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ENGINEERING DATA TRANSMITTAL

0052175

Page 1 of 2

1. EDT 702348

2. To: (Receiving Organization)
Distribution

3. From: (Originating Organization)
Requirements Planning and Support

4. Related EDT No.:
N/A

5. Proj./Prog./Dept./Div.:
TIRs/Req. Planning/Proc. Eng./RPP

6. Design Authority/Design Agent/Cog. Engr.:
M. R. Adams

7. Purchase Order No.:
N/A

8. Originator Remarks:
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9. Equip./Component No.:
N/A

10. System/Bldg./Facility:
N/A

11. Receiver Remarks:
N/A

11A. Design Baseline Document? ☐ Yes ☒ No

12. Major Assm. Dwg. No.:
N/A

13. Permit/Permit Application No.:
N/A

14. Required Response Date:
11/17/99

DEC 1999
RECEIVED
EDMC

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	RPP-5417	N/A	0	Auto Tank Interpretive Report for Tank 241-AN-103	N/A	2	1	1
2	RPP-5418	N/A	0	Auto Tank Interpretive Report for Tank 241-AN-104	N/A	2	1	1
3	RPP-5419	N/A	0	Auto Tank Interpretive Report for Tank 241-AN-105	N/A	2	1	1
4	RPP-5420	N/A	0	Auto Tank Interpretive Report for Tank 241-AW-101	N/A	2	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)	
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment	4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority									
		Design Agent									
2	1	Cog. Eng. M. R. Adams	M R Adams	11/18/99							
2	1	Cog. Mgr. J. W. Hunt	J Hunt	11/18/99							
		QA									
		Safety									
		Env.									

18. Ann E. Young
Ann E. Young 11/17/99
Signature of EDT Originator
Date

19.
Authorized Representative for Receiving Organization
Date

20. John W. Hunt
J W Hunt 11/18/99
Cognizant Manager
Date

21. DOE APPROVAL (if required)
Ctrl No.
☐ Approved
☐ Approved w/comments
☐ Disapproved w/comments

BD-7400-172 (05/96)

ENGINEERING DATA TRANSMITTAL

(CONTINUATION PAGE)

5. Proj./Prog./Dept.Div.:	6. Cog. Eng.	1. EDT	
TIRs/Req. Planning/Proc. Eng.	M. R. Adams	EDT-702348	Page 2 of 2

15.	DATA TRANSMITTED				(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Desig-nator	Reason for Trans-mittal	Origi-nator Dispo-stion	Receiv-er Dispo-sition
5	RPP-5421	N/A	0	Auto Tank Interpretive Report for Tank 241-BY-105	N/A	2	1	1
6	RPP-5422	N/A	0	Auto Tank Interpretive Report for Tank 241-S-110	N/A	2	1	1
7	RPP-5423	N/A	0	Auto Tank Interpretive Report for Tank 241-S-111	N/A	2	1	1
8	RPP-5424	N/A	0	Auto Tank Interpretive Report for Tank 241-SX-102	N/A	2	1	1
9	RPP-5425	N/A	0	Auto Tank Interpretive Report for Tank 241-SX-105	N/A	2	1	1
10	RPP-5426	N/A	0	Auto Tank Interpretive Report for Tank 241-T-110	N/A	2	1	1
11	RPP-5427	N/A	0	Auto Tank Interpretive Report for Tank 241-U-107	N/A	2	1	1
12	RPP-5428	N/A	0	Auto Tank Interpretive Report for Tank 241-U-109	N/A	2	1	1
13	RPP-5429	N/A	0	Auto Tank Interpretive Report for Tank 241-U-112	N/A	2	1	1

RPP-5419, Rev. 0

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Auto Tank Interpretive Report for Tank 241-AN-105

M. R. Adams
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: EDT-702348 UC: 2070
Org Code: 74B10 CACN/COA: 102230/ES30
B&R Code: EW 3120074 Total Pages: 23

Key Words: Tank 241-AN-105, 241-AN-105, AN-105, AN Farm, Tank Interpretive Report, TIR

Abstract: N/A

Printed in the United States of America. To obtain copies of this document, contact: Document Control Services, P.O. Box 950, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

DATE:
STA: 4
HANFORD RELEASE
ID: 2
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11/18/99

Release Approval
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This report prepared especially for Auto TIR on 11/09/99

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 September 7, 1999.

Tank: 241-AN-105

Sampling Events:
  152
  153

Reports:
  Tank Interpretive Report

Constituent Groups:

Table of Contents

Data Dictionary to Reports in this Document

Report	Field	Description
Tank Interpretive Report		Interprets information about the tank answering a series of six 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-AN-105

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-AN-105 include the Flammable Gas Data Quality Objective (DQO), Tank Safety Screening DQO, Organic Solvent Safety Issue DQO, Low-Activity Waste (LAW) Feed DQO, Provide Samples to Contractor issue, Confirm Tank T is an Appropriate Feed Source for LAW Feed Batch X (Waste Feed Delivery) DQO, Regulatory Compliance Waste Disposal Integration Team (WIT) DQO, Air Emissions DQO, and Dangerous Waste DQO. As of the date this report was prepared, August 2, 1999, the sampling events associated with this tank did not address the issues of the Regulatory Compliance WIT DQO, the Air Emissions DQO, or the Dangerous Waste DQO. The remaining issues are discussed below.

Flammable Gas DQO: Does a possibility exist for releasing flammable gases into the headspace of the tank or releasing chemical or radioactive materials into the environment?

The requirements to support the flammable gas issue are documented in the *Data Quality Objective to Support Resolution of the Flammable Gas Safety Issue* (Bauer and Jackson 1998). The Flammable Gas DQO has been extended to apply to all tanks. Analyses and evaluations will change according to program needs until this issue is resolved. Final resolution of the flammable gas issue is expected to be completed by September 30, 2001 (Johnson 1997).

