0049686 PAGE

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 627032

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	3a. USQ Required?	4. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Ruth D. Schreiber, Characterization Plans, Coordination and Reports, R2-12, 373-5589	[] Yes [X] No	12/08/95
	5. Project Title/No./Work Order No. Tank 241-AZ-102	6. Bldg./Sys./Fac. No. N/A	7. Approval Designator N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-411, Rev. 0	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work	11b. Work Package No.	11c. Modification Work Complete	11d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	N/A	N/A Cog. Engineer Signature & Date	N/A Cog. Engineer Signature & Date

12. Description of Change

This ECN is being generated because there was a revision to the analytical data.

SEP 1998 RECEIVED EDMC

13a. Justification (mark one)

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

13b. Justification Details

Some of the compatibility analytical results were incorrect due to a dilution factor error.

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

See attached distribution sheet.

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OFFICIAL RELEASE BY WHC (2) DATE DEC 08 1995

A-7900-013-2 (11/94) GEF095

A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) ECN-627032

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

18. 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 12. Enter the affected document number in Block 19.

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	[]		[]

19. 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		

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog. Eng. R.D. Schreiber RDSchreiber	12/8/95	PE	
Cog. Mgr. J.G. Kristofzski John Kristofzski	12/8/95	QA	
QA		Safety	
Safety		Design	
Environ.	12/8/95	Environ.	
Other R.F. Eggers R.F. Eggers		Other	
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

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

Ruth D. Schreiber
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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Abstract: N/A

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-411	Page 1

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

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 07/27/95 on EDT-612174.	G.W. Ryan	J.G. Kristofzski
0-A RS	Incorporate per ECN-627032.	R.D. Schreiber	J.G. Kristofzski
		RDSchreiber	JG Kristofzski 12/8/95

A-7320-005 (08/91) WEF168

Table ES-2. Double-Shell Underground Storage Tank 241-AZ-102 Concentrations and Inventories for Major Analytes and Analytes of Concern. (2 sheets)

Physical properties	Sludge results		Liquid results	
Density (g/mL)	1.49		1.10	
Percent water	51%		84.1%	
pH	--		12.9	
Heat load	<58,441 W (<199,457 Btu/hr)			
Chemical constituents	Sludge[a] concentration	Sludge inventory	Liquid concentration	Liquid inventory
Metals	(μg/g)	(kg)	(μg/g)	(kg)
Aluminum	38,688.9	19,196.3	1,400.0[b]	4,974.2
Cadmium	10,800.5	5,358.9	--	--
Chromium	1,628.5	808.0	879.0[c]	3,123.1
Iron	94,322.7	46,800.1	<9.1[b]	<32.3
Lanthanum	3,240.4	1,607.8	--	--
Sodium	54,340.0	26,961.9	48,363.6[b]	171,836.0
Nickel	6,379.7	3,165.4	--	--
Silicon	3,361.1	1,667.7	484.0[c]	1,719.7
Uranium	9,464.0	4,695.8	1,400.0[c]	4,974.2
Zirconium	13,033.0	6,466.6	--	--
TIC	13,203.2	6,551.0	5,311.8[b]	18,874.0
Ions	(μg/g)	(kg)	(μg/g)	(kg)
NO_3^-	3,424.4	1,699.1	21,636.4[b]	76,776.3
NO_2^-	11,877.6	5,893.3	25,090.9[b]	89,255.7
SO_4^{2-}	8,040.8	3,989.6	15,727.3[b]	55,879.0

Table ES-2. Double-Shell Underground Storage Tank 241-AZ-102 Concentrations and Inventories for Major Analytes and Analytes of Concern. (2 sheets)

Physical properties	Sludge results		Liquid results	
Organics	(μg/g)	(kg)	(μg/g)	(kg)
Total organic carbon	2,650.4	1,315.0	1,366.4[b]	4,855.8
Radionuclides	(μCi/g)	(Ci)	(μCi/g)	(Ci)
^{241}Am	72.7	36,081.7	<0.0039[b]	<13.9
^{137}Cs	842.8	342,801.2	945.5[b]	3,359,200.0
^{106}Ru	<2,903.9	<3,570.3	--	--
^{90}Sr	15,841.7	6,366,730.3	1.6[b]	5,792.5

Note: 1 Ci = 3.7 E+10 Bq.
[a]Based on 1989 sampling and analysis, sludge with interstitial liquids.
[b]Based on 1995 sampling and analysis, supernatant only.
[c]Based on 1989 sampling and analysis, sludge with interstitial liquids.
-- Indicates information/value not measured.

operational capacity of 3,710 kL (980 kgal), currently contains 3,590 kL (949 kgal) of waste, 3,230 kL (854 kgal) existing as supernatant and 360 kL (95 kgal) in the form of sludge (Hanlon 1995). The sludge measured 333 kL (88 kgal) when last sampled (May 1989), while the supernatant constituted 3,230 kL (854 kgal) upon its most recent sampling (February 1995).

This report summarizes four sampling and analysis events. The first two sampling events occurred in August and October of 1987 and the results are presented and used in this report only for comparison with the more recent sampling events. The third sample was taken in 1989 to support retrieval, pretreatment, and disposal and is used to represent sludge composition and properties. Finally, supernatant composition is based on grab samples taken in February of 1995 to evaluate waste compatibility. The grab samples were taken as prescribed in the *Data Quality Objectives for the Waste Compatibility Program*, WHC-SD-WM-DQO-001 (Carothers 1994).

