7,150	nr	12,100
NO_3 (μg/g)	48,300	nr	81,900
Oxalate (μg/g)	0	nr	0
Pb (μg/g)	1.27	nr	2.15
PO_4 (μg/g)	846	nr	1,430
Si (μg/g)	22,400	22,500	38,000
SO_4 (μg/g)	1,340	nr	2,270
Sr (μg/g)	0	nr	0
Zr (μg/g)	0	nr	0

Table D3-1. Comparison of Tank 241-AX-102 Hanford Defined Waste Model Sludge Layer Chemical Concentration Estimates with Sampling Data. (2 sheets)

Analyte	HDW Model Composition[1]	1974 Sampling Data Composition[2]	Adjusted HDW Model Estimate[3]
U_{TOTAL} (μg/g)	114	990[4]	193
H_2O (wt%)	66.1	42.5	42.5

Notes:

HDW = Hanford Defined Waste

nr = Not reported

[1]Agnew et al. (1997)

[2]From pre-sluicing grab sample

[3]Based on adjustment for percent water as described in text

[4]Highest of five values from post-sluicing samples (Starr 1977).

Table D3-2. Comparison of Tank 241-AX-102 Hanford Defined Waste Model Sludge Layer Radionuclide Concentration Estimates with Sampling Data. (2 sheets)

Analyte	HDW Model Composition[1,4]	1977 Sampling Data Composition[2,4]	Adjusted HDW Model Estimate[3,4]
^{3}H (μCi/g)	0.0294	nr	0.0499
^{14}C (μCi/g)	0.00906	nr	0.0154
^{59}Ni (μCi/g)	0.0441	nr	0.0748
^{60}Co (μCi/g)	0.0218	15,100 (μCi/L)	0.0370
^{63}Ni (μCi/g)	4.57	nr	7.75
^{79}Se (μCi/g)	0.165	nr	0.280
^{90}Sr (μCi/g)	5,380	1.11E+07(μCi/L)	9,130
^{93m}Nb (μCi/g)	0.478	nr	0.811
^{93}Zr (μCi/g)	0.72	nr	1.22
^{99}Tc (μCi/g)	0.0602	nr	0.102
^{106}Ru (μCi/g)	0.02	nr	0.0339

Table D3-2. Comparison of Tank 241-AX-102 Hanford Defined Waste Model Sludge Layer Radionuclide Concentration Estimates with Sampling Data. (2 sheets)

Analyte	HDW Model Composition[1,4]	1977 Sampling Data Composition[2,4]	Adjusted HDW Model Estimate[3,4]
^{113m}Cd (μCi/g)	3.59	nr	6.089
^{125}Sb (μCi/g)	0.136	1.78E+05 (μCi/L)	0.231
^{126}Sn (μCi/g)	0.262	nr	0.444
^{129}I (μCi/g)	1.17E-04	nr	0.000198
^{134}Cs (μCi/g)	0.00105	nr	0.00178
^{137}Cs (μCi/g)	14.5	4.40E+05 (μCi/L)	24.6
^{151}Sm (μCi/g)	476	nr	807
^{152}Eu (μCi/g)	0.701	nr	1.19
^{154}Eu (μCi/g)	53.6	0.152 (μCi/L)	90.9
^{155}Eu (μCi/g)	34	65,000 (μCi/L)	57.7
^{226}Ra (μCi/g)	7.38E-06	nr	1.25E-05
^{227}Ac (μCi/g)	3.50E-05	nr	5.94E-05
^{228}Ra (μCi/g)	2.93E-10	nr	4.97E-10
^{229}Th (μCi/g)	2.75E-08	nr	4.66E-08
^{231}Pa (μCi/g)	1.10E-06	nr	1.87E-06
^{232}Th (μCi/g)	3.82E-12	nr	6.48E-12
^{237}Np (μCi/g)	1.94E-04	nr	0.000329
Pu_{TOTAL} (μCi/g)	5.95E-04	0.0877 (g/L)	0.00101

Notes:

[1]Agnew et al. (1997)
[2]From post-sluicing grab sample (Starr 1977)
[3]Based on adjustment for percent water as described in text
[4]Decayed to January 1, 1994

The differences in the 1974 sludge sample-based and HDW process-based estimates for density and percent water were assumed to be caused by evaporation of water from the sludge after processing. Therefore, HDW concentrations were adjusted by algebraically calculating how much the concentrations would have changed when the water evaporated. The calculation is as follows, using Na as an example:

Assume 100 kg of sludge at 66.1 percent water and 6.32 percent Na before evaporation.

