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7. Abstract

The purpose of this document is to address concerns with the practice of continuing to transfer nuclear material between double shell tanks (DST) for which no credible nuclear material inventory exists. This report provides an evaluation which establishes plutonium inventory estimates for all DSTs based upon known tank history information, the DST plutonium inventory tracking system, tank characterization measurements, tank transfer records, and estimated average concentration values for the various types of waste. These estimates use data through December 31, 1994 and give plutonium estimates as of January 1, 1995. The plutonium inventory estimate is 224 kgs for the DSTs and 854 kgs for the SSTs for a total inventory of 1078 kgs.

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**DOUBLE SHELL TANKS PLUTONIUM
INVENTORY ASSESSMENT**

Leslie A. Tusler

May 1995

Westinghouse Hanford Company
Richland, Washington

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EXECUTIVE SUMMARY

This report addresses concerns about the practice of continuing to transfer nuclear materials between double-shell tanks (DST) for which no credible nuclear material inventory exists (Gerton 1992). Between September 1992 and December 1994 transfers were authorized under the restrictions of the *Justification for Continued Operation (JCO) of Hanford High-Level Waste Tanks Resulting from the Criticality Unreviewed Safety Question (USQ)*, 492-CRITSAF, WHC-SD-WM-JCO-001. A restriction of the JCO included the baseline estimate of fissile material in the DSTs used to receive fissile material bearing waste from generators. Waste tank inventories for these receiver tanks, while under the restrictions of the JCO, were established by internal memo. This document formally establishes the baseline effort for all DSTs on a tank-by-tank basis.

A comprehensive review and analysis of DST characterization measurements, the DST plutonium inventory tracking system, and tank transfer historical data has provided improved estimates of the plutonium inventory in each DST. These estimates are presented in Table 31-1, along with estimated concentrations in the supernate, double-shell slurry (DSS), sludge, and saltcake components associated with these tanks. They will be used to update the plutonium inventory tracking system. This information has also been used to determine average concentration values, as presented in Table 31-2, for the various waste types and tank components (supernate, DSS, sludge, and saltcake). These average concentrations values were used to estimate the total plutonium inventory of the single-shell tanks (SST).

The inventory for each tank is intended to be a "best estimate" of the fissionable materials, with the appropriate amount of conservatism. In establishing the bounding estimates, the highest value of fissionable materials was not automatically selected. Some analytical data of specific tank constituents are not appropriate for inventory purposes, i.e., centrifuged solids. As a result, some professional judgement was used to discard or use analytical laboratory information in establishing tank inventories.

This work estimates the plutonium inventory in the DSTs and SSTs as 224 kg and 854 kg, respectively, for a total inventory of 1,078 kg. An alternative estimate of the total plutonium waste inventory was made using historical information on plutonium production, plutonium recovery, and recovery efficiencies of the Plutonium Uranium Extraction facility (PUREX), Reduction Oxidation facility (REDOX), T Plant and B Plant (Roetman et al. 1994). This alternative methodology yielded a plutonium waste estimate for the Hanford Site waste tanks of 981 kg. The close agreement of these two independent methodologies establishes the plutonium waste inventory at approximately 1,000 kg and confirms the overall accuracy of the work presented here.

The plutonium inventory data system has been approved to account for plutonium losses, as well as gains, by utilizing estimated supernate concentrations. Previously, losses of plutonium from transfers out of a given tank were ignored. This work indicates the need for additional tank characterization data. It also recommends that efforts be made to improve the reporting and assembly of tank characterization data to minimize errors. The

best way to accomplish this is through the careful selection of personnel qualified to interpret and analyze the data. As additional characterization data become available, improved inventory estimates will be made. The Plutonium Inventory Tracking system is the official inventory and will be updated as new information is received. This document will not be updated as additional characterization data are received.

The primary objective of the DST plutonium tracking spreadsheet is to establish and maintain a retrievable, auditable, credible, and conservative inventory for the waste tanks. The spreadsheet is the mechanism used to ensure compliance with the Criticality Prevention Specifications (CPS) and it has been updated to include the fissile material inventory for each DST.