The fuel content of the supernatant was measured by differential scanning calorimetry (DSC) and no exotherms were found, denoting that the fuel content of the supernatant is low. Although a similar analysis was not performed on the core sample, the presence of excessive fuel is unlikely when the total organic carbon (TOC) content and process history of the tank are considered. If the sludge is sampled again the analyses should include an evaluation of the fuel content by DSC to provide an estimate of the future compatibility of this sludge with other waste types. The waste is approximately 90% supernatant, and the sludge moisture

1.0 INTRODUCTION

This report presents an overview of double-shell underground storage tank 241-AZ-102 (tank 241-AZ-102) and its waste contents. It provides estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities and background tank information. This tank characterization report for tank 241-AZ-102 describes the results of the four most recent sampling events. The first occurred in August of 1987 with the taking of a sludge and supernatant sample (Herting 1987). The second took place in October of 1987 and also included a sludge and supernatant sample (Herting 1988). A core sample consisting of two segments was obtained in 1989 (Gray et al. 1993). Finally, the tank waste was grab sampled in February of 1995 (Rollison 1995a, 1995b, and 1995c). Tank 241-AZ-102 is in active service; future plans include combining the waste in tank 241-AZ-102 with that in tank 241-AZ-101. Therefore, the composition of the tank waste can be expected to change. This report will be revised periodically to reflect new sample information and other changes. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-08 (Ecology et al. 1994).

1.1 PURPOSE

The report summarizes the information about the use and contents of tank 241-AZ-102. When possible, this information will be used to assess issues associated with safety, operations, environmental, and process development activities. This report also provides a reference point for more detailed information about tank 241-AZ-102.

1.2 SCOPE

The samples taken in 1987 were primarily intended to determine the composition of the solids which had accumulated on the floor of the tank. Chemical and radiochemical waste components were measured on the supernatant and sludge. No physical or thermodynamic analyses were performed. Other than total organic carbon (TOC), no specific organic analyses were performed.

The core sample obtained in 1989 was taken to characterize the neutralized current acid waste (NCAW) stored in tank 241-AZ-102 for support of retrieval, pretreatment, and disposal processes. Early characterization of NCAW was particularly important because at the time it was expected to be the first waste retrieved and vitrified in the Hanford Waste Vitrification Plant (Gray et al. 1993). Chemical, radiochemical and physical properties were measured on the supernatant and sludge phases of this sample. Other than TOC, no specific organic analyses were performed; and thermodynamic analyses were not conducted.

4.0 ANALYTICAL RESULTS AND WASTE INVENTORY ESTIMATES

4.1 OVERVIEW

The purpose of this section is to summarize the sampling and analytical results from the most recent sludge and supernatant samplings, as reported in the appendices. This section provides an estimate of the analyte concentrations in both the sludge and supernatant. In addition, an estimate of the total amount (inventory) of the analyte in both waste phases is presented based on the volumes of the sludge and supernatant layers estimated to be in the tank. The summary tables and appropriate appendices where the data can be found in this document are summarized in Table 4-1. Data regarding the physical characteristics of the sludge portion of the waste are presented and discussed in Section 4.3. All sampling events from which the reported results were derived are described in Section 3.

Table 4-1. Analytical Presentation Tables.

Analysis	Tabulated result location
Tank 241-AZ-102 Chemical Composition Summary	Table 4-2
Analytical Summary for the Sludge	Appendix A and Table A-1
1995 Grab Sample Results	Appendix B

The sludge composition is based on the analyses of tank 241-AZ-102, core 1, taken in 1989. The data from these analyses were obtained from Gray et al. (1993), are reported in Appendix A, and are summarized in Table 4-2. The calculated analyte concentrations for the sludge are a summation of the results acquired from centrifuged solid and centrifuged liquid samples from the sludge (refer to Appendix A for an explanation of this calculation). With regard to the centrifuged solids, the samples designated for ICP analysis were prepared by two separate fusion methods. All of the metals with the exception of potassium and nickel were analyzed after a fusion performed by potassium hydroxide in a nickel crucible. A sodium peroxide fusion in a zirconium crucible was used to evaluate potassium and nickel. No comments concerning precision were provided in existing documentation.

The supernatant composition and inventory for the tank was based on the results from the 1995 grab samples (Rollison 1995a, 1995b, and 1995c) as presented in Appendix B. A simple mean was calculated from the results for each analyte. This composition and inventory may change if transfers into and out of the tank occur.

Table 4-2. Analytical Summary for Waste in Tank 241-AZ-102. (5 sheets)

Analyte	1989 Sludge sample				1995 Grab samples	
	Centrifuged sludge concentration	Interstitial liquid concentration	Calculated average sludge concentration[a]	Total projected sludge inventory[b]	Liquid concentration[c]	Total projected supernatant inventory[d]
Metal	µg/g	µg/g	µg/g	kg	µg/g	kg
Al	53,700.0	89.1	38,688.9	19,196.3[e]	1,400.0	4,974.2
Sb	<3,410.0	<9.0	ND	ND	--	--
As	<592.0	3.8	<427.3	<212.0	--	--
Ba	553.0	0.7	398.4	197.7	--	--
Be	13.5	0.1	9.7	4.8	--	--
B	<497.0	7.3	<359.9	<178.6	--	--
Cd	15,000.0	1.7	10,800.5	5,358.9	--	--
Ca	3,020.0	5.3	2,175.9	1,079.6	--	--
Ce	<785.0	10.4	<568.1	<281.9	--	--
Cr	1,920.0	879.0	1,628.5	808.0	879.0[f]	3,123.1
Co	<1,470.0	7.5	<1,060.5	<526.2	--	--
Cu	350.0	2.7	252.8	125.4	--	--
Dy	<50.4	0.8	<36.5	<18.1	--	--
Fe	131,000.0	9.5	94,322.7	46,800.1	<9.1	<32.3
La	4,500.0	1.5	3,240.4	1,607.8	--	--
Pb	1,100.0	5.2	793.5	393.7	--	--
Li	<29.2	0.1	<21.0	<10.4	--	--
Mg	950.0	0.8	684.2	339.5	--	--
Mn	2,880.0	0.7	2,073.8	1,028.9	--	--
Mo	47.0	31.9	42.8	21.2	--	--
Nd	2,910.0	4.8	2,096.5	1,040.2	--	--
Ni	8,860.0	1.9	6,379.7	3,165.4	--	--
P	977.0	58.6	719.8	357.2	--	--