Let x = weight of water lost during evaporation

a = weight of sludge after evaporation = 100 - x

b = weight of water in sludge after evaporation = 100(0.661) – x

c = wt% water after evaporation = 42.5% (sample result)

d = wt% Na after evaporation (the mass of Na is constant)

Find d.

Solution:

$c = 42.5\% = 100\ b/a = 100((66.1-x)/(100-x));\ \ x = 41.04\ g$

$d = 100(\%\ Na_{before})/a\ =\ 100(\%\ Na_{before})/(100-41.04) = 1.696(6.32)$
$= 10.72\%.$

This calculation assumes that the mass of all analytes is conserved; only the percent water changed as a result of evaporation. Note that density is not a factor in the calculation. Based on 1974 data, the density of the sludge after evaporation was 1.57 g/mL. This compares to a density of 1.29 g/mL in the HDW model. The HDW model sludge density (1.32 g/mL) was also lower than the 1998 measured value (1.80 g/mL) for tank 241-AX-104 (Simpson 1998). It is assumed that the HDW density of 1.29 g/mL before evaporation is low.

All adjusted analyte concentrations shown in Tables D3-1 and D3-2, last column, were derived by multiplying the HDW concentration by 1.696 (see example calculation for Na).

Manganese was predicted to be absent in the sludge, but analyses show a significant concentration. The HDW model also predicted less ^{137}Cs and more ^{90}Sr than found in samples. The concentration of uranium in samples varied over a wide range (Starr 1977), from 0.13 µg/g (1.7×10^{-6} lb/gal) to 990 µg/g (0.013 lb/gal), but all of the values were much lower than the HDW model prediction.

D3.1.2 Saltcake Layer

The saltcake layer of waste in the tank was deposited during the years 1977 to 1980, when the tank was being used in conjunction with 242-A Evaporator-Crystallizer operations. The HDW model uses the SMM subroutine to predict an inventory of 125 kL (33 kgal) of saltcake.

In 1988, the tank was declared a leaker, and a liquid grab sample was taken to establish the composition of the liquid to be pumped out of the tank by salt well pumping (Appendix B). This sample contained no solids, but analysis of the liquid identifies the waste as CC waste (see Table D3-3). Specific markers for CC waste include the concentrations of carbonate, TOC, ^{241}Am, and ^{90}Sr, all of which are much higher in CC waste than in other types of Hanford liquid waste.

The composition of the solids deposited in tank 241-AX-102 during the evaporator operations was assumed to be similar to the solids deposited by CC wastes in double-shell tanks 241-AN-102 and 241-AN-107, where the solids have been analyzed. Table D3-4 shows a comparison of the compositions of the saltcake as predicted by the SMM subroutine and as determined by analysis from tanks 241-AN-102 and 241-AN-107.

Table D3-3. Comparison of 1988 Supernatant Liquid Sample from Tank 241-AX-102 with Supernatant Liquid Samples from Concentrated Complexed Waste Tanks 241-AN-102 and 241-AN-107. (2 sheets)

Component	241-AX-102[1] (*M*)	241-AN-102[2] (*M*)	241-AN-107[3] (*M*)
NO_3	3.7	3.6	3.8
NO_2	1.4	1.8	1.1
CO_3	0.98	1.1	1.2
TOC (g/L)	36.8	26.3	42.9
Al	0.006	0.55	0.044
Ca	0.014	0.011	nr
Fe	0.033	nr	0.027
Na	7.32	11.2	8.6

Table D3-3. Comparison of 1988 Supernatant Liquid Sample from Tank 241-AX-102 with Supernatant Liquid Samples from Concentrated Complexed Waste Tanks 241-AN-102, and 241-AN-107. (2 sheets)

Component	241-AX-102[1] (*M*)	241-AN-102[2] (*M*)	241-AN-107[3] (*M*)
^{241}Am (µCi/mL)	1.0	nr	0.63
$^{239/240}$Pu (µCi/mL)	0.097	nr	0.034
^{90}Sr (µCi/mL)	175	74	93
^{137}Cs (µCi/mL)	350	382	253

Notes:

[1]Appendix B
[2]Herting (1993)
[3]Herting (1994b).

