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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 663661

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 []	Toni L. Lauricella, Data Development and Interpretation, R2-12, 373-6343	[] Yes [X] No	08/07/01
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	Tank 241-S-107	241-S-107	N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	WHC-SD-WM-ER-589, Rev. 0-C	627062, 644457, and 649911	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

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14a. Justification (mark one)

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

14b. Justification Details

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

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

ENGINEERING CHANGE NOTICE	Page 2 of 2	1. ECN (use no. from pg. 1) ECN-663661

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

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

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

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

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

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. T. L. Lauricella	T L Lauricella	8-8-01	PE		
Cog. Mgr. J. G. Field	L M Sasaki for JG Field	8/9/01	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		
N. L. Hulse	N L Hulse	8-9-01			

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Data Development and Interpretation	Date 08/07/01
Project Title/Work Order		EDT No. N/A
HNF-SD-WM-ER-589, Rev. 1, "Tank Characterization Report for Single-Shell Tank 241-S-107."		ECN No. ECN-663661

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
CH2M HILL Hanford Group, Inc.					
M. R. Adams	R2-12	X			
J. G. Field	R2-12	X			
L. A. Fort	R2-11	X			
N. L. Hulse	R2-12	X			
T. L. Lauricella	R2-12	X			
L. R. Webb	R1-10	X			
Office of River Protection					
W. S. Liou	S7-54	X			
DOE/RL Reading Room	H2-53	X			

Tank Characterization Report for Single-Shell Tank 241-S-107

T. L. Lauricella
CH2M Hill Hanford Group, Inc., Richland, WA 99352
U.S. Department of Energy Contract 8023764-9-K001

EDT/ECN: ECN-663661 UC: 2070
Org Code: 7G300 Charge Code: 78-9932
B&R Code: EW 3120074 Total Pages: 23

Key Words: Tank Characterization Report, TCR, Single-Shell Tank, Single-Shell, SST, Tank 241-S-107, Tank S-107, S-107, S Farm

Abstract: N/A

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8/9/01

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STA: 4 ID: 2
AUG 10 2001

Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-589	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-S-107

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 09/19/96 on EDT-617543.	B.C. Simpson	J.G. Kristofzski
0-A RS	Incorporate per ECN-627062.	B.C. Simpson - Brett Simpson	K.M. Hall Kathleen M. Hall 1/9/97
0-B RS	Incorporate per ECN-644457	M.J. Kupfer MJ Kupfer 8-28-97	K.M. Hodgson K.M. Hodgson 8-27-97
0-C RS	Incorporate per ECN-649911	M.J. Kupfer MJ Kupfer 8-24-98	K.M. Hodgson K.M. Hodgson 9-24-98
1 RS	Incorporate per ECN-663661	T.L. Lauricella T L Lauricella 8-8-01	J.G. Field LM Sasaki for JG Field 8/9/01

A-7320-005 (08/91) WEF168

HNF-SD-WM-ER-589, REV. 1

This report prepared especially for Archive TIR on 8/7/01

Some of the reports herein may contain data that has not been reviewed or edited. The data will have been reviewed or edited as of the date that a Tank Interpretive Report (TIR) is prepared and approved. The TIR for this tank was approved on August 7, 2001.

Tank: 241-S-107

Sampling Events:
- 105
- 110
- 111
- 7S-00-1
- 7S-00-2
- 7S-00-3

Reports:
- Tank Interpretive Report

Constituent Groups:
- Anions
- Inorganics
- Metals/Nonmetals
- Organics
- PCBs
- Physical Properties
- Radionuclides

Table of Contents

Data Dictionary to Reports in this Document 1
Tank Interpretive Report For 241-S-107 2
Tank Information Drivers 2
Table 1-1. Heat Load Estimate Based on the Best-Basis Radionuclide Inventory 4
Tank History 4
Tank Comparisons 5
Disposal Implications 6
Scientists Assessment of Data Quality and Quantity 7
Unique Aspects of the Tank 9
Means and Confidence Intervals 10
Best-Basis Inventory Derivation 11
Table 8.1 Tank 241-S-107 Best-Basis Inventory Source Data 12
Reference List 16

Data Dictionary to Reports in this Document

Report	Field	Description
Tank Interpretive Report		Interprets information about the tank answering a series of eight questions covering areas such as information drivers, tank history, tank comparisons, disposal implications, data quality and quantity, and unique aspects of the tank.

Tank Interpretive Report For 241-S-107

Tank Information Drivers

Question 1: What are the information drivers applicable to this tank? What type of information does each driver require from this tank? (Examples of drivers are Data Quality Objectives, Mid-Level Disposal Logic, RPP Operation and Utilization Plan, test plans and Letters of Instruction.) To what extent have the information and data required in the driving document been satisfied to date by the analytical and interpretive work done on this tank?

The information drivers for tank 241-S-107 include the Data Quality Objectives for Tank Farms Waste Compatibility Program (Compatibility DQO), and the Tank Farm Waste Transfer Compatibility Program.