Table 4-2. Analytical Summary for Waste in Tank 241-AZ-102. (5 sheets)

Analyte	1989 Sludge sample				1995 Grab samples	
	Centrifuged sludge concentration	Interstitial liquid concentration	Calculated average sludge concentration[a]	Total projected sludge inventory[b]	Liquid concentration[c]	Total projected supernatant inventory[d]
Total Pu[g]	59.6	0.5	43.0	21.4	--	--
K	2,080.0	1,260.0	1,850.4	918.1	--	--
Re	<72.6	0.7	<52.5	<26.0	--	--
Rh	<422.0	11.2	<307.0	<152.3	--	--
Ru	<182.0	4.2	<132.2	<65.6	--	--
Se	<1,030.0	9.5	<744.3	<369.3	--	--
Si	4,480.0	484.0	3,361.1	1,667.7	484.0[f]	1,719.7
Ag	674.0	6.0	487.0	241.6	--	--
Na	59,100.0	42,100.0	54,340.0	26,961.9	48,363.6	171,836.0
Sr	327.0	0.2	235.5	116.8	--	--
Te	<345.0	2.3	249.0	123.6	--	--
Tl	<8,380.0	33.3	33.3[h]	16.5	--	--
Th	<487.0	<1.3	ND	ND	--	--
Ti	77.6	0.4	56.0	27.8	--	--
Total U[g]	12,600.0	1,400.0	9,464.0	4,695.8	1,400.0[f]	4,974.2
V	<32.6	1.8	<24.0	<11.9	--	--
Zn	141.0	0.3	101.6	50.4	--	--
Zr	18,100.0	3.7	13,033.0	6,466.6	--	--
Ion	µg/g	µg/g	µg/g	kg	µg/g	kg
Cl^-	147.0	59.9	122.6	60.8	<60.0	<213.2
Cr(VI)	--	105.0	29.4	14.6	--	--
F^-	460.0	739.0	538.1	267.0	913.6	3,245.1
OH^-	--	--	--	--	1,709.1	6,072.4
NO_3^-	2,520.0	5,750.0	3,424.4	1,699.1	21,636.4	76,766.3

Table 4-2. Analytical Summary for Waste in Tank 241-AZ-102. (5 sheets)

Analyte	1989 Sludge sample				1995 Grab samples	
	Centrifuged sludge concentration	Interstitial liquid concentration	Calculated average sludge concentration[a]	Total projected sludge inventory[b]	Liquid concentration[c]	Total projected supernatant inventory[d]
NO_2^-	15,400.0	2,820.0	11,877.6	5,893.3	25,090.9	89,255.7
PO_4^{3-}	416.0	129.0	335.6	166.5	<360.0	<1,279.1
SO_4^{2-}	6,540.0	11,900.0	8,040.8	3,989.6	15,727.3	55,879.0
Radchem	µCi/g	µCi/g	µCi/g	Ci	µCi/g	Ci
^{241}Am	101.0	1.3E-03	72.7	36,081.7	<4.3E-03	<13.9
^{125}Sb	576.0	<8.0	416.9	<24,204.7	--	--
^{14}C	1.8 E-03	1.1 E-03	1.6 E-03	0.8	--	--
^{144}Ce	ND	ND	ND	ND	--	--
^{137}Cs	880.0	747.0	842.8	342,801.2	945.5	3,359,200.0
^{154}Eu	ND	ND	ND	ND	--	--
^{129}I	ND	ND	ND	ND	--	--
^{237}Np	0.1	1.7 E-03	0.1	49.2	--	--
^{238}Pu	--	--	0.02[e]	169.6	<2.7 E-03	<9.6
$^{239/240}Pu$	--	--	42.7[e]	1,558.8	<2.7 E-03	<9.6
^{241}Pu	--	--	0.3[e]	13,794.0	--	--
^{106}Ru	4,030.0	<8.1	<2,903.9	<3,570.3	--	--
^{79}Se	<3.0 E-05	3.7 E-04	<1.2 E-04	<0.1	--	--
$^{89/90}Sr$	--	--	--	--	1.6	5,792.5
^{90}Sr	22,000.0	6.0	15,841.7	6,366,730.3[f]	--	--
^{99}Tc	0.6	0.1	0.4	220.3	--	--
Physical property	µg/g	µg/g	µg/g	kg	µg/g	kg
$\%H_2O$Grav	--	--	--	--	84.5	--
$\%H_2O$TGA	--	--	--	--	84.1	--

Table 4-2. Analytical Summary for Waste in Tank 241-AZ-102. (5 sheets)

Analyte	1989 Sludge sample				1995 Grab samples	
	Centrifuged sludge concentration	Interstitial liquid concentration	Calculated average sludge concentration[a]	Total projected sludge inventory[b]	Liquid concentration[c]	Total projected supernatant inventory[d]
Density (g/mL)	1.73	1.05	1.49	--	--	--
SpG	--	--	--	--	1.10	--
pH	--	11.8	--	--	12.9	--
Carbon	µgC/g	µgC/g	µgC/g	kg	µgC/g	kg
TOC	3,160.0	1,340.0	2,650.4	1,315.0	1,366.4	4,855.8
TIC	15,600.0	7,040.0	13,203.2	6,551.0	5,311.8	18,874.0

-- not measured, analyzed, or applicable.
ND = not detected.
TIC = total inorganic carbon.
TOC = total organic carbon.
[a]This column lists the average concentration of each analyte and is calculated as follows:

(Sludge concentration) (Sludge Wt%) + (Supernatant concentration) (1-Sludge Wt%)

Example calculation for aluminum:

(53,700 µg/g)(0.72) + (89.1 µg/g)(1-0.72) = 38,688.9 µg/g

[b]Projected sludge inventory calculated using Agnew estimate for 1989 sludge level of 333 kL (88 kgal). This sludge level translates to a total sludge mass of 496,170 kg (as calculated in Section 4.2).