Table D3-4. Composition of Saltcake Layer in Tank 241-AX-102 as Predicted by HDW and Analytical Results for Tanks 241-AN-102, 241-AN-107, and 241-AX-102. (Values in µg/g, except as noted) (2 sheets)

Component	HDW AX-102[1]	AN-102[2]	AN-102[3]	AN-107[4]	AN-102/107 Average[5]	AX-102 Sample[6]
Density (g/mL)	1.60	1.53	1.50	1.47	1.50	nr
Wt% H_2O	34.0	41.0	40.3	45.6	42.3	nr
Na	198,000	177,000	234,000	140,500	184,000	nr
Al	28,900	12,000	12,200	16,000	13,400	nr
Bi	163	nr	nr	nr	nr	nr
Fe	343	1,200	1,500	3,900	2,200	nr
Cr	4,250	1,300	1,370	450	1,040	nr
Pb	158	200	< 270	330	265	nr
Ni	208	260	420	330	337	nr
Mn	149	250	480	510	413	nr
Ca	761	450	810	440	567	nr

Table D3-4. Composition of Saltcake Layer in Tank 241-AX-102 as Predicted by HDW and Analytical Results for Tanks 241-AN-102, 241-AN-107, and 241-AX-102 (Values in µg/g, except as noted). (2 sheets)

Component	HDW AX-102[1]	AN-102[2]	AN-102[3]	AN-107[4]	AN-102/107 Average[5]	AX-102 Sample[6]
K	1,600	1,500	< 1,700	1,100	1,300	nr
La	2.26	nr	nr	nr	nr	nr
NO_3	176,000	136,000	112,000	142,000	130,000	239,000
NO_2	71,700	55,000	39,300	42,000	45,400	35,000
CO_3	18,100	80,000	61,500	49,000	63,500	81,000
PO_4	5,380	4,400	3,030	4,050	3,830	1,970
Si	1,360	<13.2	1,360	nr	1,360	nr
SO_4	16,200	20,000	25,900	8,400	18,100	4,160
Sr	0	nr	<19.9	nr	<19.9	nr
F	780	1,250	< 890	1,150	1,200	262
Cl	5,290	2,600	2,060	1,350	2,000	696
U	1,310	<131	1,590	nr	1,590	nr
Zr	10.4	nr	554	nr	554	nr
TOC	11,200	23,000	16,300	27,000	22,100	55,000
$^{239/240}Pu$ (µCi/g)	0.0366	nr	nr	0.085	0.085	nr
^{137}Cs (µCi/g)	184	215	285	300	267	nr
^{90}Sr (µCi/g)	74.4	105	169	115	130	nr

Notes:

[1]Agnew et al. (1997)
[2]Based on grab samples taken in 1994 and 1995 (Herting 1996)
[3]Based on core sample taken in 1990 (Douglas et al. 1996)
[4]Based on grab samples taken in 1994 (Herting 1994a)
[5]Average of analytical data in columns 3-5
[6]Average of 1995 auger and 1998 grab sample results (Section B3.4)

Agreement between the SMM subroutine predictions and the analytical data is generally good. but the subroutine appears to have a tendency to underestimate the concentrations of sparingly soluble components (Fe, Pb, Ni, Mn) and to overestimate concentrations of very soluble components (NO_3, NO_2, CO_3).

Auger samples and finger trap grab samples were taken from the surface of the 241-AX-102 waste in February 1995 and February 1998 to support the safety and organic complexants issues for the tank. Limited analyses were obtained from these samples (Section B2.0).

Where available, analytical results from tank 241-AX-102 were used to calculate the saltcake inventories. Most of the chemical inventories were based on average values for tank 241-AN-102 and 241-AN-107 samples. Except where sample data were available, radionuclide inventories were based on HDW model SMM concentrations, the current saltcake volume (87.1 kL [23-kgal]), and a density of 1.5 g/mL (see Table D3-4).

D3.2 ASSUMPTIONS FOR RECONCILING WASTE INVENTORIES

This section presents the results of this inventory evaluation for tank 241-AX-102 (as detailed in Section D3.1). A set of simplified assumptions forms the basis for the best-basis inventory values (Tables D3-5 and D3-6). The following assumptions and observations are based upon best technical judgement pertaining to parameters that can significantly influence tank inventories:

1. The volume of sludge in the tank is 26.5 kL (7 kgal). The volume of saltcake is 87.1 kL (23 kgal). There is no supernatant in the tank.