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TERMS

AGING	aging waste
APDU	analytical process development unit
ASF	ammonia scrubber feed
CC	complexant concentrate
CP	concentrated phosphate waste
CPS	criticality prevention specification
DC	dilute complexed waste
DN	dilute noncomplexed waste
DSS	double-shell slurry
DSSF	double-shell slurry feed
DST	double-shell tank
JCO	justification for continued operation
NCRW	neutralized cladding removal waste
PCL	Process Chemistry Laboratory
PD	PUREX TRU solids
PNL	Pacific Northwest Laboratory
PT	PFP TRU solids
PUREX	Plutonium Uranium Extraction (Facility)
SST	single-shell tank
SWL	salt well liquor
TRAC	track radionuclide components
TRU	transuranic (waste)
USQ	unreviewed safety question
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION

This report provides an evaluation that establishes plutonium inventory estimates for all DSTs based on known tank history information, the DST plutonium inventory tracking system (Vail 1994a), tank characterization measurements, tank transfer records (Koreski 1994), and estimated average concentration values for the various types of waste. These estimates use data through December 31, 1994, and give plutonium estimates as of January 1, 1995. The plutonium inventory values for the DSTs are given in Section 31.

Average concentration values for the various waste types and tank components (supernate, sludge, DSS, and saltcake) are also given in Section 31. These values were obtained by averaging the best estimate of plutonium concentration values presented in Section 31 for various waste types and tank components. An estimate of the total plutonium inventory in the SSTs was made using these average concentration values.

The plutonium inventory estimate is 224 kg for the DSTs and 854 kg for the SSTs for a total of 1,078 kg. This value compares favorably with the total plutonium inventory value of 981 kg obtained from the total plutonium production minus plutonium recovery analysis estimates (Roetman et al. 1994).

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2.0 DESCRIPTION OF METHOD

A number of approaches can be taken in determining the waste tank plutonium inventories. These approaches include:

- The **Track Radionuclide Components (TRAC) Model**, which is a computer program that modeled waste streams from the processing plants into the individual tanks and then followed tank transfers through 1980. The results of the TRAC computer model were estimates of various chemical compounds and radioisotopes in each waste tank. The total estimated value of plutonium in the tanks, as reported by TRAC, is ≈ 385 kg. Some scientists and engineers think this estimate is too low. However, it is important to understand that, to comply with classification requirements in place at the time, TRAC used established plutonium values from old, unclassified records and old, special nuclear material accountability records, and was not intended to calculate accurate amounts of plutonium (Roetman et al. 1994).
- A **Plutonium Balance Model** that uses plutonium mass inputs, mass transfer, and a simple tank stratification model. Again, such a model would lack the records of important transfers and the knowledge needed to predict stratification of plutonium between the supernate, sludge, and saltcake fractions.
- A **Tank Characterization Data Model** that uses tank history, data from the DST plutonium tracking system, and tank characterization data. In the rare instances, where no reliable information is available from these sources, a concentration value is selected based on engineering judgement. The tank history is reviewed for events that would invalidate estimates based on tank characterization data. If such events are noted, such data are either not used or are used in a weighted fashion to account for the expected effects. After selecting the appropriate concentration values for the supernate, DSS, sludge, and saltcake, the tank inventory for each of these components is computed by multiplying the concentration value by the corresponding tank volume as reported in the December 1994 edition of *Waste Tank Summary Report* (Hanlon 1995).
- A **Tank Transfer Model** that uses available historical tank transfer records and assigns either measured or average concentration values to the input streams and the supernate output streams. Tank transfer history records are also reviewed as checks in making these assignments. In addition, this model may use one or more baseline assignments that are adjustments to the concentration to force agreement with the total tank inventory at the time of past tank characterization measurements. This model's main advantage is that it permits a current tank inventory estimate that considers transfers since the date of the last tank comprehensive inventory assessment, such as the one provided by this report.