Total projected inventory is calculated using the following equation:

(Total Sludge Mass) x (Average Sludge Analyte Concentration)

Table 4-2. Analytical Summary for Waste in Tank 241-AZ-102. (5 sheets)

Analyte	1989 Sludge sample				1995 Grab samples	
	Centrifuged sludge concentration	Interstitial liquid concentration	Calculated average sludge concentration[a]	Total projected sludge inventory[b]	Liquid concentration[c]	Total projected supernatant inventory[d]

Example calculation for aluminum:

$$\frac{(496{,}170\ \text{kg})\ (1{,}000\ \text{g/kg}) \times [(38{,}688.9\ \mu\text{g/g})\ (1 \times 10^{-6}\ \text{g/}\mu\text{g})]}{1{,}000\ \text{g/kg}} = 19{,}196.3\ \text{kg}$$

[c]Concentration values in μg/mL (as listed in Appendix B) have been converted to μg/g using the supernatant density of 1.10 g/mL.

[d]Projected supernatant inventory calculated using Hanlon estimate for February 1995 supernatant level of 3,230 kL (854 kgal) and a supernatant density of 1.10 g/mL. This is calculated using the following equation:

[(Supernatant Concentration)(Supernatant Density)(Total Supernatant Volume)(Unit Conversions)] x (Unit Conversions)

Example calculation for aluminum:

$$[(1{,}400.0\ \mu\text{g/g})(1.10\ \text{g/mL})(3{,}230{,}000\ \text{L})(1{,}000\ \text{mL/L})$$

$$(1 \times 10^{-6}\ \text{g/}\mu\text{g})] \times (1 \times 10^{-3}\ \text{kg/g}) = 4{,}974.2\ \text{kg}.$$

[e]It should be noted that additional aluminum may have precipitated since the 1989 sludge sampling as a result of the OH^- depletion which results from absorption of atmospheric carbon dioxide. This would account for some of the 26 kL (7 kgal) increase in sludge volume since the 1989 sampling event.

[f]A significant quantity of this element is expected in the supernatant. Since the 1995 grab sampling analyses did not analyze for this element, the supernatant concentration is taken from the 1989 core sample analysis.

[g]See Table A-2 in Appendix A for isotopic distributions.

[h]The large less than value (<) for the centrifuged sludge was ignored.

[i]Independent computer modelling of the PUREX waste streams entering this tank account for only approximately 50% of this value. This suggests that the calculated average sludge concentration for this radionuclide, based on the measured core sample concentrations, may be excessively conservative.

When all of the results for an analyte were less than the instrument detection limit, the average analyte concentration is reported as not detected (ND). Similarly, the calculated projected inventory is also reported as ND. In the case of one detected concentration result and one value at less than the detection limit, the resulting mean is calculated between the detected concentration value and the minimum detection limit value. In this situation the calculated projected inventory is shown preceded by a less than sign (<).

4.2 DATA PRESENTATION

The chemical composition of the sludge layer and the liquid which exists above the sludge layer is reported in Table 4-2. The projected inventory calculations associated with the sludge in the tank were calculated using a sludge volume of 333 kL (88 kgal). This was the approximate amount of sludge present at the time of the 1989 sampling (Agnew 1995). According to Gray et al. (1993), the weight of centrifuged solids from the core composite comprise 72% of the sludge in tank 241-AZ-102 with the remainder of the core composite being interstitial liquids (28%). The density of the composite sludge was determined to be 1.49 g/mL (see Section 4.3.1 for discussion), so the volume of sludge can be converted from liters to kilograms by utilizing the following equation:

Volume of Sludge (L) x Determined Sludge Density

$$333{,}000 \text{ L} \times 1{,}000 \text{ mL/L} \times 1.49 \text{ g/mL} \times 1.0 \times 10^{-3} \text{ kg/g} = 496{,}170 \text{ kg}$$

The volume of supernatant liquid waste existing above the sludge layer in tank 241-AZ-102 was 3,230 kL (854 kgal) when the February 1995 sampling event occurred. This volume and appropriate conversion factors were utilized to calculate inventory estimates from the liquid grab sample data (Appendix B, column 7).

A brief narrative of each column in Table 4-2 follows. The first column, labeled Analyte, gives the abbreviation for the name of the analyte being calculated or measured. The second column, labeled Centrifuged Sludge Concentration, is the analyte concentration calculated in the centrifuged sludge sample using tabulated information from Appendix A and Gray et al. (1993). The third column, labeled Interstitial Liquid Concentration, is the analyte concentration measured in the interstitial liquid sample drained/centrifuged from the sludge (Appendix A and Gray et al. [1993]). The fourth column, labeled Calculated Average Sludge Concentration, is the analyte concentration calculated to be present in the tank sludge as it exists in the tank with interstitial liquids (not centrifuged). The fifth column, labeled Total Projected Sludge Inventory, is the total projected inventory of the analyte calculated to be present in the sludge layer. The sixth column, labeled Liquid Concentration, is the concentration of analyte found in the supernatant samples (Appendix B). The seventh column, labeled Total Projected Supernatant Inventory, is the amount/total projected inventory of analyte calculated to be in supernatant layer above the sludge in the tank.