Closed and previously addressed issues for tank 241-S-107 include the Tank Safety Screening DQO, the Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue (Organic Complexant DQO), the Historical Model Evaluation Data Requirements DQO (Historical DQO), the Strategy for Sampling Hanford Site Tank Wastes for Development of Disposal Technology (Pretreatment DQO), the Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution (H&S Vapor DQO).

Compatibility DQO: Will safety problems be created as a result of mixing waste in interim storage? Do operations issues exist which should be addressed before waste is transferred?

Grab samples were acquired on September 19, 2000, as directed by the tank sampling and analysis plan (TSAP) (Lauricella 2000) to provide data for an assessment of the compatibility of the waste in tank 241-S-107 with wastes in tanks in the double-shell tank system. This was in accordance with the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Compatibility DQO) (Mulkey et al. 1999) and the *Tank Farm Waste Transfer Compatibility Program* (Fowler 2000). Grab sampling and analysis was performed to meet the sampling needs for criticality, corrosion, organics, energetics, and flammable gas as required by the Compatibility DQO Table 10-1 single-shell to double-shell transfers (Mulkey et al. 1999). In accordance with the Compatibility Program requirements, sampling tank 241-S-107 for compatibility in 2000 is within the required time frame of five years for sample data, based on current schedules and plans.

The compatibility assessment for possible transfer of tank 241-S-107 waste will be performed in May 2002 in accordance with the Compatibility Program requirements in Fowler (2000). This assessment is based on sample data and operational considerations including heat generation rate, phosphate, and sodium inventories, plugged pipelines and equipment, and complexant waste segregation. Saltwell pumping of 241-S-107 is scheduled for November 2002 according to the *SST Interim Stabilization Project Plan* (Vladimiroff 2000). For single-shell tanks (SSTs), there are no active operating tank limits for sample results for hydroxide or nitrate and only limits for nitrite and sodium concerning the issue of corrosion control. For double-shell tanks and saltwell receivers, there are variable limits dependent on nitrate concentration. Energetics

data from the September 2000 grab samples are available in the data package (Steen 2001). The sole sample exhibiting exothermic behavior showed an exothermic to endothermic ratio of 0.01, well below the limit of 1.0.

Closed Issues and Issues Previously Addressed:

Issues previously addressed include the Tank Safety Screening DQO (Dukelow et al. 1995), the Organic Complexant DQO (Turner et al. 1995, Meacham et al. 1997), the Historical DQO (Simpson and McCain 1995), the Pretreatment DQO (Kupfer et al. 1995), and the H&S Vapor DQO (Osborne and Buckley 1995).

The *Evaluation of Tank Data for Safety Screening* by Reynolds et al. (1999) performed a formal review of tank 241-S-107 data and determined the sampling and analysis performed were consistent with the requirements of the Safety Screening DQO. The organic complexant issue was closed for all tanks in 1998 (Owendoff 1998).

For the Historical DQO (Simpson and McCain 1995), the 1996 core samples were acquired and composited according to the *Tank Characterization Plan* (TCP) (Homi 1996). The *Tank Characterization Report for Single-Shell Tank 241-S-107* (Simpson et al. 1997) used the composite sample analytical results to perform the comparison analysis. The Historical DQO classified tank 241-S-107 as "spatially complex" because historical information indicates that the tank received many different waste types. The waste type comparisons were made for the REDOX sludge layer segments and were found to satisfy the historical DQO gateway assessment. Simpson et al. (1997) compared the tank 241-S-107 composite data with the *Historical Tank Contents Estimate* (HTCE) (Brevick et al. 1997) and found that only six of twenty-five analytes compared well between the two sources.

For the Pretreatment DQO (Kupfer et al. 1995), sub-samples from three cores were designated as archive samples from tank 241-S-107 to supply sample material to the pretreatment program in accordance with the *Tank 241-S-107 Push Mode Core Sampling and Analysis Plan* (SAP) (Bell 1996a). The archived material is stored at the 222-S Laboratory is available for use by other programs (Renberger and Seidel 2001).

Vapor samples from tank 241-S-107 were taken on June 18, 1996, as specified in the *Vapor Tank Sampling and Analysis Plan* (Vapor TSAP) (Homi and Huckaby 1996) and as required for the *Health and Safety Vapor Data Quality Objective* (H&S Vapor DQO) (Osborne and Buckley 1995). The vapor samples were analyzed for volatile organic compounds, semi-volatile organic compounds, inorganic gases, and the permanent gases and results were reported in the *Headspace Vapor Characterization of Hanford Waste Tank 241-S-107* (Pool et al. 1997). Ammonia was detected above the notification limit of 150 parts per million volume (ppmv). Organic compounds methanol (190 ppb), 1-butanol (23 ppb), ethanol (134 ppb), and acetone (27 ppb) were detected above the estimated quantitation limits (EQL in parts per billion). The total non-methane organic compounds gases were detected above the EQL (0.82 mg/m^3) and found to be 3.54 mg/m^3 (Pool et al. 1997). Hydrogen and nitrous oxide were detected above the EQL (31 ppmv) but below the lower flammability level (LFL). The average of concentration

results reported for carbon dioxide, carbon monoxide, and methane were less than detectable (<17 ppmv).