Methods such as TRAC and the Plutonium Balance Model are not recommended because good transfer data and knowledge about the tank stratification

processes are lacking. The Tank Transfer Model has been incorporated into a recent revision of the Plutonium Inventory Tracking System spreadsheets in which all of the DSTs have been rebaselined using the plutonium inventory estimates provided in this report. This system will be valuable in maintaining current inventory estimates provided accurate records can be maintained of plutonium concentrations and solution volumes transferred into and out of the various tanks. Over time such records will provide insights and better understanding of the tank stratification processes that occur within the various tanks. Of the four methods listed, the **Tank Characterization Data Model**, is considered to be the method with real utility at this point in the history of the waste tanks. Accurate estimates of plutonium inventory cannot be made in the absence of good tank characterization data for all tank components (supernate, DSS, sludge, and saltcake). Accurate estimates also need supporting data, such as tank historical information and inventory estimates from the plutonium inventory tracking system. The predictions obtained using this method can be improved as better tank characterization data become available or as existing data are better used.

In this report, the **Tank Characterization Data Model** was used to estimate the current inventory for all the DSTs. The concentration values obtained for each tank component (supernate, DSS, sludge, and saltcake) have been tabulated and were used to compute average values. These average values were used to provide a rough estimate of the inventory in all the SSTs.

This report also presents an evaluation of the plutonium inventory and average concentrations of the supernate, sludge, DSS, and saltcake. The basis of this evaluation consists of examining the tank history, plutonium inventory tracking system, tank sample data useful for characterization of tank contents, average concentration values, other miscellaneous relevant data, and engineering judgement. The objective of this evaluation is to establish current plutonium inventory estimates for all the DSTs. Note that if a solids density is unknown, a density of 1,200 g/L is assumed based on the CPS (Vail 1994b). Also note that plutonium concentrations with less-than values were not used unless no other data were available.

3.0 TANK 241-AN-101 PLUTONIUM INVENTORY

3.1 Tank History

The fill history indicates more than 15 major transfers of waste into Tank 241-AN-101 (Tank AN-101). This tank has received waste from sources such as Plutonium Uranium Extraction (PUREX) miscellaneous waste, noncomplexed Salt Well Liquor (SWL), 300 and 400 Area, 100 N sulfate, and B Plant. A major transfer involving SWL, 100 N sulfate, and 300 and 400 Area waste types occurred in late 1987. The tank was sampled in July 1988. In early 1989 the tank was essentially drained. Since that time the tank has been refilled to the volume of 2.721×10^6 L (719 kgal) of supernatant liquid from SWL. The tank was sampled again in April 1993. Since then, the tank has been filled with SWL to a current volume of 3.251×10^6 L (859 kgal). The April 1993 sampling, along with the SWL transfer information, is considered representative of the current tank supernate concentration.

3.2 Plutonium Tracking System

This system has records for Tank AN-101 from May 1985 to October 1994. Other records may exist, but are probably in archive. The plutonium inventory was baselined on January 1, 1994 to 19.6 g (Miles 1994). It currently shows an inventory of 23 g.

3.3 April 1993 Bottle On String Samples

Currently Tank AN-101 contains 3.251×10^6 L (859 kgal) of supernate and no sludge, saltcake, or DSS. This tank was sampled in April 1993. The analytical results of the supernate are reported in Sutey (1993). This document reports the concentrations of three bottle-on-string samples. The plutonium concentration of the samples are 3.27×10^{-5} $\mu\text{Ci/mL}$, 3.62×10^{-5} $\mu\text{Ci/mL}$, and 1.56×10^{-5} $\mu\text{Ci/mL}$. At the time of this sampling the tank contained 2.419×10^6 L (639 kgal) of supernate. Using the highest of the three measured concentrations and converting it to g/L yields:

$$(3.62\text{E-}05 \mu\text{Ci/mL}) * (1,000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 5.84\text{E-}07 \text{ g/L}$$

Using the volume of waste in the tank at the time the sample was taken yields a plutonium inventory of:

$$(5.84\text{E-}07 \text{ g/L}) * (639,000 \text{ gal}) * (3.785 \text{ L/gal}) = 1.41 \text{ g}$$