Also, please note the activity levels for radioactive components (Table 4-1, column 5) have been decayed approximately six years (May 1989 through June 1995) from the value shown to determine the total projected activity level (Ci) in the sludge.

4.3 PHYSICAL MEASUREMENTS

Physical measurements were performed on both of the sets of samples which were used as a basis for this report. These sample sets were a characterization core sample obtained in the second quarter of 1989 (Gray et al. 1993), and three waste compatibility samples obtained in the first quarter of 1995 (Rollison 1995a, 1995b, and 1995c). The physical measurements of the core samples were extensive, while only DSC and TGA were performed on the waste compatibility samples. Physical characterization includes, as discussed in this section, measured quantities such as density, percent solids, percent water, viscosity, and energetics as well as cohesiveness, color, and texture. Table 4-3 lists the results of the physical tests conducted on the core samples obtained in 1989. A discussion of physical testing methodology and interpretation of results can be found in *The Tank Characterization Reference Guide* (De Lorenzo et al. 1994).

Table 4-3. Tank 241-AZ-102 Physical Measurements.*

Physical property	Composite solids	40% Slurry	10% Slurry	Core composite	Washed solids
Density (g/mL)	1.49	1.24	1.10	1.36	1.11
Vol% settled solids	100	76	NM	NM	67
Vol% centrifuged solids	64	26	NM	46	22
Wt% centrifuged solids	72	37	NM	58	31
Centrifuged solids density	1.69	1.78	NM	1.73	1.52
Centrifuged supernatant density	1.13	1.10	NM	1.05	0.99
Wt% dissolved solids	3.4	12	NM	NM	NM
Wt% total solids	49	32	15	37	14
Wt% oxides	37	NM	NM	28	11

*Gray, W. J., M. E. Peterson, R. D. Scheele, J. M. Tingey, 1993, *Characterization of the First Core Sample of Neutralized Current Acid Waste from Double-Shell Tank 102-AZ*, Pacific Northwest Laboratories, Richland, Washington.

NM = not measured.

Table 4-6. Critical Reynold's Numbers and Velocities.

Slurry	Temperature (°C)	Nominal pipe diameter (in.)	Critical velocity (m/s)	Reynold's number	Critical flow (L/min)
40 wt% Solids	65	2.0	2.77	6,500	29
			2.69	8,100	28
		3.0	2.52	7,700	58
			2.40	10,500	55
	95	2.0	2.60	10,400	27
			2.35	20,300	25
		3.0	2.33	13,200	54
			2.01	34,900	46
10 wt% Solids	65	2.0	0.16	2,100	2
			0.02	2,200	2
		3.0	0.12	2,200	3
			0.14	2,100	3
	95	2.0	0.01	6,000	0.1
			0.17	2,200	2
		3.0	0.12	2,200	3
			0.14	2,100	3
Washed solids	33	2.0	1.46	7,400	15
			1.65	5,200	17
		3.0	1.31	9,400	30
			1.49	6,200	34

Gray, W. J., M. E. Peterson, R. D. Scheele, J. M. Tingey, 1993, *Characterization of the First Core Sample of Neutralized Current Acid Waste from Double-Shell Tank 102-AZ*, Pacific Northwest Laboratories, Richland, Washington.

4.3.6 Thermodynamic Analyses

DSC analyses were performed on the 1995 waste compatibility grab samples. No exothermic reactions were noted (Rollison 1995a, 1995b, and 1995c). TGA was utilized to determine the percentage of water in the 1995 grab samples, and the results are reported in Appendix B. No DSC or TGA were conducted on the 1989 core sample.

5.1.2 Quality Control Assessment of Analytical Data

An attempt is always made to quantify the different sources of error possible during the chemical analysis of a sample. When these errors are summarized, they give a strong indication of data reliability. If one or more of the error estimates are outside the acceptable limits, the accuracy of the concentration estimate is drawn into question. Possible sources of error are analytical method error, matrix interferences, sample contamination, and poor instrument calibration. Error estimates are determined from the analysis of standards, spike recoveries, blank contamination, and sample duplicate variation.

Quality control information was not provided in the sludge core sample data package. Therefore, the accuracy and precision of those analytical results are unknown. The data package for the 1995 grab samples provided some quality control information, which is discussed in the following paragraphs (Rollison 1995a, 1995b, 1995c).

Standards are used to estimate the accuracy of the analytical method, and are evaluated prior to and concurrent with sample analysis. Standards contain the analytes of interest at known concentrations. Standard solutions may or may not be independent of the standard used for calibration. The criterion for standard recovery is 100 $\pm$ 10%. If a standard is above or below the criterion, then the analytical results may be biased high or low, respectively. For the three grab samples, two standards were run for DSC, $^{89/90}$Sr, and $^{239/240}$Pu, no standards run for the ICP metals (aluminum, iron, and sodium), and one standard was run for the remainder of the analytes. The only standard that failed the criteria was for ^{241}Am (87.3% recovery), which indicated the data for this analyte may be biased slightly low.

Matrix spikes are used to estimate the bias of the analytical method due to matrix interferences. Spike samples are prepared by splitting a sample into two aliquots and adding a known amount of a particular analyte to one aliquot to calculate a percent recovery. The quality control criterion for matrix spikes is 100 $\pm$ 20% recovery. As with standards, if a spike is above or below the criterion, then the analytical results may be biased high or low, respectively. Spikes were only conducted on TOC (3 spikes), all anions except hydroxide (1 spike), and aluminum and iron (2 spikes). The only spike to fall outside the criteria was one of the two conducted for aluminum (78.3). Thus the analytical results for aluminum may be biased slightly low. The possible influence of matrix interferences on the data results of the remaining analytes cannot be assessed or estimated since no matrix spikes were conducted on them.