Heat Load Estimate:

A factor in assessing tank safety is the heat generation and temperature of the waste. The tank heat load based on the Best-Basis Inventory (See Standard Report *Best-Basis Inventory [Radioactive]*), decayed to January 1, 2001, was 3,178 W (10,849 Btu/hr). Agnew et al. (1997a) estimated the tank heat load to be 3,190 W (10,900 Btu/hr) and Kummerer (1995) estimated the tank heat load to be 2,730 W (9,327 Btu/hr). All these heat load estimates are comparable.

Table 1-1. Heat Load Estimate Based on the Best-Basis Radionuclide Inventory.

Radionuclide	Waste Inventory	Decay Heat Generation[1]	Heat Load (Watts)
Strontium-90	3.43E+05 Ci	0.00669 W/Ci	2,295
Cesium-137	1.87E+05 Ci	0.00472 W/Ci	883
Total			3,178

Note: [1]Includes daughter isotopes.

Tank History

Question 2: What is known about the history of this tank as it relates to waste behavior?

The S-Tank farm was constructed from 1950 to 1951 in the 200 West Area. The S-Tank farm contains twelve second-generation, 100-series, single-shell tanks. These tanks have a nominal capacity of 2,869 kL (758 kgal), a diameter of 23 m (75 ft), and a nominal operating depth of 7 m (23 ft). Tank 241-S-107 has a dished bottom with a 1.2 m (4 ft) radius knuckle and is passively ventilated. The tanks in the S-Tank farm were designed for non-boiling waste with a maximum fluid temperature of 104°C (220°F). Tank 241-S-107 entered service in the fourth quarter of 1952. It is first in a three-tank cascade series including tanks 241-S-108 and 241-S-109. Each succeeding tank in the cascade is 30 cm (1 ft) lower in elevation than the previous. A 7.6-cm (3-in.) cascade overflow line connects the three tanks in each cascade series (Brevick et al. 1997). Tank descriptions and figures are presented in the tank 241-S-107 standard reports *Description of Tank, Tank Plan View, Tank Profile View*, and *Riser Configuration Table*.

The first waste streams to enter tank 241-S-107 were from the reduction oxidation (REDOX) S-Plant starting the fourth quarter of 1952 (Agnew et al. 1997b, Anderson 1990). The tank received REDOX centrifuge cake from the first quarter of 1953 through the fourth quarter of 1954, REDOX cladding waste from 1955 through 1967, and zirconium cladding waste in 1966

and 1967. From 1968 through 1980, the tank received transfers of REDOX evaporator bottoms, cladding waste, supernatant waste such as 242-T Evaporator (saltcake) waste, B-Plant low-level waste (BL), B-Plant high-level waste, REDOX ion exchange waste, decontamination waste, plutonium-uranium extraction (PUREX) low level waste, N-Reactor waste, partial neutralized feed, double-shell slurry feed, laboratory waste, REDOX waste, Battelle Northwest waste, and complexant concentrate waste (Anderson 1990). Approximately 1,310 kL (346 kgal) of waste remained after a final transfer in the third quarter of 1980 when the tank was removed from service.

Since 1980, tank 241-S-107 has shown a slow, steady increase in surface level; from January 1981 through July 2001, the surface level has increased approximately 36 cm (14 in.). This type of surface level increase is indicative of slurry growth caused by gas generation and retention within the waste. A standard hydrogen monitoring system (SHMS) cabinet was installed on the tank in March 1998 and set to standby mode in February 2000 (McCain 2000).

A description and the waste type, volume, and status of tank 241-S-107 are summarized in the *Best-Basis Inventory* in Table 8.1. Current surveillance data and observations appear to support these amounts. Tank 241-S-107 is listed as sound and partially stabilized, but intrusion prevention and interim stabilization have not been completed. This tank was removed from service in 1980. A saltwell pump was installed in the tank in 1991. The *Waste Tank Summary Report* (Hanlon 2001) reports that tank 241-S-107 is scheduled to begin saltwell pumping to remove liquid waste in November 2002 for completion in September 2003.

Tank Comparisons

Question 3: What other tanks have similar waste types and waste behaviors, and how does knowledge of the similar tanks contribute to the understanding of this tank?

Tank 241-S-107 received primarily REDOX waste and REDOX cladding waste during the first fifteen years of operation. Zirconium cladding waste, transfers of REDOX evaporator bottoms, cladding waste, supernatant waste such as 242-T Evaporator (saltcake) waste, B Plant low-level waste (LLW), organic wash waste, REDOX ion exchange waste, decontamination waste, PUREX high-level waste (HLW), PUREX LLW, N Reactor waste, partially neutralized feed, double-shell slurry feed, laboratory waste, Battelle Northwest waste, cesium supernatant recovery waste, 224-U (LaF_3) waste, and non-complexed waste were received during the last twelve years of operation (Anderson 1990 and Agnew et al. 1997a).