2. The best-basis inventory of the chemicals in the sludge layer is based on the analytical results for a grab sample of the sludge taken in 1974. Radionuclide inventory estimates are based on 1977 grab sample. For analytes that were not measured, the HDW model estimates are used after adjusting the values to account for water losses attributed to evaporation. The basis for radionuclide values is defined in Table D3-6. The concentration of TOC in the sludge was assumed to be zero.

3. The best-basis inventory of the saltcake layer is based on analytical results for tank 241-AX-102, where available. Because analytical data for saltcake in tank 241-AX-102 were limited, the balance of the chemical inventory estimates were based on analytical results for samples from tanks 241-AN-102 and 241-AN-107. It was assumed that the composition of solids in these tanks is similar to that in tank 241-AX-102 because the composition of the supernatant liquids was similar. Tanks 241-AN-102 and 241-AN-107 contain waste that was previously stored in 241-AX-102, though some additional blending of waste occurred. That is, the waste was transferred first to tank 241-AZ-102,

where it was blended with CC waste from other single-shell tanks before being transferred to tanks 241-AN-102 and 241-AN-107. Supernatant mixing model (SMM) concentrations from the HDW model (Agnew et al. 1997) were used to calculate inventories for most of the radionuclides and analytes not measured (Bi, Hg, La, Zr, Si, Sr, and U). The basis for calculating uranium and alpha isotope inventories is defined in Table D3-6.

4. The overall best-basis inventory of the tank is the sum of the inventories for the sludge layer and the saltcake layer. Sludge, saltcake and total best-basis inventories are presented in Tables D3-5 and D3-6.

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valence of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997).

Table D3-5. Saltcake, Sludge, and Total Best-Basis Chemical Inventory Estimates for Tank 241-AX-102. (2 sheets)

Component	Saltcake (kg)[1]	Sludge (kg)[2]	Total Best-Basis Inventory (kg)	HDW Inventory (kg)[3]
Na	24,000	4,460	28,500	41,500
Al	1,750	1,510	3,260	6,390
Bi	21.3	0	21.3	32.6
Fe	287	3,770	4,060	1,740
Cr	136	6.74	143	852
Pb	<34.6	<0.09	<34.7	31.7
Ni	44.0	167	211	111
Mn	54.0	316	370	29.8
Ca	74.1	211	285	386
K	170	7.99	178	323
La	<0.30	<0	<0.30	0.452

Table D3-5. Saltcake, Sludge, and Total Best-Basis Chemical Inventory Estimates for Tank 241-AX-102. (2 sheets)

Component	Saltcake (kg)[1]	Sludge (kg)[2]	Total Best-Basis Inventory (kg)	HDW Inventory (kg)[3]
NO_3	31,200	3,410	34,600	36,600
NO_2	4,570	503	5,080	14,500
CO_3	10,600	849	11,400	3,960
PO_4	257	59.5	317	1,100
Si	177	936	1,110	925
SO_4	543	94.4	638	3,290
Sr	2.6	0	2.6	0
F	34.2	0	34.2	156
Cl	90.9	33.1	124	1,070
U	<208	<41.2	<249	266
Zr	<72.4	0	<72.4	2.08
TOC	7,190	0	7,190	2,250

Notes:

[1]Based on a volume of 87.1 kL (23 kgal) and analyte compositions shown in Table D3-3

[2]Based on a volume of 26.5 kL (7 kgal) and Table D3-1 analyte compositions

[3]Agnew et al. (1997) total inventory estimate for tank 241-AX-102

Table D3-6. Saltcake, Sludge and Total Best-Basis Radionuclide Inventory Estimates for Tank 241-AX-102.[1] (2 sheets)