Method blanks document the contamination resulting from the analytical process, and are prepared by filling sample containers with deionized, distilled water. They are carried through the complete sample preparation and analytical procedure, and all reagents used in the sample processing are added in the same volumes. One blank was conducted on all of the anions, $^{89/90}$Sr, and ^{241}Am, and two blanks were conducted on ^{238}Pu and $^{239/240}$Pu. The

August 1987, October 1987, and February 1995 are compared in Table 5-5, and two digestion methods for the solid samples from August 1987 are compared in Table 5-6.

The comparison of the supernatant results gives an indication of the precision of the analyses, assuming that the supernatant was relatively unchanged between 1987 and 1995. It is a good assumption, given the transfer history of the tank in that period (see Section 2.0 for a detailed discussion). Five analytes (aluminum, sodium, nitrate, fluoride, and hydroxide) showed good agreement among all three data sets. Total beta and total organic carbon showed good agreement between two data sets.

The solid samples from August 1987 are compared in Table 5-6, in order to give personnel involved in retrieval an idea of the solubility of the analytes. The concentrations of analytes which appear in both data reports at levels above the minimum detectable are listed. Results from the August 1987 sampling event are used because that sample set has the larger number of common and detected analytes. The data comes from samples which were centrifuged, and the supernatant discarded. The remaining solids were water washed, then recentrifuged and the solids dissolved in acid. The solid sample results for the acid digestion are assumed to represent all of the analytes present in the sample, i.e., it is assumed that the acid digestion is complete. The percent solubility is a ratio of the water digestion results and the total water and acid results.

5.3 TANK WASTE INVENTORY PROFILE

Several restraints were encountered in the attempt to describe the horizontal and vertical disposition of the waste in tank 241-AZ-102. The risers from which the two samples from 1987 were taken were not identified; therefore, it is not known whether they were the same risers from which the 1989 sludge sample or the 1995 supernatant sample were taken. This precludes any effort to compare or incorporate the 1987 information with the 1989 and 1995 information for horizontal or vertical analysis.

The three 1995 supernatant samples were all taken from the same riser at evenly spaced depths: the first near the top of the supernatant layer, the second near the middle, and the third near the bottom of the supernatant layer. Considering that for a given analyte none of the samples was more than 20% different than another, and that the criterion for duplicate precision is also 20%, any differences between the supernatant samples are not large enough to be considered different from another. Thus, based on these results, the contents of the supernatant layer appear to be homogeneous.

The two sludge segments from the 1989 sample were divided into two sub-segments, giving a total of four subsegments. Table 5-7 lists the sub-segments in columns 2-5, with tank depth increasing from left to right. Samples L1 and L2 were obtained from the upper segment and samples L3 and L4 from the second segment. Note that the numerical order of sampling was reversed between the two samplers. Sample L1 came from the upper sludge layer, sample L3 came from near the bottom, and samples L2 and L4 came from near the

Table 5-5. Comparison of Supernatant Constituents.

Metal/Ion	August 1987	October 1987	February 1995
	μg/mL		
Aluminum	2,620	2,300	1,540
Sodium	37,000	36,100	53,200
Nitrate	21,700	21,700	23,800
Nitrite	12,400	12,400	27,600
Fluoride	703	722	1,005
Sulfate	10,800	10,600	17,300
Chloride	248	2,160	--
Hydroxide	3,400	3,060	1,880
TOC	1,520	720	1,503
TIC	12,000	16,200	5,843
Radionuclide	μCi/mL		
$^{89/90}Sr$	1.46	0.00165	1.79
^{137}Cs	936	735	1,040
Total Beta	1,370	1,360	--

-- Not detected/measured.

Table 5-6. Comparison of Sludge Constituents.

Metal/Ion	Water Digest	Acid Digest	% Solubility
	μg/mL		
Aluminum	1,120	2,970	27.4
Sodium	27,200	6,110	81.7
Uranium	157	5,120	2.98
Fluoride	589	21,500	2.67
Phosphate	190	3,520	5.12
Radionuclide	μCi/mL		
^{137}Cs	550	290	65.5
$^{89/90}Sr$	0.843	9,300	<0.01

Herting, D. L., 1987, *Chemical Analysis of Tank 102-AZ Samples Taken in August 1987*, (internal memo 12221-PCL87-041 to L. A. Mihalik, December 8, 1987), Westinghouse Hanford Company, Richland, Washington.

more than satisfies the 17 wt% water requirement of the safety screening DQO (Babad and Redus 1994). This value more than satisfies the 17% criteria established by the safety screening DQO.

Another factor in assessing the safety of the tank waste is the heat generation and temperature of the wastes. Heat is generated in the tanks primarily from radioactive decay. The major contributors for tank 241-AZ-102 are ^{90}Sr, ^{106}Ru, and ^{137}Cs. The estimated heat generated from the isotopes in the tank is <58,441 W (<199,457 Btu/hr) as shown in Table 5-8. This heat load is high when compared to other double-shell tanks, but is expected because of the aging waste. The maximum heat limit for tank 241-AZ-102 is 4,000,000 Btu/hr (Bergmann 1989), so the heat load is only about 5% of this maximum limit. Temperature data for the previous year (December 1993 through December 1994) is displayed graphically in Figure 2-6. In that time the temperature has ranged from 78 °C (172 °F) to 83 °C (181 °F), excluding one suspect spike.