Tank 241-S-107 currently contains four defined waste phases, including supernatant, saltcake liquid, saltcake solids, and sludge solids and is designated as non-complex (NCPLX). Tanks that contain similar wastes are tanks 241-S-101, 241-S-104, 241–S-105, 241-S-106, 241-S-107, 241-S-108, 241-S-109, 241-S-110, 241-S-111, and 241-S-112, as well as T-Tank farm 241-T-101 (Hanlon 2001). Templates were used to generate the missing analytes based upon the sampling data from tanks that contain similar waste types as tank 241-S-107.

Disposal Implications

Question 4: Given what is known about the waste properties and waste behaviors in this tank, what are the implications of the waste properties and behaviors to the waste retrieval/processing methodologies and equipment selection?

Tank 241-S-107 has not yet been interim stabilized and has been scheduled for saltwell pumping in November 2002. A compatibility assessment, to be performed at a later date, is required to determine how the waste properties and behaviors would affect transfer of waste from tank 241-S-107. Steen (2001) reported that the exothermic to endothermic ratio is 0.01, well below the limit of 1.0; therefore organic and energetic reactions are not expected to be an issue. The temperature was measured from April 1, 2000 to March 31, 2001 with a range of 24.2°C (76.0°F) to 41.7°C (107.0°F). The likelihood of supersaturation and pluggage in the transfer line because of a waste temperature decrease during interim stabilization should be considered, as historically this has been a concern with waste from the S-Tank farm. Heat tape on the transfer line will likely be used to maintain temperatures similar to the in-tank conditions.

Tank 241-S-107 has been selected as a Phase II source tank for vitrification. The *Single-Shell Tank Retrieval Sequence: Fiscal Year 2000 Update* (Garfield et al. 2000) lists tank 241-S-107 as a Category 4 tank because it is sound, and because it contains less than 1.83 m (6 ft) of saltcake/sludge. Kirkbride et al. (2000) estimates that retrieval of the waste from the tank will commence in August 2020 and proceed until December 2022.

The waste in tank 241-S-107 is approximately one-third saltcake or salt slurry and two-thirds soft sludge. According to the *Core Profiles Standard Report*, the waste in the tank was sampled nearly to the bottom of the tank by push mode sampling equipment.

Because of the questionable leak integrity of the SSTs, the use of large amounts of liquid to mobilize or dissolve the waste will not be permitted. Sixty-seven of the SSTs are known or suspected to have leaked although tank 241-S-107 is listed as sound (Hanlon 2001). All of the SSTs have exceeded their design lives. Therefore, the current approach is to demonstrate retrieval technologies that use very little, if any, liquids to mobilize and retrieve the waste. Any liquid that is used will be small in volume and used in a confined manner. Tank 241-S-107 is a combined saltcake and sludge tank. The wastes will be retrieved from tank 241-S-107 using the AEA Technology (AEAT) Power Fluidics™ Mixing and Pumping System. Efforts are also underway to demonstrate the Russian Pulsating Mixing and Pumping System for use in retrieving mixed saltcake and sludge tanks according to the Single-Shell Tank Retrieval Program. Enhanced methods of waste removal, including a remote vehicle equipped with a localized sluicing nozzle and transfer pump, are under consideration (Kirkbride et al. 2000).

The industrial hygiene survey associated with the most recent sample event in September 2000 was not available at the time this report was prepared. The data associated with the core sampling event in 1995 (*Tank 241-S-107 IH Sniff Data* standard report) reported 0 percent of the lower flammability limit for flammable gases, and 8.3 parts per million of organic vapor

detected. The extent that waste retrieval operations, such as mixing and pumping, will cause emissions of organic vapors should be considered.

The headspace vapors of tank 241-S-107 were within health hazard threshold limits for all analytes measured except ammonia (Pool et al. 1997). The sampling of the headspace vapors was performed at steady-state conditions.

Retained gas in the solid waste layers may affect retrieval of waste from this tank. While tank 241-S-107 is not on the Flammable Gas watch list, it is equipped with a Standard Hydrogen Monitoring System (SHMS). The SHMS data showed that the tank has not experienced a gas release as reported in the *Results of Vapor Space Monitoring of Flammable Gas Watch List Tanks* (McCain 2000). As determined by the SHMS, the peak concentration of hydrogen was 370 ppm and is below the action limit of 6,250 ppm. As a result, SHMS coverage was discontinued on February 14, 2000 (McCain 2000). However, during the core-sampling event, the drill string required purging to eliminate the high LFL within the drill string during the push-mode core sampling (WHC 1995). Flammable gas trapped within the waste layers may have caused the high LFL within the drill string. Neither the SHMS monitor nor the vapor-sampling event may have been able to detect this flammable gas from the undisturbed waste surface. The gradual surface level increase of 36 cm (14 in.) over a period of two decades may also indicate the formation and retention of gas within the waste.