Component	Saltcake (Ci)[2]	Sludge (Ci)[3]	Total Best-Basis Inventory (Ci)	HDW Inventory (Ci)[4]
^{137}Cs	34,900	11,700	46,600	37,300
^{90}Sr	17,000	2.93E+05	3.10E+05	172,000
^{3}H	20.6	2.07	22.7	32.4
^{14}C	3.16	0.639	3.80	5.1
^{59}Ni	0.186	3.11	3.30	1.57
^{60}Co	3.91	401	405	6.61
^{63}Ni	18.3	322	341	161
^{79}Se	0.312	11.6	12.0	5.29
^{93m}Nb	1.11	33.7	34.8	15.6
^{93}Zr	1.54	50.8	52.3	23.3
^{99}Tc	23.5	4.25	27.8	37.7
^{106}Ru	0.000672	1.41	1.41	0.585
^{113m}Cd	8.37	253	262	117
^{125}Sb	17.5	4,710	4,730	30.8
^{126}Sn	0.472	18.5	19.0	8.35
^{129}I	0.0453	0.00826	0.0536	0.0728
^{134}Cs	0.310	0.0741	0.384	0.504
^{151}Sm	1100	33,900	34,700	15,500
^{152}Eu	0.408	49.5	49.9	21.1
^{154}Eu	60.9	0.00	60.9	1,660
^{155}Eu	24.0	1,720	1,750	1,030
^{226}Ra	1.23E-05	0.000521	0.000533	2.34E-04
^{227}Ac	7.66E-05	0.00247	0.00255	0.00114
^{228}Ra	0.0248	2.07E-08	0.0248	0.0379
^{229}Th	0.000576	1.94E-06	0.000578	8.82E-04

Table D3-6. Saltcake, Sludge and Total Best-Basis Radionuclide Inventory Estimates for Tank 241-AX-102.[1] (2 sheets)

Component	Saltcake (Ci)[2]	Sludge (Ci)[3]	Total Best-Basis Inventory (Ci)	HDW Inventory (Ci)[4]
^{231}Pa	0.000366	7.76E-05	0.000443	5.91E-04
^{232}Th	0.00252	2.7E-10	0.00252	0.00386
^{237}Np	0.0830	0.0137	0.0967	0.133
^{238}Pu	2.00	19.3	21.3	60.7
^{239}Pu	6.51	13.1	78.2	415
^{240}Pu	11.3	47.0	58.2	148
^{241}Pu	138	1,340	1,470	4,200
^{242}Pu	7.62E-04	0.00967	0.0104	0.0303

Notes:

[1]All radonuclide values decayed to January 1, 1994.

[2]Radionuclide inventories were mostly based on HDW model concentrations. Plutonium inventories were based on 1995/1998 total alpha data ratioed to HDW model isotopes. A saltcake volume of (87.1 kL [23 kgal]) and density of 1.5 g/mL were used for inventory calculations.

[3]Inventories were based on 1977 sludge samples and HDW model sludge concentrations adjusted for water content (Section D3.1.1). Plutonium isotope inventories were based on tank 241-AX-102 1974 data for plutonium and HDW model plutonium isotope ratios. A sludge volume of 26.5 kL (7 kgal) and density of 1.57 g/mL were used for inventory calculations.

[3]Agnew et al. (1997)

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

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, risk assessment associated with waste management activities, and 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 them into a form suitable for long-term storage/disposal.

Chemical and radiological inventory information are generally derived using three approaches: 1) component inventories are estimated using the results of sample analyses, 2) component inventories are predicted using the HDW model based on process knowledge and historical information, or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

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

- Limited analytical results for 1998 grab sample composite and 1995 auger saltcake samples (Appendix B)
- Analytical results for 1974 data (Horton 1974) and 1977 (Starr 1977) sludge data
- Adjusted HDW model inventory estimates (Agnew et al. 1997)
- Inventory estimates based on sample results for tanks with similar process histories.

Tables D4-1 and D4-2 list the best-basis inventory of nonradioactive and radioactive components in tank 241-AX-102 as determined from consideration of sample results, independent assessment values, HDW model values, and use of a 114 kL (30 kgal) tank waste volume. Sampling results were chosen as the best basis for those analytes for which analytical values were available. The engineering inventory was calculated using adjusted HDW model results if no sample based information was available. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (LMHC 1998) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1998), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, have been

infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. These computer models are described in Kupfer et al. (1997), Section 6.1, and in Watrous and Wootan (1997.) Model-generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample- or engineering assessment-based result, if available.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AX-102. (Effective October 1, 1998) (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	3,260	M/E	AN tanks and adjusted HDW
Bi	21.3	M/E	AN tanks and adjusted HDW
Ca	285	S/E	AN tanks and 1974 sludge sample
Cl	124	M/E	AN tanks and adjusted HDW
TIC as CO_3	11,400	S/M	1995 and 1998 saltcake samples
Cr	143	M/E	AN tanks and adjusted HDW
F	34.2	S/M	1995 and 1998 saltcake samples and adjusted HDW
Fe	4,060	S/E	AN tanks and 1974 sludge sample
Hg	0	E	Simpson (1998)
K	178	M/E	AN tanks and adjusted HDW
La	0	E	No process history of La
Mn	370	S/E	AN tanks and 1974 sludge sample
Na	28,500	M/E	AN tanks and adjusted HDW
Ni	211	M/E	AN tanks and adjusted HDW
NO_2	5,080	S/M	1995 and 1998 saltcake samples and adjusted HDW
NO_3	34,600	S/M	1995 and 1998 saltcake samples and adjusted HDW
OH_{TOTAL}	9,150	C	Calculated from charge balance

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AX-102. (Effective October 1, 1998) (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Pb	34.7	M/E	AN tanks and adjusted HDW
PO_4	317	S/M	1995 and 1998 saltcake samples and adjusted HDW
Si	1,110	S/E	AN tanks and 1974 sludge sample
SO_4	638	S/M	1995 and 1998 saltcake samples and adjusted HDW
Sr	2.60	M/E	AN tanks and adjusted HDW
TOC	7,190	S/M	1995 and 1998 saltcake samples and adjusted HDW
U_{TOTAL}	249	S/E	AN tanks and 1974 sludge sample
Zr	72.4	M/E	AN tanks and adjusted HDW

Note:

[1]S = sample based, M = Hanford defined waste model (Agnew et al. 1997), E = engineering assessment-based, and C = calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994. (Effective October 1, 1998) (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	22.7	M/E	
^{14}C	3.80	M/E	
^{59}Ni	3.30	M/E	
^{60}Co	405	M/E	HDW model SMM and 1977 sludge data
^{63}Ni	341	M/E	
^{79}Se	12.0	M/E	
^{90}Sr	3.10E+05	S/E	AN tank saltcake and 1977 sludge data
^{90}Y	3.10E+05	S/E	Referenced to ^{90}Sr
^{93m}Nb	34.8	M/E	
^{93}Zr	52.3	M/E	
^{99}Tc	27.8	M/E	
^{106}Ru	1.41	M/E	
^{113m}Cd	262	M/E	
^{125}Sb	4,730	M/E	HDW model SMM and 1977 sludge data
^{126}Sn	19.0	M/E	
^{129}I	0.0536	M/E	
^{134}Cs	0.384	M/E	
^{137m}Ba	44,100	S/E	Referenced to ^{137}Cs
^{137}Cs	46,600	S/E	AN tank saltcake and 1977 sludge data
^{151}Sm	34,700	M/E	
^{152}Eu	49.9	M/E	HDW model SMM and 1977 sludge data
^{154}Eu	60.9	M/E	HDW model SMM and 1977 sludge data
^{155}Eu	1,750	M/E	
^{226}Ra	0.000533	M/E	
^{227}Ac	0.00255	M/E	
^{228}Ra	0.0248	M/E	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994 (Effective October 1, 1998). (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{229}Th	0.000578	M/E	
^{231}Pa	0.000443	M/E	
^{232}Th	0.00252	M/E	
^{232}U	0.118	S/E/M	Based on 1977 data and AN tank U_{TOTAL} and HDW model isotopic ratios
^{233}U	0.451	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{234}U	0.0927	S/E/M	Based on 1977 data and AN tank U_{TOTAL} and HDW model isotopic ratios
^{235}U	0.00371	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{236}U	0.00303	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{237}Np	0.0967	M/E	
^{238}Pu	21.3	M/E	Based on 1995/1998 saltcake total alpha, 1974 total Pu and HDW model ratios.
^{238}U	0.0831	S/E/M	Based on 1977 and AN tank U_{TOTAL} and HDW model isotopic ratios
^{239}Pu	78.2	S/M/E	Based on 1995/1998 saltcake total alpha, 1977 total Pu and HDW model ratios.
^{240}Pu	58.2	S/M/E	Based on 1995/1998 saltcake total alpha, 1977 total Pu and HDW model ratios.
^{241}Am	1,330	M	
^{241}Pu	1,470	S/M/E	Based on 1995/1998 saltcake total alpha, 1977 total Pu and HDW model ratios.
^{242}Cm	1.79	M	HDW model adjusted to 114 kL volume.
^{242}Pu	0.0104	S/M/E	Based on 1995/1998 saltcake total alpha, 1977 total Pu and HDW model ratios.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-AX-102 Decayed to January 1, 1994 (Effective October 1, 1998). (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{243}Am	0.148	M	
^{243}Cm	0.218	M	
^{244}Cm	8.96	M	

Note:

[1]S = sample-based, M = Hanford defined waste model-based (Agnew et al. 1997), and E = Engineering assessment-based.