Retained gas samples (RGSs) from the 1996 tank 241-AN-105 core samples (core 152: segments 15, 17, 19, and 21; core 153: segments 4, 16, 18, and 20) were analyzed to address flammable gas issues. The results of RGS testing are reported in Shekarriz et al. (1997). The retained gas volumes were 160 ± 37 m^3 retained gas in the solid, or nonconvective, layer and 10 ± 4 m^3 in the liquid, or convective, layer. This corresponds to average gas volume fractions of 0.045 ± 0.005 in the solid layer and 0.003 ± 0.001 in the liquid layer. The gas composition of the convective and nonconvective layers combined included 27 mole % nitrogen, 60 mole % hydrogen, and 11 mole % nitrous oxide. The remainder was ammonia, methane, and other hydrocarbons. The measured local ammonia concentrations in tank 241-AN-105 ranged from 890 to 2,100 µmole/liter of waste. More than 99.9 percent of the ammonia is dissolved in the liquid.

Tank 241-AN-105 is equipped with a standard hydrogen monitoring system (SHMS) for the collection of vapor-phase data that support resolution of flammable gas issues. The SHMS monitors hydrogen continuously and has been operating since September 1994. From August 1995 to July 1999 seven hydrogen gas release events (GREs) were documented for tank 241-AN-105 based upon SHMS data. The maximum concentration of hydrogen released was 17,000 ppm on August 21, 1995. This is the largest hydrogen release in a double-shell tank, other than tank 241-SY-101, and at a concentration of 17,000 ppm is well above the action level of 6,250 ppm of hydrogen. These releases are documented in the report *Results of Vapor Space Monitoring of Flammable Gas Watch List Tanks* (McCain 1999).

Safety Screening DQO: Does the waste pose or contribute to any recognized potential safety problems?

The data needed to screen the waste in tank 241-AN-105 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.

The threshold limit for energetics is 480 J/g on a dry weight basis. Results obtained using differential scanning calorimetry (DSC) indicated that no exothermic reactions (on a dry weight basis) exceeded the threshold limit. The highest individual dry weight sample and duplicate exothermic results for liquid were 36.4 and 414 J/g, respectively. Because of the high relative percent difference (RPD), a rerun was requested. The DSC results were 0.0 J/g for the sample and 92.5 J/g for the duplicate. The maximum dry weight exotherm measured for solid was 174 J/g. The maximum upper limit to a 95 percent confidence interval for this sample was 384 J/g. These results suggest that energetics are not a concern for this tank.

As requested in the tank *241-AN-105 Push Mode Core Sampling and Analysis Plan* (Eggers 1996), headspace vapor measurements were taken before obtaining the push mode core samples in June 1996. Combustible gas tests showed a flammable gas reading of 0 percent of the LFL in riser 9 and 1 % in riser 13 (see "*IH Sniff Data*"). These are well below the action level of 25 percent of the LFL. However, the GREs documented in McCain (1999) were above this action level.

The threshold limit for criticality is 1 g/L of plutonium. Assuming that all alpha activity is from ^{239}Pu, and using the maximum segment sample density of 1.66 g/mL, 1 g/L of ^{239}Pu is equivalent to 37 µCi/g of alpha activity for the salt slurry and 61.5 µCi/mL of alpha activity for the liquid. Concentrations in all samples were well below this limit with the maximum value being 0.133 µCi/g. Additionally, as required by the DQO, the upper limits to a one-sided 95 percent confidence interval on the mean were calculated. All upper limits were well below the criticality decision limits, with the maximum value being 0.18 µCi/g. Therefore, criticality is not a concern for this tank.

Organic Solvent Safety Issue DQO: Does an organic solvent pool exist that may cause a fire or ignition of organic solvents in entrained waste solids?

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

No vapor samples have been taken from tank 241-AN-105 to estimate the organic pool size. However, the organic program has determined that even if an organic solvent pool does exist, the consequence of a fire or ignition of organic solvents is below risk evaluation guidelines for all tanks (Brown et al. 1998). The organic solvent issue is expected to be closed for all tanks in 1999.

LAW Feed DQO: Do the samples taken from tank 241-AN-105 and the subsequent laboratory analyses meet the needs of the privatization low-activity waste DQO?

The sampling and analysis of tank 241-AN-105 to support privatization was based on the requirements of Wiemers and Miller (1997). The purpose of the LAW Feed DQO (Wiemers and Miller 1997) was to address technical issues pertinent to pretreatment, immobilization, and balance-of-plant for LAW processing. Waste was to be characterized to determine whether it fell within the defined process design envelope. Data collected in support of this DQO were to be used primarily for planning activities of the privatization contractors as specified in the privatization request for proposals.

In June 1998, archived 1996 core samples from tank 241-AN-105 were subsampled and analyzed in accordance with the letter of instruction (LOI) *Request to Perform Additional Analysis for Tank 241-AN-105 for Privatization Project* (Jo 1998). The 1996 solid composite from core 152 segments 14 through 20 was used to provide three solid subsamples for analysis. The 1996 drainable liquid composite was used to provide three liquid composite subsamples for analysis.

The 222-S Laboratory performed the analysis according to the requirements of the LAW Feed DQO (Wiemers and Miller 1997). The results from these analyses are reported in Esch (1998). The following statistical calculations were performed on this data as directed by Kinzer (1999):

- the mean concentration ($\hat{\mu}$) of the composite subsample results,
- the standard deviation of the mean $SD(\hat{\mu}) = S / \sqrt{n}$, and
- the relative standard deviation (RSD) associated with the mean $(RSD(\hat{\mu}) = (SD(\hat{\mu}) / \hat{\mu}) \times 100)$. Both $SD(\hat{\mu})$ and $RSD(\hat{\mu}) = (SD(\hat{\mu}) / \hat{\mu}) \times 100$ represent the random variability associated with the analytical measurements.