Polychlorinated biphenyls (PCBs) were not measured in the 2000 grab samples; however, samples were archived for future PCB analysis (Nguyen 2001).

No organic layers were observed in tank 241-S-107 during the 1995 core sampling or 2000 grab sampling (Bell 1996b, Steen 2001).

Scientists Assessment of Data Quality and Quantity

Question 5: Given the current state of understanding of the waste in this tank on the one hand and the information drivers on the other; should additional tank data be sought via sampling/analysis from a strictly technical point-of-view? Can the waste behavior in this tank be adequately understood by other means (eg. archive samples, tank grouping studies, modeling) without additional sampling and analysis? If so, what characteristics of the tank waste lend themselves to a non-sample alternative? Is the quality of the data from this tank adequate from a field sampling and analytical laboratory point-of-view? Are there any clarifications or explanations needed for the data tables and figures?

Sampling and Analysis

All current applicable DQOs and waste issues have been addressed for this tank, and no additional sampling and analyses are necessary to satisfy current safety issue requirements. Saltwell pumping is scheduled from tank 241-S-107 in 2002; no additional sampling is necessary to support this activity. Tank 241-S-107 is scheduled as a Phase II LAW feed tank, to be delivered to the Waste Treatment Plant in 2022 (Kirkbride 2000). Prior to delivery of the waste

from tank 241-S-107 to the Waste Treatment Plant, existing data and archived samples will be evaluated to determine if additional sampling will be necessary to address the applicable Disposal DQOs.

On September 19, 2000, three liquid grab samples were taken to address the Compatibility DQO. The samples were taken from riser 005 through the salt screen and analyzed, as directed by the *Compatibility Grab Sampling and Analysis Plan for Fiscal Year 2000* (TSAP) (Lauricella 2000), and the results were reported in the *Tank 241-S-107 Grab Samples, 7S-00-1, 7S-00-2, and 7S-00-3 Analytical Results for the Final Report* (Steen 2001). Sample 7S-00-1 was archived for future use as directed in the TSAP (Lauricella 2000). Sampling events preceding those discussed above are not addressed in this document because they add no information regarding the current drivers for tank 241-S-107.

Data Quality

The data from the 2000 grab sampling event was collected and analyzed with approved and recognized sampling and laboratory procedures and in accordance with the TSAP (Lauricella 2000). Quality Control (QC) parameters assessed in conjunction with tank 241-S-107 samples included standard recoveries, spike recoveries, duplicate analyses, and blanks. Appropriate QC footnotes were applied to data outside QC parameter limits. Analytical results and data quality are discussed in the tank 241-S-107 data package (Steen 2001). The vast majority of QC results were within the boundaries specified in the sampling and analysis plans. Small discrepancies noted in the analytical reports and footnoted in the A*nalytical Results* standard report should not impact the data validity or use.

For the 2000 grab samples, the pH values were >13.50. Accuracy at pH higher than the calibration buffer of 12.50 may be questionable.

Clarification and Explanation of Data Tables and Figures

The *241-S-107 Average Monthly Tank Surface Levels (after 1/1/96 only)* standard report: This graph shows tank waste surface levels after January 1, 1996. The tank surface level has increased less than three inches in five years. The probable cause of this increase is the slow generation and accumulation of gas within the waste. Comments in the Surveillance Analysis Computer System (SACS) database indicate several minor rebaselinings of the ENRAF™ instrument.

The *241-S-107 Core Profiles* standard report: These profiles show the waste phases present in tank 241-S-107 based on visual examination during extrusion. These phases may not be identical to the reported tank contents based on analytical data, as tank phases may be difficult to determine by visual examination only.

The *241-S-107 Tank Temperature Profile* standard report: This profile reports the maximum temperature for the thermocouples in the tank waste as a function of time. The tank temperatures are consistent with the small inventory of radionuclides in the waste, and the gradual decrease in tank temperature with time is consistent with the decay of radionuclides within the waste. The

small fluctuations in waste temperature evident in the graph are attributed to seasonal temperature variations. The graph shows a large apparent drop in temperature in 1986. This apparent drop is an artifact caused by the way the report generator selected the data to be shown in the graph and does not reflect a real change in tank waste temperature.

The *241-S-107 HTCE Surface Levels* standard report: This graph reports the historical waste transfer activity for tank 241-S-107 on a quarterly basis and does not represent a complete waste transfer history for the tank. The transfer notations at the top of the graph are only representative and are not an exhaustive listing of waste transfers to and from the tank. For a more complete listing of historical waste transfers for tank 241-S-107, see Agnew et al. (1997b). From 1980 through 1996, the graph shows two distinct step increases in the waste surface level. An examination of the surface level data from the Surveillance Analysis Computer System (SACS) database does not show any step increases during that time period. Instead, the surface level has shown a slow, steady increase of about 36 cm (14 in.) from January 1981 through July 2001. This waste level increase is probably caused by the generation and accumulation of gas within the waste.