D5.0 APPENDIX D REFERENCES

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Herting, D. L., 1996, *Tank 241-AN-102 Caustic Demand and Sludge Characterization*, (internal memorandum 75764-PCS96-085 to K. G. Carothers, August 22), Westinghouse Hanford Company, Richland, Washington.

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AX-102

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-AX-102

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

The references in this bibliography are separated into three 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

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

- IIa. Sampling of Tank 241-AX-102
- IIb. Sampling of 242-A Evaporator Streams

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

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

The bibliography is broken down into the appropriate sections of material with an annotation at the end of each reference describing the information source. Most information listed below is available in the Lockheed Martin Hanford Corporation Tank Characterization and Safety Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste information to 1981.

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

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

Ib. Fill History/Waste Transfer Records

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Waste Status and Transaction Record Summary (WSTRS) Rev. 4*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

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

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Contains single-shell tank fill history and primary campaign and waste information to 1981.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History*, WHC-SD-WM-TI-302, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Contains information on the sluicing of single-shell tanks.

Ic. Surveillance/Tank Configuration

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

- Shows tank riser locations in relation to a tank aerial view and a description of risers and their contents.

Lipnicki, J., 1997, *Waste Tank Risers Available for Sampling*, HNF-SD-RE-TI-710, Rev. 4, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Assesses riser locations for each tank; however, not all tanks are included or completed. A estimate of the risers available for sampling are also included.

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

- Contains riser and thermocouple information for Hanford Site waste tanks.

Id. Sample Planning/Tank Prioritization

Adams, M. R., T. M. Brown, J. W. Hunt, and L. J. Fergestrom, 1998, *Fiscal Year 1999 Waste Information Requirements Document*, HNF-2884, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains tank waste requirements for the 1999 fiscal year.

Brown, T. M., J. W. Hunt, and L. J. Fergestrom, 1997, *Tank Characterization Technical Sampling Basis*, HNF-SD-WM-TA-164, Rev. 3, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Summarizes the 1997 technical basis for characterizing tank waste and assigns a priority number to each tank.

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DOE-RL, 1996, *Recommendation 93-5 Implementation Plan*, DOE/RL-94-0001, Rev. 1, U.S. Department of Energy, Richland, Washington.

- Describes the organic solvents issue and other tank issues.

Field, J. G., 1998, *Tank 241-AX-102 Grab Sampling and Analysis Plan*, HNF-2190, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains sampling and analysis requirements for tank 241-AX-102 grab samples based on applicable DQOs.

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Sasaki, L. M.,1997, *Letter of Instruction for Subsampling and Organic Speciation of Tank Samples*, (internal memorandum 74620-97-217 to A. D. Rice and J. A. Campbell, September 29), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Memorandum requests analysis of archived auger samples for the organic complexants issue.

Schreiber, R. D.,1997, *Letter of Instruction for Analysis of Samples from Tanks 241-AX-102 and 241-BY-103*, (internal memorandum 7A110-98-013 to D. B. Hardy and S. G. Metcalf, April 29), Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Memorandum requests PRSST and support analyses of grab samples for the organic complexants issue.

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

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Horton, J. E., 1974, *Analyses and Characterization of Sludge Samples Received from Tank 102-AX* (letter to O. R. H. Rasmussen, September 25), Atlantic Richfield Hanford Company, Richland, Washington.

- Contains results for 1974 sludge samples.

Rice, A. D., 1995, *90-Day Final Report for Tank 241-AX-102, Auger Samples 95-AUG-006 and 95-AUG-007*, WHC-SD-WM-DP-100, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Contains 1995 auger sample analytical results.

Starr, J. L., 1977, *Analysis of Tank 102-AX Sludge* (internal letter 072077 to J. W. Bailey, July 20), Rockwell Hanford Operations, Richland, Washington.