3.4 Addition of Plutonium from Transfers

Since the April 1993 samples were taken, an additional 8.327×10^5 L (220 kgal) of SWL has been added to Tank AN-101. The first batch of transfers came from 241-BX-110 and 241-BX-111, which had a plutonium concentration of 2.51×10^{-5} $\mu\text{Ci/mL}$ (Sutey 1993). According to transfer records, approximately 6.510×10^5 L (172 kgal) were added to Tank AN-101. The second group of transfers came from 241-BY-102 and 241-BY-109. According to sampling

information, these tanks contained no plutonium (Dodd 1994c). Converting to g/L yields:

$$(2.51\text{E-}05 \text{ } \mu\text{Ci/mL}) * (1,000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 4.05\text{E-}07 \text{ g/L}$$

Using the volume of waste transferred from the BX tanks gives a plutonium amount transferred of:

$$(4.05\text{E-}07 \text{ g/L}) * (172,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.26 \text{ g}$$

3.5 Discussion

Because the tank contains no sludge or saltcake, the tank analysis of supernate sample and the transfer samples provide an excellent estimate of the tank's plutonium inventory. Adding plutonium value from the transfer to the sample value yields a total inventory of:

$$1.41 \text{ g} + 0.26 \text{ g} = 1.67 \text{ g Pu}$$

and yields a concentration of:

$$(1.67 \text{ g}) / ((859,000 \text{ gal}) * (3.785 \text{ L/gal})) = 5.14\text{E-}07 \text{ g/L}$$

3.6 Conclusions

The April 1993 bottle-on-string samples and SWL transfer samples are recommended as the basis for estimating the plutonium inventory for Tank AN-101. The recommended estimate of the current inventory is 1.67 g. The recommended supernate concentrations value is 5.14×10^{-7} g/L.

4.0 TANK 241-AN-102 PLUTONIUM INVENTORY

4.1 Tank History

The fill history indicates that four major transfers of waste into Tank 241-AN-102 (Tank AN-102) occurred. These include 1982 transfers from 241-SY-102 (Tank SY-102) and 241-AW-102 (Tank AW-102), a 1983 transfer from 241-AY-102 (Tank AY-102) and 241-AW-105 (Tank AW-105), and 1984 transfers from Tank AN-101 and 241-AW-101 (Tank AW-101). Before the 1984 transfer from Tank AW-101, the tank had a volume of only 1.514×10^5 L (40 kgal). Following this transfer its volume increased to over 4.164×10^6 L (1,100 kgal). Since 1984 the tank has experienced no significant activity. Therefore, the current tank inventory should be characteristic of the concentrated complexed waste transfer from Tank AW-101 in 1984. Currently this tank contains 3.789×10^6 L (993 kgal) of supernatant liquid and 3.369×10^5 L (89 kgal) of sludge.

4.2 Plutonium Tracking System

The plutonium tracking system is incomplete, showing only six transfer records. These were all recorded after the system was baselined on June 30, 1992, at 276.6 g (Vail 1992d). The plutonium inventory was rebaselined on January 1, 1994, to 2,210 g plutonium (Miles 1994).

4.3 February 1985 Supernatant and Bottom Samples

In February 1985 two complexant concentrate (CC) samples were taken from Tank AN-102 (Bratzel 1985a). A supernatant sample, Sample R-3639, was taken at 15 ft and a bottom sample, Sample R-3640, was taken at 0 ft. These samples were analyzed by the Analytical Laboratory and the Analytical Process Development Unit (APDU). Table 4-1 shows the results of the supernate sample analysis.

Table 4-1. Tank AN-102 Supernate Sampling Results.