The *Tank 241-S-107 IH Sniff Data* standard report: The industrial hygiene survey associated with the most recent sample event in September 2000 was not available at the time this report was prepared.

Unique Aspects of the Tank

Question 6: What are unique chemical, physical, historical, operational or other characteristics of this tank or its contents?

There are no unique chemical, physical, historical, operational, or other characteristics of this tank or its contents. While not unique, the following physical descriptions of the tank waste may be of interest. Current in-tank photographs were available; the tank has an uneven surface around the margin, with a pool of supernatant that comprises up to 70 percent of the surface area. Based on appearance of the samples from the September 1995 push mode sampling event, the waste is composed of saltcake and sludge with little free liquid (see *Subsampling Scheme and Sample Description and Core Profiles* Standard Reports).

Tank 241-S-107 has shown a slow, steady increase in surface level. This waste level increase is indicative of slurry growth caused by gas generation and retention within the waste. A SHMS was installed in the tank in 1998 and set to standby mode in February 2000.

Tank 241-S-107 is currently approximately half full, containing nearly 149 inches of waste. The tank is scheduled to begin interim stabilization in November 2002 (Hanlon 2001).

Sample results from the tank 241-S-107 2000 grab sampling event were screened against current toxic chemical limits shown in Table 3.4.1-10 of the *Tank Farms Final Safety Analysis Report* (Ryan 2001). Vanadium and neodymium results exceeded the toxic chemical bounding concentration limits. Notification was made in accordance with the requirements of Adams (2001). The unit liter doses (ULDs) for radionuclide results from the 2000 grab sampling event

were compared against the limits in the *Radiological Source Terms for Tank Farms Safety Analysis* (Cowley et al. 2000). No gross alpha was available from the 2000 grab sampling data for compatibility; however, the highest gross alpha from the 1995 core drainable liquid data for tank 241-S-107 was used to complete the unit-liter dose (ULD) spreadsheet calculations. No ULD limits were exceeded for single-shell liquids.

Means and Confidence Intervals

Question 7: What statistical model was used to generate the means and confidence intervals? What data was included in the calculations?

A nested analysis of variance (ANOVA) model was fit to the laboratory sample data. Mean analyte concentrations, and 95 percent confidence intervals on the mean, were estimated using results from the ANOVA. Two variance components were estimated and used in the computations. The variance components represent concentration differences between laboratory samples and between analytical replicates.

The model is:

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

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

where

Y_{ij}	=	concentration from the jth analytical result from the ith riser
μ	=	the mean
L_i	=	the effect of the ith laboratory sample
A_{ij}	=	the analytical error
a	=	the number of laboratory samples
n_i	=	the number of analytical results from the ith laboratory sample.

The variable L_i is a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(L)$, 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 concentrations and standard deviations of the mean were used to calculate the 95 percent confidence intervals. Each table in the *241-S-107 Means and Confidence Intervals Standard Report* gives the estimate of the mean, degrees of freedom, and confidence interval on the mean.

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

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

$$\text{LL}(95\%): \hat{\mu} - t_{(df,\ 0.025)} \times \hat{\sigma}(\hat{\mu})$$

$$\text{UL}(95\%): \hat{\mu} + t_{(df,\ 0.025)} \times \hat{\sigma}(\hat{\mu}).$$

In these equations, $\hat{\mu}$ 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 are the number of laboratory samples with data minus one. In cases where the lower limit of the confidence interval was negative, it was reported as zero.

The means for each data set are listed separately in the *241-S-107 Means and Confidence Intervals* Standard Report. The *Tank 241-S-107 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solids 1995 Push Mode Core Samples* table refers to data generated from three core samples taken September 18 and 30, 1995. The *Tank 241-S-107 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquids 1995 Push Mode Core Samples* table refers to data generated from three core samples taken September 18 and 30, 1995. The *Tank 241-S-107 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid 2000 Grab Samples* table refers to data generated from three grab samples taken September 19, 2000. *Means and Confidence Intervals* tables were not generated for sampling events prior to 1995, and the waste from those events were not used to represent material currently in tank 241-S-107.

Best-Basis Inventory Derivation

Question 8: What is the source data used to derive this tank's Best-Basis inventories by mass (kg) and activity (Ci) for the standard list of 25 chemicals and 46 radionuclides?

The Best-Basis Inventory (BBI) effort involves developing and maintaining waste tank inventories comprising 25 chemical and 46 radionuclide components in the 177 Hanford Site underground storage tanks. These BBIs provide waste composition data necessary as part of the River Protection Project (RPP) process flowsheet modeling work, safety analyses, risk assessments, and system design for waste retrieval, treatment, and disposal operations.