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Weiss, R. L., 1988, *Analysis of Tank 241-AX-102 Sample* (internal memo 12712-PCL88-018 to J. A. Eacker, November 14), Westinghouse Hanford Company, Richland, Washington.

- Contains results for 1988 liquid samples.

IIb. Sampling 242 A-Evaporator Waste Streams (1977 to 1980)

Field, J. G., 1997, *Tank Characterization Report for Single-Shell Tank 241-A-101*, HNF-SD-WM-ER-673, Rev. 0B, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information on SMMA1 waste types.

Field, J. G., 1998, *Tank Characterization Report for Single-Shell Tank 241-AX-101*, HNF-SD-WM-ER-649, Rev. 1, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information on SMMA1 waste types.

Lambert, S. L., 1998, *Preliminary Tank Characterization Report for Single-Shell Tank 241-A-103: Best-Basis Inventory*, HNF-SD-WM-ER-709, Rev. 0A, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc. Richland, Washington.

- Contains information on SMMA1 waste types.

Winward, R. T., and M. J. Kupfer, 1997, *Preliminary Tank Characterization Report for Single-Shell Tank 241-A-106: Best-Basis Inventory*, HNF-SD-WM-ER-721, Rev. 0, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains information on SMMA1 waste types.

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Bendixsen, R. B., 1980, *Dilute Customer Waste Concentration First Pass 242-A Evaporator-Crystallizer Campaign 80-1, October 10 to October 20, 1979*, RHO-CD-80-1045-1, Rockwell Hanford Operations, Richland, Washington.

Bendixsen, R. B., 1980, *Dilute Waste Concentration 242-A Evaporator-Crystallizer Campaign 80-2, October 28 to November 11, 1979*, RHO-CD-80-1045-2, Rockwell Hanford Operations, Richland, Washington.

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Brown, G. E., 1979, *Hot Boildown of Cross-Site Transfer Waste*, (internal letter 60120-79-011 to K. G. Carothers, January 18), Rockwell Hanford Company, Richland, Washington.

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Teats, M. C., 1982, *242-A Evaporator Campaign 80-10 Post Run Letter*, SD-WM-PE-006 (revision number unknown), Rockwell Hanford Operations, Richland, Washington.

Teats, M. C., 1982, *242-A Evaporator Campaign 80-10 Post Run Letter*, SD-WM-PE-007 (revision number unknown), Rockwell Hanford Operations, Richland, Washington.

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 Model Rev. 4*, LA-UR-96-3860, 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.

Brevick, C. H., R. L. Newell, and J. W. Funk, 1997, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 Areas*, HNF-SD-WM-ER-349, Rev. 1B, Fluor Daniel Northwest, Inc. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains summary information from the supporting document as well as in-tank photograph collages and the solid composite inventory estimates.

Klem, M. J., 1990, *Total Organic Carbon Concentration of Single-Shell Tank Waste* (internal letter 82316-90-032 to R. E. Raymond, April 27), Westinghouse Hanford Company, Richland, Washington.

- Provides a list of total organic carbon concentration for many tanks.

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

- Contains tank inventory information.

IIIb. Compendium of Data from Other Physical and Chemical Sources

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Supporting Document for the Historical Tank Content Estimate for AX Farm*, WHC-SD-WM-ER-308, Rev. 1B, Westinghouse Hanford Company, Richland, Washington.

- Contains historical data and solid inventory estimates.

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

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

Hanlon, B. M., 1998, *Waste Tank Summary Report for Month Ending June 30, 1998*, WHC-EP-0182-123, Lockheed Martin Hanford Corp. for Fluor Daniel Hanford, Inc., Richland, Washington.

- Contains a monthly summary of the following: fill volumes, Watch List tanks, occurrences, integrity information, equipment readings, equipment status, tank location, and other miscellaneous tank information.

Husa, E. I., 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Westinghouse Hanford Company, Richland, Washington.

- Contains in-tank photographs and summaries on the tank description, leak detection system, and tank status.

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

- Assesses relative dryness between tanks.

LMHC, 1998, *Tank Characterization Data Base*, Internet at http://twins.pnl.gov:8001/htbin/TCD/main.html

- Contains analytical data for each of the 177 Hanford Site waste tanks.

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

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