The mean, the SD of the mean, and the RSD on the mean are reported in Table 1-1. Table 1-2 provides a comparison of the ratio of each analyte to sodium with the Envelope A contract limits. The Envelope A contract limits are reported as a ratio of moles of analyte to moles of sodium. The LAW Feed DQO (Wiemers and Miller 1997) establishes a sensitivity boundary around the envelope limits of ± 30%. For tank 241-AN-105, all constituents analyzed met the Envelope A contract limits for LAW. As seen in Table 1-2, only two analytes (aluminum: 77.15% and chloride: 75.75%) fell within the sensitivity boundary. Solubility screening tests were also performed on the drainable liquid composite as directed by Herting (1997a), according to the LAW Feed DQO (Wiemers and Miller 1997) requirements. The data from these tests are reported in *Results of Dilution Studies with Waste from Tank 241-AN-105* (Herting 1997b).

At the time the sampling and analysis to support privatization were performed, tank 241-AN-105 was identified as one of the first tanks to be retrieved for LAW pretreatment and immobilization. Since then, the waste feed delivery staging plan has been revised (Kirkbride 1999). The revised staging plan retains tank 241-AN-105 as a Phase I candidate LAW feed tank; however, the waste will not be staged until later in the operations.

The current data needed to support DOE Waste Processing and Disposal (WP&D) are documented in the *Low-Activity Waste and High-Level Waste Feed Processing Data Quality Objectives* (Patello et al. 1999). This revised DQO imposes additional sampling, compositing, and analytical requirements that address the Privatization contract's allowance for entrained solids to be processed as LAW, high-level waste (HLW), or returned to tank farms. Additionally, the DQO accommodates the LAW and HLW treatment scenario, allowing for liquids separated from HLW feed to be treated as LAW feed. Further sampling and analysis of tank 241-AN-105 may be required to meet these revised DQO requirements.

Provide Samples to Contractor issue: Have the required samples been provided to the Privatization Contractor?

The Waste Disposal Division and Waste Disposal Integration Team (WIT) identified the need for tank waste samples to be provided to the Privatization Contractor for process validation work prior to the commencement of hot operations. The estimated quantity of sample needed from tank 241-AN-105 is 1.5 to 2 liters (Gasper 1998). The sampling and shipment of this sample material are not currently scheduled (BNFL 1998).

Waste Feed Delivery DQO: Does the waste feed meet specifications as a feed source for tank waste privatization?

The current data required to support waste feed delivery for Phase I LAW are documented in *Data Quality Objectives for TWRS Privatization Phase I: Confirm Tank T is an Appropriate Feed Source for Low-Activity Waste Feed Batch X* (Nguyen 1999). However, this assessment is based on the requirements of a previous version of this DQO (Certa 1998), because the sampling and analysis were performed to meet these requirements.

Laboratory tests were performed on the samples taken in 1996 to study the dilution of this waste since retrieval of the tank waste will require dilution to dissolve solids. The solids solubility screening tests were performed on composites that had been diluted in accordance with the *Test Plan for Tank 241-AN-105 Dilution Studies* (Herting 1997a). The results of these studies satisfied the Waste Feed Delivery DQO requirements in effect at the time of sampling (Certa 1998) and are documented in *Results of Dilution Studies with Waste from Tank 241-AN-105* (Herting 1997b).

Table 1-1. Variance Components For Tank 241-AN-105 Supernatant Composite Means.[1]

Constituent	Analysis Method Group	Units	Mean	SD (mean)	%RSD (mean)
Aluminum	ICP	μg/mL	36,300	289	0.797
Barium	ICP	μg/mL	<30.1	n/a	n/a
Cadmium	ICP	μg/mL	<3	n/a	n/a
Calcium	ICP	μg/mL	<60.1	n/a	n/a
Chloride	IC	μg/mL	9,120	354	3.89
Chromium	ICP	μg/mL	223[2]	1.50	0.674
Fluoride	IC	μg/mL	433	10.9	2.52

Table 1-1. Variance Components For Tank 241-AN-105 Supernatant Composite Means.[1]

Constituent	Analysis Method Group	Units	Mean	SD (mean)	%RSD (mean)
Hydroxide	OH:W	µg/mL	58,600[2]	1,950	3.33
Iron	ICP	µg/mL	<30.1	n/a	n/a
Lanthanum	ICP	µg/mL	<30.1	n/a	n/a
Lead	ICP	µg/mL	<60.1	n/a	n/a
Mercury	ICP	µg/mL	<0.50[3]	n/a	n/a
Nickel	ICP	µg/mL	<12	n/a	n/a
Nitrate	IC	µg/mL	151,000	4,250	2.82
Nitrite	IC	µg/mL	112,000	3,540	3.15
Phosphate	IC	µg/mL	1,110	131	12
Potassium	ICP	µg/mL	6,520[2]	30	0.460
Sodium	ICP	µg/mL	211,000	1,590	0.752
Sulfate	IC	µg/mL	1,470	58.6	3.98
Total inorganic carbon	TIC/TOC	µg/mL	2,370	131	5.53
Total organic carbon	Furnace Oxidation	µg/mL	2,710	62.9	2.32
Total organic carbon	TIC/TOC	µg/mL	2,650	100	3.77
U-TOTAL	n/a	µg/mL	<5.18[4]	n/a	n/a
TRU[5]	Alpha Rad	µCi/mL	<0.015[2]	n/a	n/a
Cesium-137	GEA	µCi/mL	378	3.18	0.842
^{90}Sr	Sr-89/90	µCi/mL	0.041[2]	0.0006	1.45
^{99}Tc	Te:F	µCi/mL	0.274[2]	0.006	2.01

Notes:

IC = ion chromatography
TIC = total inorganic carbon
TOC = total organic carbon
GEA = gamma energy analysis
n/a = not applicable

[1] Means derived from 1998 analytical results unless noted otherwise.