Table 5-8. Tank 241-AZ-102 Projected Heat Load.

Radionuclide	Curies* (Ci)	Watts
^{241}Am	<36,097	<1,206
^{137}Cs	3,712,801	14,554
$^{239/240}Pu$	<1,568	<49
^{106}Ru	<3,570	<0.2
$^{89/90}Sr$ (supernatant)	5,793	39
^{90}Sr (sludge)	6,366,730	42,593
Total watts		<58,441

*Analyte values from the liquid portion of the tank were added to the sludge portion. Therefore, the total tank inventory is based on 1987 sludge and 1995 liquid grab sample results.

The potential for criticality is assessed from either total alpha or plutonium analysis. Criticality specifications for double-shell storage tanks are defined in Vail (1994). The safety screening criteria is 1 g/L. This is equivalent to 41.3 μCi of $^{239/240}Pu$/g in the waste, using the sludge density of 1.49 g/mL. The 1989 core data showed that the sludge contained 43.0 μg/g of plutonium (Table 4-2), which translates to 3.14 μCi/g of $^{239/240}Pu$ when using the plutonium isotope weight percentage breakdown given in Gray et al. (1993) and tabulated in Table A-2. The concentration of $^{239/240}Pu$ in the supernatant is $<2.7 \times 10^{-3}$ μg/g, so the total waste inventory of $^{239/240}Pu$ is well below the safety screening limit. The criticality specifications also require the pH of the waste to be greater than 8.0 when the plutonium inventory exceeds 10 kg and the depth of the supernatant liquid exceeds 30 cm. The pH of

Table 5-9. Compatibility Assessment for Tank 241-AZ-102 Supernatant.

Parameter	Criteria	1995 Result
$^{239/240}Pu$	< 0.05 g/gal (0.8 μCi/g)[a]	< 2.7 E-03 μCi/g
SpG	< 1.41	1.10
Energetics	exotherm/endotherm < 1	0
Corrosivity[b]	If $[NO_3^-]$ and $[OH^-]$ each < 1.0 M, then $[NO_2^-] \geq 0.011$ M	$[NO_3^-] = 0.384$ M $[OH^-] = 0.110$ M $[NO_2^-] = 0.600$ M
TRU	< 100 nCi/g	< 7 nCi/g
TOC	< 10 g/L	1.50 g/L

[a]In converting g/gal to μCi/g, the specific activity of ^{239}Pu was used and the supernatant density assumed to be 1 g/mL.

[b]Corrosivity decision rules were not developed for the aging waste tanks in the waste compatibility DQO because aging wastes are no longer generated with the permanent shutdown of PUREX (Carothers 1994). Instead, the wastes stored in tank 241-AZ-102 must comply with the corrosion specifications listed in *Operating Specifications for Aging-Waste Operations in 241-AY and 241-AZ* (Bergmann 1989). The criteria shown in the table are from (Bergmann 1989).

SpG = specific gravity.

measurements, discussed in Section 4.3, will be important in evaluating retrieval and pretreatment process equipment needs. Solubility information was obtained from results of the analyses of water washed solids. Table 5-10 compares the results from these water washed solids with those obtained from analyzing the core composite centrifuged solids. The analytes listed in the table were chosen because of their environmental concern. All of the data was taken from Gray et al. (1993).

Specific analyses were also requested to be performed on tank 241-AZ-102 waste for process testing purposes. A sludge washing test has been developed to gain information relative to the use of tanks 241-AZ-101 and 241-AZ-102 to fully test the process, equipment, and instruments needed for in-tank processing of the waste. The test plan for this operation has just recently been completed and is contained in Herting (1995). Utilizing this test plan, the requested analyses will be performed in accordance with the requirements outlined in Schreiber (1995).

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Three additional samples (S95T000743, S95T000744, and S95T000746) were taken and archived. The samples in Tables B-4 through B-24 are listed in order of increasing depth.

Result is the specific concentration of the analyte determined at different sampling points. No quality control data such as matrix spikes, serial dilutions, or duplicate analyses are listed. This information may be obtained from the tank 241-AZ-102 grab sample data package (Rollinson 1995a, 1995b, and 1995c).

The number listed is an average between the primary sample and its duplicate sample. Where more than one duplicate sample was performed the primary sample was averaged with all the duplicates.

The last column lists the total projected inventory of tank 241-AZ-102 (after μg/mL have been converted to μg/g using a supernatant density of 1.10 g/mL) using a total supernatant volume of 3,230 kL. This is calculated using the following equation:

[(Supernatant Concentration)(Total Supernatant Volume)(Unit Conversions)]

Example calculation for aluminum:

[(1,540 μg/mL)(1,000 mL/L)(3,230,000 L)(1 kg/1E+09 μg) = 4,974.2 kg]

Numbers that are preceded by a less than symbol (<) indicate the analyte was noted, but was below the analytical instrument's calibrated detection limit for the sample.

Table B-4. Tank 241-AZ-102 Analytical Data: Aluminum.