This BBI is part of the BBI baselining effort that will update all BBIs to the current standards and protocols and establish consistent BBI documentation for all tanks. An evaluation of the BBI for tank 241-S-107, as of January 1, 2001, was performed and is documented in the following text. The following information was used in this evaluation:

- Statistical means from analysis of the three 1995 core samples (see *Means and Confidence Intervals Standard Report*) as reported in Raphael (1996).

- Statistical means from analysis of 2000 grab samples (see *Means and Confidence Intervals Standard Report*) as reported in Steen (2001).

- BBI templates for the following waste types: T-Plant Evaporator saltcake generated from 1965 to 1976 (T2 saltcake), 242-S Evaporator saltcake generated from 1973 to 1976 (S1 saltcake), 242-S Evaporator salt slurry generated from 1977 to 1980 (S2 salt slurry), REDOX coating removal waste generated from 1952 to 1960 (CWR1), REDOX coating removal waste generated from 1961 to 1967 (CWR2), REDOX zirconium cladding removal waste (CWZR1) and REDOX sludge (R1 sludge).

Table 8-1 represents how the available information was used to derive best-basis inventories for tank 241-S-107.

Table 8-1. Tank 241-S-107 Best-Basis Inventory Source Data (2 Sheets)

Waste Phase	Waste Type	Applicable Concentration Data[1]	Multiplier	Density (g/mL)	Associated Volume
Supernatant		S1-SltCk Liquid Template, P/U204/36	0.51	1.63	53 kL (14 kgal)
		S-107 1995 Core Drainable Liquid, S/S107/06	1.0	1.24	
		Fiscal Year (FY) 2001 Grab Sample, S/S107/07	1.0	1.31	
Saltcake solid	T2-SltCk	T2-SltCk Solid Template, P/U204/21	0.716	1.67	27 kL (7 kgal)
		1995 Core Segment Samples of saltcake solids, S/S107/05	1.0	1.57	
	S1-SltCk	S1-SltCk Solid Template, P/U204/23	0.776	1.65	34 kL (9kgal)
		1995 Core Segment Samples of saltcake solids, S/S107/05	1.0	1.57	
	S2-SltCk	S2-SltSlry Solid Template, P/U204/24	0.826	1.59	15 kL (4 kgal)
		1995 Core Segment Samples of saltcake solids, S/S107/05	1.0	1.57	
Saltcake liquid	T2-SltCk	T2-SltCk Liquid Template, P/U204/39	0.652	1.47	8 kL (2 kgal)
		S-107 1995 Core Drainable Liquid, S/S107/06	1.0	1.24	
		FY 2001 Grab Sample, S/S107/07	1.0	1.31	
	S1-SltCk	S1-SltCk Liquid Template, P/U204/36	0.51	1.63	11 kL (3 kgal)
		S-107 1995 Core Drainable Liquid, S/S107/06	1.0	1.24	
		FY 2001 Grab Sample, S/S107/07	1.0	1.31	
	S2-SltCk	S2-SltSlry Liquid Template, P/U204/37	0.377	1.83	4 kL (1 kgal)
		S-107 1995 Core Drainable Liquid, S/S107/06	1.0	1.24	
		FY 2001 Grab Sample, S/S107/07	1.0	1.31	

Table 8-1. Tank 241-S-107 Best-Basis Inventory Source Data (2 Sheets)

Waste Phase	Waste Type	Applicable Concentration Data[1]	Multiplier	Density (g/mL)	Associated Volume
Sludge[2]	R1	241-U-204, R1 Solid Template, P/U204/14	0.916	1.75	484 kL (128 kgal)
		1995 Core Segment Samples of sludge solids, S/S107/04	1.0	1.8	
	CWR1	CWR1 Solids Template, P/U204/15	0.962	1.62	469 kL(124 kgal)
		1995 Core Segment Samples of sludge solids, S/S107/04	1.0	1.8	
	CWZR1	CWZR1Solids Template, P/U204/90	2.61	1.29	95 kL (25 kgal)
		1995 Core Segment Samples of sludge solids, S/S107/04	1.0	1.8	
	CWR2	CWR2 Solids Template, P/U/204/98	1.39	1.66	223 kL (59 kgal)
		1995 Core Segment Samples of sludge solids, S/S107/04	1.0	1.8	
Total Tank					1423 kL (376 kgal)

Notes:

[1]Vector handles, shown in parentheses, are unique serial identifiers for the vectors used in the BBIM database.

[2]The sludge waste phase includes both solids and interstitial liquid; the interstitial liquid volume is estimated to be 191 kL (51 kgal).

Tank 241-S-107 received REDOX waste and REDOX cladding waste (aluminum clad fuel) from 1952 through 1967 and zirconium cladding waste in 1967. It also received transfers of REDOX evaporator bottoms, cladding waste, supernatant waste such as 242-T Evaporator (saltcake) waste, B-Plant low-level waste, organic wash waste, REDOX ion exchange waste, decontamination waste, PUREX high-level waste, laboratory waste, REDOX waste, Battelle Northwest waste, cesium supernatant recovery waste, 224-U (LaF_3) waste, and noncomplex waste from 1968 through 1980. Agnew et al. (1997a) identified transfers of a total of eight waste types into the tank. The types included R1, R SltCk, CWR1, CWZr1, CWR2, T2 SltCk, S1 SltCk, and S2 SltSlr, in order of their addition.