[2] Mean derived from 1996 analytical results.

[3] Mean derived from Esch (1997).

[4] Derived by summing results for the individual uranium isotopes as measured by inductively coupled plasma/mass spectroscopy (ICP/MS) and atomic mass unit (AMU)-238, which is assumed to be U-238. Approximately 82 percent of this total is from a detected result (AMU-238); the remainder is a sum of detection limits.

[5] Transuranic (TRU) is represented by the total alpha activity.

Table 1-2. Comparison of Tank 241-AN-105 Supernatant Results to Envelope A Contract Limits.[1]

Analyte	Average (µg/mL)	Average (M)	Ratio (Avg/ Na)	Envelope Limit	Found Analyte/Env. Spec. [(Avg/Na)/Env. Spec.]
				(moles analyte/moles Na)	
			A	B	A/B
Al	3.63E+04	1.35E-00	1.47E-01	1.9E-01	77.15%
Ba	3.01E+01[2]	2.19E-04	2.39E-05	1.0E-04	23.88%
Ca	6.01E+01[2]	1.50E-03	1.63E-04	4.0E-02	0.41%
Cd	3.00E-00[2]	2.67E-05	2.91E-06	4.0E-03	0.07%
Cl	9.12E+03	2.57E-01	2.80E-02	3.7E-02	75.75%
Cr	2.23E+02	4.29E-03	4.67E-04	6.9E-03	6.77%
F	4.33E+02	2.28E-02	2.48E-03	9.1E-02	2.73%
Fe	3.01E+01[2]	5.39E-04	5.87E-05	1.0E-02	0.59%
Hg	5.00E-01[2]	2.49E-06	2.72E-07	1.4E-05	1.94%
K	6.52E+03	1.67E-01	1.82E-02	1.8E-01	10.09%
La	3.01E+01[2]	2.17E-04	2.36E-05	8.3E-05	28.45%
Na	2.11E+05	9.18E-00	1	1	100.00%
Ni	1.20E+01[2]	2.04E-04	2.23E-05	3.0E-03	0.74%
NO2	1.12E+05	2.43E-00	2.65E-01	3.8E-01	69.80%
NO3	1.51E+05	2.44E-00	2.65E-01	8.0E-01	33.17%
OH	5.86E+04	3.45E-00	3.75E-01	7.0E-01	53.63%
Pb	6.01E+01[2]	2.90E-04	3.16E-05	6.8E-04	4.65%
PO4	1.11E+03	1.17E-02	1.27E-03	3.8E-02	3.35%
SO4	1.47E+03	1.53E-02	1.67E-03	9.7E-03	17.19%
TIC (P)	2.37E+03	1.97E-01	2.15E-02	3.0E-01	7.17%
TOC (F)	2.71E+03	2.26E-01	2.46E-02	6.0E-02	40.97%
TOC (P)	2.65E+03	2.21E-01	2.40E-02	6.0E-02	40.07%
U ICP/MS	5.18E-00[2]	2.18E-05	2.37E-06	1.2E-03	0.20%
	µCi/mL	Bq/L		(Bq analyte/moles Na)	
TRU	1.15E-02[2]	4.26E+05	4.64E+04	4.8E+05	9.66%
^{137}Cs	3.78E+02	1.40E+10	1.52E+09	4.3E+09	35.44%
^{90}Sr	4.10E-02	1.52E+06	1.65E+05	4.4E+07	0.38%
^{99}Tc	2.74E-01	1.01E+07	1.10E+06	7.1E+06	15.56%

Notes:

[1] Mean concentrations were reported previously. See Table 1-1 for additional notes.

[2] Mean concentrations based on non-detected values.

Heat Load Estimate:

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. The heat load estimate based on the process history was 11,400 W (39,000 Btu/hr) (Agnew et al. 1997a). The heat load estimate derived from the tank headspace temperature was 7,320 W (25,000 Btu/hr) (Kummerer 1995). The heat load estimated from the best-basis inventory is 9,240 W (31,600 Btu/hr), as shown in Table 1-3. All of these estimates are below the 20,500 W (70,000 Btu/hr) operating specification limit for double-shell tanks (Fowler 1999).

Table 1-3. Heat Load Estimate Based on the Best-Basis Inventory.

Radionuclide	Waste Inventory[1] (Ci)	Specific Activity (W/Ci)	Heat Load (W)
^{90}Sr	48,000	0.00670	322
^{137}Cs	1.89E+06	0.00472	8,920
Total			9,240

Note:

[1] See *"Best-Basis Inventory Estimate (Radioactive Components)"* Standard Report.