Sample Number	Sample Type	Analytical Lab	APDU
R-3639	Supernatant	13.8 $\mu\text{Ci/L}$	4.25 $\mu\text{Ci/L}$
R-3640	Sludge (interstitial liquor)	24.6 $\mu\text{Ci/L}$	13.0 $\mu\text{Ci/L}$

Because the Analytical Laboratory procedure is suspected of being more susceptible to organic interferences than the APDU method, it is recommended that the APDU results be used for engineering evaluation. Converting the APDU value for the supernatant to g/L gives plutonium concentrations of:

$$(4.25 \mu\text{Ci/L}) * (1.0\text{E}-06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 6.85\text{E}-05 \text{ g/L}$$

A total solids concentration of 0.06 $\mu\text{Ci/g}$ and an acid soluble fraction of 0.026 $\mu\text{Ci/g}$ for Sample R-3640 are reported in Bratzel (1985b). Table 1 of

this reference indicates that 82 percent of this sample is centrifuged solids. If it is assumed that this 82 percent represents the solids and the other 18 percent represents the acid soluble fraction, the concentration of this bottom sample or sludge is given by:

$$(0.82)*(0.06 \mu\text{Ci/g})+(0.18)*(0.026 \mu\text{Ci/g}) = 0.054 \mu\text{Ci/g}$$

Assuming a density of 1,200 g/L¹ for this sludge and converting to g/L, we obtain:

$$(0.054 \mu\text{Ci/g})*(1,200 \text{ g/L})*(1\text{E-}06 \text{ Ci}/\mu\text{Ci})/(0.062 \text{ Ci/g}) = 1.05\text{E-}03 \text{ g/L}$$

The volume of supernate and sludge in Tank AN-102 at the time these samples were taken was 3.940×10^6 L (1,041 kgal) and 3.369×10^5 L (89 kgal), respectively. Using these volumes with the plutonium concentrations will give the total plutonium inventory in Tank AN-102.

$$(6.85\text{E-}05 \text{ g/L})*(1,041,000 \text{ gal})*(3.785 \text{ L/gal}) = 270 \text{ g Pu in supernate}$$

$$(1.05\text{E-}03 \text{ g/L})*(89,000 \text{ gal})*(3.785 \text{ L/gal}) = 354 \text{ g Pu in sludge}$$

4.4 May 1989 Supernate Sample

In May 1989 a supernate sample was taken from Tank AN-102 (Herting 1994b). The reported plutonium concentration in this sample is 8.52 $\mu\text{Ci/L}$. Converting this value to g/L gives a plutonium concentration of:

$$(8.52 \mu\text{Ci/L})*(1.0\text{E-}06 \text{ Ci}/\mu\text{Ci})/(0.062 \text{ Ci/g}) = 1.374\text{E-}04 \text{ g/L}$$

When this sample was taken, Tank AN-102 contained 3.880×10^6 L (1,025 kgal). Using this supernate volume, the plutonium inventory in the supernate can be calculated.

$$(1.374\text{E-}04 \text{ g/L})*(1,025,000 \text{ gal})*(3.785 \text{ L/gal}) = 533 \text{ g Pu}$$

4.5 July 1990 Core Sample

In July 1990 a three-segment core sample was taken from Tank AN-102 (Tingey 1991). A composite core material was made from the three segments extruded. The samples analyzed were 102AN-SOL (centrifuged solids from the composite slurry material prepared from core Segments 1, 2, and 3) and 102AN-SUP (supernate decanted from the centrifuged core composite material). The reported plutonium concentrations for the supernate and solids samples are 7.03×10^1 nCi/mL and 8.55×10^1 nCi/g, respectively. The reported density of the solids is 1.74 g/mL. Converting these values to g/L gives plutonium concentrations of:

¹If a measured solids density is not available, a density of 1,200 g/L is assumed (Vail 1994b).

$$\begin{aligned}
 (7.03\text{E}+01 \text{ nCi/mL}) * (1000 \text{ mL/L}) * (1\text{E}-09 \text{ Ci/nCi}) / (0.062 \text{ Ci/g}) &= \\
 &1.13\text{E}-03 \text{ g/L in supernate} \\
 (8.55\text{E}+01 \text{ nCi/g}) * (1.74 \text{ g/mL}) * (1000 \text{ mL/L}) * (1\text{E}-09 \text{ Ci/nCi}) / (0.062 \text{ Ci/g}) &= \\
 &2.40\text{E}-03 \text{ g/L in solids}
 \end{aligned}$$