Analyte	Sample Number	Result	Mean	RSD (Mean)	Projected Inventory
Metal					
Drainable Liquid		μg/mL	μg/mL	%	kg
ICP.a.Al	S95T000266	1,550	1,540	0.22	4,974.2
	S95T000267	1,540			
	S95T000268	1,540			

Table B-5. Tank 241-AZ-102 Analytical Data: Iron.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Metal					
Drainable liquid		µg/mL	µg/mL	%	kg
ICP.a.Fe	S95T000266	<10.0	<10.0	N/A	<32.3
	S95T000267	<10.0			
	S95T000268	<10.0			

Table B-6. Tank 241-AZ-102 Analytical Data: Sodium.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Metal					
Drainable liquid		µg/mL	µg/mL	%	kg
ICP.a.Na	S95T000266	53,400	53,200	0.23	171,836.0
	S95T000267	53,200			
	S95T000268	53,000			

Table B-7. Tank 241-AZ-102 Analytical Data: Chloride.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
IC.Cl^-	S95T000263	<121	<66	N/A	<213.2
	S95T000264	<66			
	S95T000265	<66			

Table B-8. Tank 241-AZ-102 Analytical Data: Fluoride.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
IC.F^-	S95T000263	1,080	1,005	4.69	3,245.1
	S95T000264	914			
	S95T000265	1,020			

Table B-9. Tank 241-AZ-102 Analytical Data: Hydroxide.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
Pot.Titrat.OH^-	S95T000246	1,920	1,880	2.39	6,072.4
	S95T000247	1,840			

Table B-10. Tank 241-AZ-102 Analytical Data: Nitrate.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
IC.NO_3^-	S95T000263	25,600	23,800	5.10	76,766.3
	S95T000264	21,400			
	S95T000265	24,300			

Table B-11. Tank 241-AZ-102 Analytical Data: Nitrite.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
IC.NO_2^-	S95T000263	29,600	27,600	4.77	89,255.7
	S95T000264	25,100			
	S95T000265	28,200			

Table B-12. Tank 241-AZ-102 Analytical Data: Phosphate.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
IC.PO_4^{3-}	S95T000263	<726	<396	N/A	<1,279.1
	S95T000264	<396			
	S95T000265	<396			

Table B-13. Tank 241-AZ-102 Analytical Data: Sulfate.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Anion					
Drainable liquid		µg/mL	µg/mL	%	kg
IC.SO_4^{2-}	S95T000263	18,700	17,300	5.04	55,879.0
	S95T000264	15,700			
	S95T000265	17,500			

Table B-14. Tank 241-AZ-102 Analytical Data: ^{241}Am.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Radionuclide					
Drainable liquid		µCi/mL	µCi/mL	%	Ci
Extr.^{241}Am	S95T000263	<0.00429	<0.00429	N/A	< 13.9
	S95T000264	<0.00439			
	S95T000265	<0.00462			

Table B-15. Tank 241-AZ-102 Analytical Data: ^{137}Cs.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Radionuclide					
Drainable liquid		µCi/mL	µCi/mL	%	Ci
GEA.^{137}Cs	S95T000263	1,040	1,040	0.47	3,359,200.0
	S95T000264	1,040			
	S95T000265	1,040			

Table B-16. Tank 241-AZ-102 Analytical Data: ^{238}Pu.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Radionuclide					
Drainable liquid		µCi/mL	µCi/mL	%	Ci
IonEx. ^{238}Pu	S95T000263	<0.00863	<0.00296	N/A	<9.6
	S95T000264	<0.0119			
	S95T000265	<0.00296			

Table B-17. Tank 241-AZ-102 Analytical Data: $^{239/240}Pu$.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Radionuclide					
Drainable liquid		µCi/mL	µCi/mL	%	Ci
IonEx. $^{239/240}Pu$	S95T000263	<0.00863	<0.00296	N/A	<9.6
	S95T000264	<0.0119			
	S95T000265	<0.00296			

Table B-18. Tank 241-AZ-102 Analytical Data: $^{89/90}Sr$.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Radionuclide					
Drainable liquid		µCi/mL	µCi/mL	%	Ci
HighLev. $^{89/90}Sr$	S95T000263	1.59	1.79	13.10	5,792.5
	S95T000264	1.53			
	S95T000265	2.26			

Table B-22. Tank 241-AZ-102 Analytical Data: pH.

Analyte	Sample Number	Result	Mean	RSD (Mean)	Projected Inventory
Physical Property					
Drainable liquid				%	
pH	S95T000245	12.9	12.9	0.07	N/A
	S95T000246	12.9			
	S95T000247	13.0			

Table B-23. Tank 241-AZ-102 Analytical Data: Total Organic Carbon.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Carbon					
Drainable liquid		µg/mL	µg/mL	%	kg
Coul.TOC	S95T000263	1,560	1,503	3.16	4,855.8
	S95T000264	1,540			
	S95T000265	1,410			

Table B-24. Tank 241-AZ-102 Analytical Data: Total Inorganic Carbon.

Analyte	Sample number	Result	Mean	RSD (mean)	Projected inventory
Carbon					
Drainable liquid		µg/mL	µg/mL	%	kg
Coul.TIC	S95T000263	5,690	5,843	3.57	18,874.0
	S95T000264	5,980			
	S95T000265	5,860			

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D. J. Washenfelder	H5-27	X
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K. A. White	S5-13	X
W. I. Winters	T6-50	X
TFIC (Tank Farm Information Center)	R1-20	X
Central Files	A3-88	X
EDMC	H6-08	X
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C. S. Cho	B4-55	X	
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M. L. Dexter	R1-51	X	
G. L. Dunford	S7-81	X	
S. J. Eberlein	R2-12	X	
D. B. Engelman	R1-49	X	
K. O. Fein	H4-65		X
G. D. Forehand	S7-21	X	
J. S. Garfield	H5-49	X	
J. D. Guberski	R2-06		X
R. D. Gustavson	R1-51	X	
G. A. Hanson	S7-16	X	
D. L. Herting	T6-09	X	
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N. W. Kirch	R2-11	X	
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D. L. McGrew	R3-25	X	
B. D. McVeety	K6-96	X	
J. E. Meacham	S7-15	X	
W. C. Miller	R1-30	X	
C. T. Narquis	T6-16	X	
R. J. Nicklas	R1-43	X	
D. E. Place	H5-27	X	
D. A. Reynolds	R2-11	X	
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