Tank History

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

The AN Tank Farm was built between 1980 and 1981 in the 200 East area. This tank farm consists of seven 4,391 kL (1,160 kgal) tanks. These tanks were designed for boiling waste with a maximum fluid temperature of 177 °C (350 °F). The 241-AN Tank Farm does not use a cascade system between tanks. Tank 241-AN-105 is a double-shell tank constructed of a reinforced concrete shell with two (inner and outer) carbon-steel liners on the bottom and sides. Tank 241-AN-105 has 22 risers that provide access to the tank and 37 risers that provide access to the annulus. Additional tank descriptive material is contained in Standard Reports *"Tank Plan View," "Tank Profile View," and "Riser Configuration Table."*

Tank 241-AN-105 entered service in 1982. Water was initially added to tank 241-AN-105 in the second quarter of 1982. During the fourth quarter of 1982 through the first quarter of 1983, the tank received double-shell slurry feed (DSSF) from tank 241-AW-102 (Koreski 1997). A small amount of waste from an unknown source was added in the third quarter of 1984. The tank received non-complexed waste from tank 241-AN-104 in the first quarter of 1984. Most of the waste was then removed to tank 241-AW-102 during the first quarter of 1985 for an evaporator campaign, leaving approximately 583 kL (154 kgal) waste in tank 241-AN-105. During the first two quarters of 1985, the tank received DSSF waste from tank 241-AW-102 via the evaporator, then waste reception ceased. The only transfer since that time has been an addition of flush water from miscellaneous sources from the fourth quarter of 1995 to the first quarter of 1996 (Agnew et al. 1997b).

Tank 241-AN-105 has an operating capacity of 4,391 kL (1,160 kgal), and presently contains an estimated 4,262 kL (1,126 kgal) of DSSF. This total waste volume was derived from surface level measurements (Hanlon 1999). The tank is estimated to contain 1,772 kL (468 kgal) of salt slurry, 2,400 kL (634 kgal) of supernatant, and 87 kL (24 kgal) of retained gas. (see Table 7-1 for Best-Basis Inventory Source Data.)

Tank 241-AN-105 is listed as sound and is actively ventilated. The tank was added to the Watch List for the Flammable Gas issue (Public Law 101-510) in January 1991. Tank 241-AN-105 is one of the double-shell tanks scheduled for waste retrieval at Hanford. The tank is currently scheduled to be retrieved during fiscal year 2008 (Kirkbride et al. 1999).

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-AN-105 is a flammable gas-containing tank that has had periodic GREs. Other tanks that are on the flammable gas watch list are tanks 241-SY-101, 241-AW-101, 241-AN-103, 241-AN-104, and 241-SY-103. Similar to tank 241-AN-105, these tanks also have a history of gas releases.

In 1997, a report titled *Investigation of Flammable Gas and Thermal Safety Issues for Retrieval of Waste from Tank 241-AN-105* (Caley et al. 1998) was issued. This report noted that the physical properties of the waste in tank 241-AN-105 are similar to the waste that was present in tank 241-SY-101 prior to its mitigation in 1993. It also concluded that tank 241-AN-105 waste could be safely degassed without exceeding 25% of the LFL in the tank headspace. This conclusion was based on tank 241-SY-101 mitigation experience as well as comparisons of the waste in these two tanks.

Tank 241-AN-105 contains DSSF. Hanlon (1999) lists the following double-shell tanks as containing primarily DSSF: tanks 241-AN-104, 241-AW-101, 241-AP-101, and 241-AP-105. Of these tanks, tank 241-AN-104 and 241-AW-101 most closely resemble the volumes of supernatant and solids in tank 241-AN-105. Analytical data from tanks 241-AN-104 and 241-AW-101 were used for comparison with the 1998 tank 241-AN-105 analytical concentrations. These comparisons showed good agreement between the data sets.

Based on the process history of the waste in the tank, the entire contents of tank 241-AN-105 are Supernatant Mixing Model type A2 (SMMA2) waste from 242-A Evaporator campaigns. Tanks 241-AN-102, 241-AN-103, 241-AN-104, and 241-AN-107 also contain SMMA2 waste and contribute to an understanding of the waste in tank 241-AN-105 (Agnew et al. 1997a).

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?

Given what is known about the waste types and behaviors in tank 241-AN-105, there should be little difficulty in retrieving this waste as no critical retrieval concerns were identified. However, several items should be considered in regard to waste retrieval. Tank 241-AN-105 is on the Watch List for the flammable gas issue, has a thin layer of crust above the supernatant layer, and has solids in the supernatant, all of which may potentially affect retrieval of the waste.

The primary concern for this tank is the retained gas in the crust, supernatant, and slurry waste layers. Flammable gas issues should be carefully considered before waste retrieval methods are implemented because disturbance of the waste may cause the retained gases to be released. The retained gas volumes for tank 241-AN-105 were calculated by Meyer et al. (1997) using void fraction instrument measurements and RGS data. The retained gas volume for the supernatant is 10 kL (3 kgal), 71 kL (19 kgal) for the upper salt slurry, and 6 kL (2 kgal) for the lower salt slurry layer.

As discussed in Question 1, the SHMS has documented several hydrogen GREs over the last five years, with a maximum peak of 17,000 ppm released on August 21, 1995. This is above the action level of 6,250 ppm of hydrogen gas. These releases are documented in *Results of Vapor Space Monitoring of Flammable Gas Watch List Tanks* (McCain 1999).

In 1998, a report titled *Investigation of Flammable Gas and Thermal Safety Issues for Retrieval of Waste from Tank 241-AN-105* (Caley et al. 1998) was issued. The purpose of this report was to identify and resolve some of the flammable gas and thermal safety issues potentially associated with the retrieval of waste from tank 241-AN-105. Based on the investigations described in Caley et al. (1998), the following conclusions were made:

- Tank 241-AN-105 waste can be de-gassed safely, that is, without exceeding 25% of the LFL in the tank headspace.
- Dissolved ammonia in tank 241-AN-105 waste poses no flammability threat during supernatant dilution and transfer.
- Tank 241-AN-105 waste temperatures should remain below safety limits during retrieval activities.

The above-mentioned report did not address the potential worker safety issue caused by the presence of ammonia in the waste. This issue should be examined prior to the retrieval of waste from this tank.