When this sample was taken, Tank AN-102 contained $3.857 \times 10^6 \text{ L}$ (1,019 kgal) of supernate and $3.369 \times 10^5 \text{ L}$ (89 kgal) of sludge. Using these volumes, the plutonium inventory when the sample was taken can be calculated.

$$(1.13\text{E}-03 \text{ g/L}) * (1,019,000 \text{ gal}) * (3.785 \text{ L/gal}) = 4,374 \text{ g Pu in supernate}$$

$$(2.40\text{E}-03 \text{ g/L}) * (89,000 \text{ gal}) * (3.785 \text{ L/gal}) = 808 \text{ g Pu in solids}$$

4.6 October 1994 Samples

On October 21, 1994, three supernate and one sludge sample were taken from Tank AN-102 (Herting 1994b). Table 4-2 lists the samples and their depths in the tank.

Table 4-2. Sample Results from Tank AN-102.

<u>Sample</u>	<u>Depth</u>	<u>Sample Type</u>
102-AN-1	324 in.	supernate
102-AN-2	459 in.	supernate
102-AN-3	667 in.	sludge
102-AN-4	662 in.	supernate

The sludge sample was archived for possible future characterization. The supernate samples have not been analyzed for plutonium.

4.7 Discussion

Tank AN-102 has experienced very little activity since being sampled in February 1985. Therefore, there is little reason to believe the concentration of either the supernate or the sludge has changed significantly. However, plutonium concentrations measured in 1985 and 1990 differ considerably. Because the sample taken in 1990 is a core sample and was taken most recently, it is recommended that it be used as the basis for the plutonium inventory for Tank AN-102. Using the total plutonium inventories calculated for the supernate and sludge with the current volumes will give the estimated plutonium concentrations in the tank.

$$(4,374 \text{ g}) / ((993,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.16\text{E}-03 \text{ g/L in supernate}$$

$$(808 \text{ g}) / ((89,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.40\text{E}-03 \text{ g/L in sludge}$$

$$\text{Total plutonium} = 4,374 \text{ g} + 808 \text{ g} = 5,182 \text{ g Pu}$$

4.8 Conclusions

The recommended estimate of the plutonium inventory in Tank AN-102 is 5,182 g. The recommended supernate and sludge concentration values are 1.16×10^{-3} g/L and 2.40×10^{-3} g/L, respectively.

5.0 TANK 241-AN-103 PLUTONIUM INVENTORY

5.1 Tank History

The fill history indicates six major transfers of waste into Tank 241-AN-103 (Tank AN-103). These include a 1982 transfer from Tank SY-102, a 1983 transfer of noncomplexed salt well liquor from the 300/400 Area and B Plant, a 1984 transfer from Tank AW-102, transfers from 241 AN-104 (Tank AN 104) and Tank AW-102 in 1985, and a final DSS transfer from Tank AW-102 in 1986. Currently the tank contains 5.678×10^4 L (15 kgal) of supernatant liquid and 3.547×10^6 L (937 kgal) of DSS. Essentially all of the current tank contents should be viewed as consisting of DSS transferred to this tank since 1984. The latest sample was a core sample taken in December 1986. It should be representative of the plutonium inventory currently in the tank.

5.2 Plutonium Tracking System

This system shows a December 1983 entry in which 52 g of plutonium were transferred into Tank AN-103. No other transfers are shown. The inventory was baselined to 112 g on January 1, 1994 (Miles 1994).

5.3 December 1986 Core Sample

Tank AN-103 was core sampled in December 1986. The tank contained an estimated 8.48 m (334 in.) of DSS (Mudge 1987). Eighteen segments were recovered. A composite of the core sample was analyzed by Pacific Northwest Laboratory (PNL). The reported plutonium concentration in the DSS sample was 1.24×10^{-6} Ci/L (Toste 1987). Converting this value to g/L gives a plutonium concentration of:

$$(1.24\text{E-}06 \text{ Ci/L}) / (0.062 \text{ Ci/g}) = 2.0\text{E-}05 \text{ g/L}$$