The total volume in Table 8-1 is 1423 kL (376 kgal) and is based on the values reported in Agnew et al. (1997b). This volume is consistent with the displacement height of the three cores corrected to elevation of the bottom centerline of the tank. It is important to note that the current ENRAF™ reading of 378 cm (149 inches), which corresponds to a total volume of 1472 kL (389 kgal), was not used for the BBI. This reading has gradually increased over the last several years and is believed to be due to gas generation because there have been no transfers into the tank. No neutron readings have been taken for this tank. Fort and Ubay (2000) estimate a supernatant volume of 53 kL (14 kgal), which seems to be a reasonable estimate given the presence of a pool of liquid identified in past photographs and the analysis of the core samples taken and, therefore, used in this BBI. The core data suggest that a higher volume of liquid is present; however, there was concern with contamination of hydrostatic fluid in two of the three cores in the segments containing liquid. Based on the analytical results of soluble constituents

divided by results for insoluble for the three core samples of the waste, the bulk of the waste appears to be sludge. Two of the sub-segments (2 Lower and 3 Upper) from core 105 and one sub-segment (3A upper) from core 110 clearly appear to be saltcake. None of the sub-segments from core 111 appeared to be saltcake. Therefore, volume of the wet saltcake was estimated to be 99 kL (26 kgal) by assuming that it is equivalent to 1/2 of a 48 cm (19 inch) depth of solids as wet saltcake. The saltcake was divided into the three largest saltcake types in the same proportions that Agnew (1997a) estimated in the HDW model. The smallest volume saltcake (R SltCk) was not used because it was small and there was no indication of saltcake in the bottom portion of the tank where it should have been located. Each saltcake type was further divided into liquids and solids by assuming a 25 percent porosity from Fort and Ubay (2000).

The sludge was estimated by subtracting the wet saltcake and supernatant from the total volume of waste (1423 - 99 – 53 = 1271 kL). The sludge was divided into the four sludge types in the same proportions that Agnew (1997a) estimated in the HDW model. It was assumed that the sample analyses used in the sludge templates and the tank 241-S-107 sample vector represented both solids and interstitial liquid. As a result, a separate interstitial liquid inventory was not determined for the sludge waste phase. Assuming an average in-tank sludge porosity of 0.15 (Fort and Ubay 2000), the volume of interstitial liquid in the sludge is estimated to be 191 kL (51 kgal).

Means calculated from the saltcake solids core sub-segments mentioned above were preferentially used for component data for saltcake solids. Means calculated from the remaining solids core sub-segments were preferentially used for component data for the sludge solids. Means calculated from the 2000 grab samples were preferentially used for component data for liquids. In some instances, means from the 1995 core drainable liquid were used when they were believed to be more accurate than less-than values from the grab samples. Template data were used only when sampling data were not available, or when template data provided a better estimate than sample-based less-than values. Templates are based on sampling data from tanks that contain the same waste type as tank 241-S-107, supplemented with HDW data (Agnew et al. 1997a). The mercury concentrations taken from Higley (2000) were included in the R1 template. A multiplier was used to scale the template vector to the sample data using the sample-based weight percent water and density. Template data are normally scaled to the sampling data using the sample-based weight percent water and density. The multipliers for the saltcake solids were determined from the measured weight percent water (44.9 percent) and density (1.57 g/mL). The multipliers for the sludge solids were determined from the measured weight percent water (33.0 percent) and density (1.80 g/mL). The multipliers for the liquids were determined from the measured weight percent water (64 3percent) and density (1.31 g/mL). A more detailed description of template data is found in Tran (1999).

The inventories for the uranium isotopes were calculated using sample total uranium values and distributed using the HDW ratios for the isotopes. The inventories for plutonium, americium, and curium in the saltcake solids and sludge were calculated using sample total alpha activity values and distributed using the HDW ratios for those isotopes. For the supernatant, plutonium isotopes, ^{243}Am, and ^{242}Cm inventories were calculated from the sample $^{239/240}$Pu and ^{241}Am and the HDW ratios. Hydroxide inventories for the supernatant and saltcake liquid were calculated from the sample hydroxide concentrations while the hydroxide inventory for the total tank was

calculated by performing a charge balance with the valences of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997a).

All inventory calculations were performed using the Best-Basis Inventory Maintenance Tool. The sample-based inventories in this BBI were developed in accordance with the BBI rules in Sasaki (2001). The updated BBI values for tank 241-S-107 are shown in the *Best-Basis Inventory (Non-Radionuclides)* and *Best-Basis Inventory (Radionuclides)* standard reports.

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