Another possible concern is the amount of solids that may be encountered during the retrieval of supernatant from tank 241-AN-105. Sample results from the push mode core samples taken in 1996 indicate tank 241-AN-105 has floating sections of crust on the surface of the waste. Meyer et al. (1997) describes the waste surface in tank 241-AN-105 as thin and non-continuous, with no large vertical features. Photographs of the waste surface from 1995 show floating solids in the region of riser 6. While no solids were measured in the first segment of core 153 taken from riser 9, 6 cm (2.5 in.) of solids were extruded in segment one of core 152 taken from riser 13 (Esch 1998). In addition to the solids in the crust layer, trace amounts of solids were noted in each of the supernatant segments from cores 152 and 153.

Other than the issues discussed above, there should be little difficulty encountered during the retrieval of supernatant from tank 241-AN-105. The presence of organic vapors in tank 241-AN-105 appears small. The RGS data indicate that organics comprise 3.8% of the total in-situ gas. The total organic carbon was measured at 32 ppm in riser 9 and 4 ppm in riser 13 prior to the June 1996 core sampling event. Sample results showed that the tank waste has low total alpha concentrations.

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

The following DQOs and waste issues have been addressed for this tank and accepted by the Project Hanford Management Contract River Protection Project (RPP): Flammable Gas, Safety Screening, Organic Solvent, and Waste Feed Delivery. No additional sampling or analyses are necessary to satisfy current safety issue requirements for this tank. Further action may be identified to address the LAW Feed DQO, Provide Samples to Contractor issue, Regulatory Compliance WIT DQO, Air Emissions DQO, and Dangerous Waste DQO.

More sampling and analysis may be necessary to meet the additional requirements of the recently issued *Low-Activity Waste and High-Level Waste Feed Processing Data Quality Objectives* (Patello et al. 1999). Given the schedule for Phase I retrieval, this additional analytical/physical information has a high priority.

Tank 241-AN-105 samples are scheduled to be collected and provided to the Privatization Contractor during fiscal year 2001, thus will meet the requirements of the Provide Samples to Contractor issue. Finally, to date, no sampling has been performed to address the issues of the Regulatory Compliance WIT DQO, Air Emissions DQO, or Dangerous Waste DQO. These activities will be scheduled as needed to meet the Retrieval Program requirements.

Data Quality

Samples obtained in the core sampling event were collected and analyzed with approved and recognized sampling and laboratory procedures and in accordance with Steen (1997a) and Jo (1998). The laboratory procedures for the core sample analysis can be found in the Standard Report "*Analytical Methods and Procedures.*" Quality Control (QC) parameters assessed in conjunction with tank 241-AN-105 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 Steen (1997b) and Esch (1998).

A high RPD for total organic carbon by persulfate oxidation was reported for one of the subsamples analyzed from the drainable liquid composite (32.5% for sample S98T001783.) Because this analyte was not within the sensitivity boundary for Envelope A, a reanalysis was requested. The reanalysis RPD also exceeded 20%. High RPDs were reported for several other analytes but no reruns were requested.

Fluoride had a spike recovery outside the requested limits on one of the direct drainable liquid composite subsamples. Examination of the raw data indicated that there were unidentified peaks that eluted at the same time as the fluoride. The analytical method was unable to resolve the peaks, which makes it difficult to determine the baseline for fluoride. Since a reanalysis would not improve the recovery, no reanalysis was requested.

Spike recoveries were outside the requested limits for aluminum and sodium in the drainable liquid composites. The failures were due to the high concentration of these analytes in the samples. A spike analysis on a more dilute sample was performed with acceptable recovery results.

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 "*Analytical Results*" Standard Report should not impact the data validity or use.

Some of the samples were prepared for analysis using a potassium hydroxide fusion in a nickel crucible. This preparation method contaminates the nickel and potassium results. Therefore, means for these analytes from the fusion preparation were not included in the "*Means and Confidence Intervals*" Standard Report.

Data anomalies were observed in the supernatant ion chromatography (IC) results from segments 5, 6, and 10 of core 152. In segment 5, the results were much lower for several of the analytes, while in segment 6 the results were much higher. For example, the nitrite results from segments 1 through 4 of core 152 averaged around 125,000 μg/mL. The concentration dropped to 31,500 μg/mL in segment 5, and then increased to 329,000 μg/mL in segment 6. The concentrations in segments 7 through 14 returned to the 125,000 μg/mL level. This pattern was not observed in the core 153 segments. Such extreme waste heterogeneity in the middle of the supernatant layer is unlikely. In the core 152 segment 10 supernatant samples, the primary result was high for some analytes, while the duplicate result was below detection limits. Using phosphate as an example, the primary result was 17,300 μg/mL and the duplicate result was $<$492 μg/mL. The phosphate mean for all of the drainable liquid segments was 695 μg/mL. Because of these anomalies, the IC data from the drainable liquid of segments 5, 6, and 10 of core 152 were not used in any of the mean computations as reported in the Standard Report "*Means and Confidence Intervals.*"

Hydrostatic head fluid (HHF) was used during the 1996 core sampling event. Based on the lithium and bromide results, only segment 21 of core 153 was suspected of being contaminated by the HHF. Calculations revealed that 31.9 percent of the water measured in the liquid from this segment was HHF. Adjusting for the HHF intrusion yielded a corrected weight percent water value of 44.75 for this sample. The weight percent water result from the solids of segment 21, core 153, was not adjusted because calculations demonstrated that less than ten percent of the value was from HHF intrusion.

Addendum 2 of Gasper (1996) identified tank 241-AN-105 as an alternate tank for Envelope B waste feed. In 1997, a composite from the archived drainable liquids of both 1996 core samples was prepared. To better simulate Envelope B waste, the drainable liquid composite was spiked with potassium chromate and cesium hydroxide. Results from these Envelope B tests can be found in Esch (1997). In 1998, the composite created in 1996 and modified in 1997 was retrieved from archive and analyzed again to support the *Request to Perform Additional Analysis for Tank 241--AN-105 for Privatization Project* (Jo 1998). Analyses were performed on three subsamples of the composite to compare the sample composition with the Envelope A specifications (Esch 1998). As a result of the drainable liquid composite being previously spiked with potassium chromate, the K and Cr ICP results do not represent tank waste and were, therefore, not included in the "*Means and Confidence Intervals*" Standard Report. Because the added cesium was non-radioactive, the ^{137}Cs results were not impacted. The remaining analytes were unaffected by the addition of potassium chromate and cesium hydroxide.

Segments 15, 17, 19, and 21 from core 152 and segments 4, 16, 18, and 20 from core 153 were sampled using the retained gas sampler. The RGS results are reported in Shekarriz et al. (1997). Core 152 segment 14 was originally identified as a RGS sample. However, since the integrity of the sample was compromised because of a leaking sampler seal, it was extruded and analyzed as a non-RGS sample.

Clarification and Explanation of Data Tables and Figures

Description of Tank Standard Report: The waste phase volumes in this Standard Report differ from those reported in Hanlon (1999), because the retained gas volumes have been subtracted out of the totals. In addition, the solids have been designated saltcake instead of sludge based on the analytical results and extrusion observations. For additional discussion, refer to Question 7, "Best-Basis Inventory Derivation." The Hanlon (1999) drainable interstitial liquid volume has also been revised based on the extrusion observations. Only two of the solid segments (segments 19 and 21 of core 153) had drainable liquid. The small amount of liquid (30 mL) from segment 19 was analyzed with the solids. The liquid from segment 21, or at least some portion of it, is suspected of being hydrostatic head fluid based on the bromide results. Any interstitial liquid associated with the solids is already accounted for in the solids analysis.

"*Core Profile*" Standard Report: A small amount of crust material (6.4 cm [2.5 in.]) was obtained in segment 1 of core 152. However, an immeasurable amount of solids was received in segment 1 of core 153. The remainder of segment 1 through a portion of segment 14 was liquid in both cores. Visually, the liquid appeared homogeneous. Although not represented on the "*Core Profile*" Standard Report, a trace amount of solids was recovered with the drainable liquid in all of the segments. The solids in segments 14 through 21 primarily resembled a salt slurry, and varied in color from light gray to dark gray. Segment 22 generally resembled the other segments, however, the color turned darker near the bottom of the segment. The lower 10 cm (4 in.) of segment 22 of core 153 were black, and physically resembled a sludge slurry. Compositionally, the bottom of segment 22 is quite different from the rest of the waste, with the upper portion of the segment being a transitional phase. [See the "*Subsampling Scheme and Sample Description*" Standard Report for more information regarding sample appearance.]

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 exceptional unique chemical, physical, historical, operational or other characteristics of the contents of tank 241-AN-105. The waste types in this tank are relatively well defined and understood with the same waste types found in a number of other tanks.

Best-Basis Inventory Derivation

Question 7: 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 program is chartered to develop and maintain best-basis inventories of 25 chemical and 46 radionuclide components in the 177 Hanford Site underground storage tanks. These best-basis inventories now serve as waste composition data for the RPP process flowsheet modeling work, safety analyses, risk assessments, and waste retrieval, treatment, and disposal system design.

Development and maintenance of the best-basis inventory is an on-going effort. Since new sample data was recently made available for double-shell tank 241-AN-105, a re-evaluation of the best-basis inventories was performed and is documented in the following text. The following information was used in this evaluation:

- Statistical means based on the tank 241-AN-105 1996 core samples (cores 152 and 153) from the 1996 analysis (see "*Means and Confidence Intervals*" Standard Report).
- Statistical means from archived 1996 core material analyzed in 1998 (see "*Means and Confidence Intervals*" Standard Report).
- The Hanford Defined Waste (HDW) model document (Agnew et al. 1997a) which provides tank content estimates in terms of component concentrations and inventories.

The following table represents how the available data are used to derive best-basis inventories for tank 241-AN-105. Three waste phases were identified for the tank: supernatant, upper salt slurry, and lower salt slurry. Inventories were computed for each phase separately and then summed to obtain the overall tank inventory.

Table 7-1. Tank 241-AN-105 Best-Basis Inventory Source Data

Waste Phase	Waste Type	Applicable Concentration Data	Associated Density	Associated Volume
Supernatant	SMMA2 (DSSF)	1998 DL composite from cores 152 & 153	1.42[1]	2,400 kL (634 kgal)
		1996 DL composite from core 152	1.42	
		1996 DL segment data	1.42	
Upper salt slurry	SMMA2 (DSSF)	1998 core composite from core 152, segments 14, 16, 18, 20	1.62[2]	1,643 kL (434 kgal)
		1996 core composite from core 152, segments 14, 16, 18, 20	1.62	
		1996 segment data minus segment 22	1.57	
Lower salt slurry	SMMA2 (DSSF)	1996 core composite from core 152, segment 22	1.67	129 kL (34 kgal)
		1996 segment 22 data	1.61	
Retained gas	n/a	n/a	n/a	91 kL (24 kgal)
Total tank	Overall tank volume			4,262 kL (1,126 kgal)[3]

Notes:

DL = drainable liquid
n/a = not applicable

[1] Not analyzed; 1996 composite density is assumed.

[2] Not analyzed; 1996 composite density is assumed.

[3] The HDW Model volume was 4,277 kL (1,130 kgal) with a density of 1.88 g/mL. The difference in volume is due to evaporation and surface-level equipment adjustments.

Waste phases were based on the core sampling extrusion results and the analytical results (see *"Means and Confidence Intervals"* Standard Report). The upper salt slurry phase included the solids recovered from segments 1, 14, 16, 18, and 20 of core 152 and segments 14, 15, 17, 19, and 21 of core 153, while the lower salt slurry consisted of the material obtained from segment 22 of both cores. The break in the salt slurries was drawn at segment 22 because of differences in appearance between this and the other segments, and because of substantial differences in the concentrations of some analytes. The volume of the lower salt slurry was based on the length of the extruded solids from segment 22 of core 152. The upper salt slurry volume was derived by subtracting the lower salt slurry volume from the overall solids volume. The overall solids volume is based on a 1997 volume assessment of ball rheometer, void fraction instrument, and temperature readings (Stauffer

1997). Note that segments 15, 17, 19, and 21 of core 152 and segments 4, 16, 18, and 20 of core 153 were taken using the retained gas sampler.

Results from analysis of the solids recovered from segment 1 of core 152 were included in the upper salt slurry means. Prior to combining the segment 1 solids data with the segments 14 through 21 solids data, a statistical analysis was performed to determine if any significant differences existed in constituent concentrations. The analysis revealed that no significant difference existed.

The supernatant volume was based on the February 1999 Waste Tank Summary Report supernatant value (Hanlon 1999). Supernatant was found in segments 1 through 14 (see "*Tank Subsampling Scheme and Sample Description*" Standard Report).

The current overall tank volume, 4,262 kL (1,126 kgal), is in agreement with surveillance information (see "*Tank Surface Level*" Standard Report). The HDW Model total tank volume, 4,277 kL (1,130 kgal), differs from the current tank volume because of evaporation, equipment adjustments, etc. The retained gas volume, based on the retained gas samples, ball rheometer tests, void fraction instrument readings, and temperature data, was obtained from Meyer et al. (1997). This volume differs from that derived solely from the retained gas samples as reported in Shekarriz et al. (1997) and Question 1 of this Tank Interpretive Report. The volumes used to compute the best-basis inventory do not include the retained gas volumes. Note that because the "*Description of Tank 241-AN-105*" Standard Report does not contain an entry for retained gas volume, the volumes reported in the standard report will not add up to the total volume.

All densities used in the best-basis inventory calculations were analytically determined, and the values reported in Table 7-1 are means. No density analyses were performed on the 1998 composites. Therefore, densities for these samples were based on the density means for the 1996 composites.

The waste type designations were based on tank process history (Agnew et al. 1997a). The DSSF term is used by Hanlon (1999) to represent waste that has been concentrated in an evaporator up to the sodium aluminate boundary, without exceeding receiver tank composition limits.

Three sample-based concentration vectors were available for the supernatant. Where possible, the 1996 segment data means were used to derive the best-basis inventory for this waste phase. Where segment data means were not available for the supernatant, the 1998 composite means were used. The 1998 composite contained supernatant from both cores. The core 152 material that went into this composite had been spiked with potassium chromate and cesium hydroxide (the spiking was done in 1996 in order to simulate Privatization Envelope B conditions [Esch 1997]). This addition compromised the potassium and chromium data; however, the remaining analytes were unaffected (Esch 1997). The ^{137}Cs data were not affected because the added cesium was non-radioactive. In several cases, the 1996 supernatant composite means were used. For TOC, the 1996 composite mean was selected over the 1998 composite mean because the 1996 method (furnace oxidation) is considered more rigorous than the 1998 method (persulfate). The 1996 composite was formed from only core 152 material. Results were available from two preparation methods, acid dilution and acid digestion. The acid dilution results were used in all cases because of concerns that the acid digestion may have digested solids along with the liquids. Poor correlation was observed between the two preparation methods for some analytes, with the acid digest samples displaying elevated results.

Values from the HDW Model (Agnew et al. 1997a) were used for the radionuclides that did not have analytical data.

Three sample-based concentration vectors were also available for the upper salt slurry. Again, where possible, the 1996 segment data means were used in the best-basis inventory calculations. In most cases, the acid digest results were used over the fusion digest results because the fusion digest results were below detection limits. For sodium, mass and charge balances revealed that the acid digest mean was more reasonable than the fusion digest mean. The 1998 segments 14 through 20 composite means were used to supplement the 1996 segment data. In a few instances, means based on the 1996 segments 14 through 20 composite were used. Hanford Defined Waste Model values were used for the radionuclides that were not analyzed.

The lower salt slurry had two sample-based concentration vectors, the 1996 segment 22 means and the 1996 composite means. The 1996 composite was formed using equal parts of the lower and upper half solids of segment 22 from core 152. The means from this composite were used to derive the lower salt slurry best-basis inventory for all analytes except sodium. Based on a mass and charge balance, it was determined that the 1996 segment 22 sodium acid digest mean was more reasonable than the composite mean or the 1996 segment 22 fusion digest mean. The segment 22 means were based on the upper half solids from core 152 and the upper and lower half solids of core 153. Unfortunately, all of the lower half solids from segment 22 of core 152 were used during the making of the composite, so none was available during the segment analysis.

All calculations were performed using the Best-Basis Inventory Maintenance Tool. Best-basis inventory values for tank 241-AN-105 are shown in the "*Best-Basis Inventory (Non-Radionuclides)*" and "*Best Basis Inventory (Radionuclides)*" Standard Reports. Discussions of unique data treatments are provided below by analyte.

Radionuclides. When radionuclide analytical results were below detection limits, comparisons were made between the inventory based on the nondetected values and the HDW Model inventory. The lower of the two inventory values was selected. For ^{243}Cm and ^{244}Cm, the sample data generated high less-than values for the inventories. Consequently, inventories for these two radionuclides were derived from the ^{241}Am analytical results using the standard best-basis method.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory 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).

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