The volume of the tank when this sample was taken was 3.477×10^6 L (919 kgal). Using this value, the plutonium inventory can be calculated:

$$(2.0\text{E-}05 \text{ g/L}) * (919,000 \text{ gal}) * (3.785 \text{ L/gal}) = 70 \text{ g Pu}$$

5.4 Discussion

Evidently very little plutonium has been transferred into this tank. The plutonium tracking system yields an inventory of 52 g and the most recent 1986 core sample predicts an inventory of 70 g. It is recommended that the higher value of 70 g be used as the current plutonium inventory estimate for Tank AN-103. Using this value with the current volume yields a plutonium concentration of:

$$(70 \text{ g}) / ((952,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.94\text{E-}05 \text{ g/L}$$

5.5 Conclusions

The recommended current inventory estimate for Tank AN-103 is 70 g of plutonium. The recommended plutonium concentration is 1.94×10^{-5} g/L.

6.0 TANK 241-AN-104 PLUTONIUM INVENTORY

6.1 Tank History

Three major transfers have occurred to this tank: 1982 transfer from Tank AW-102, 1984 transfer of double-shell slurry feed (DSSF) from Tank AW-102, and 1985 transfer of DSSF from Tank AW-102. No major transfers have occurred since 1985. Therefore any samples analyzed after July of 1985 should be characteristic of the current concentration. Currently the tank contains 3.017×10^6 L (797 kgal) of supernatant liquid and 9.992×10^5 L (264 kgal) of sludge.

6.2 Plutonium Tracking System

This system shows a December 1983 entry in which 183 g of plutonium were transferred into Tank AN-104. The plutonium inventory was baselined on January 1, 1994, to 112 g (Miles 1994).

6.3 April 1984 Supernatant Sample

A sample was taken from Tank AN-104 in April 1984. The results of this sample are reported as 1.68×10^{-4} g/L (Jansky 1984). When this sample was taken, the tank contained 1.310×10^6 L (346 kgal) of supernate. Using this volumes and the plutonium concentration, the plutonium inventory can be calculated:

$$(1.68\text{E-}04 \text{ g/L}) * (346,000 \text{ gal}) * (3.785 \text{ L/gal}) = 215 \text{ g Pu in supernate}$$

6.4 Discussion

The plutonium inventory estimate for this tank is questionable because it is based on a supernate sample taken before major transfers took place in October of 1984 and July of 1985. In addition, no sludge sample results are available. In the absence of this information, the average DSSF sludge plutonium concentration found in Section 31 will be assumed for the sludge. This yields an estimated concentration of 5.07×10^{-3} g/L. Using the plutonium concentration from the April 1984 supernate sample and the assumed plutonium concentration in the sludge along with the current volumes in Tank AN-104, a plutonium inventory can be estimated:

$$(1.68\text{E-}04 \text{ g/L}) * (797,000 \text{ gal}) * (3.785 \text{ L/gal}) = 507 \text{ g Pu in supernate}$$

$$(5.07\text{E-}03 \text{ g/L}) * (264,000 \text{ gal}) * (3.785 \text{ L/gal}) = 5,066 \text{ g Pu in sludge}$$

$$\text{Total plutonium} = 507 \text{ g} + 5,066 \text{ g} = 5,573 \text{ g Pu}$$

6.5 Conclusions

The recommended current inventory estimate for Tank AN-104 is 5,573 g of plutonium. The recommended current supernate and sludge concentration estimates are 1.68×10^{-4} g/L and 5.07×10^{-3} g/L, respectively.

7.0 TANK 241-AN-105 PLUTONIUM INVENTORY

7.1 Tank History

Three major transfers to this tank have occurred: (1) 1982 transfer from Tank AW-102, (2) 1984 transfer from Tank AN-104, and (3) 1985 transfer of DSSF from Tank AW-102, which increased the tank volume from 5.678×10^5 L (150 kgal) to over 4.164×10^6 L (1,100 kgal). No major transfers have occurred since 1985. Therefore any samples analyzed after July of 1985 should be characteristic of the current concentration. Currently the tank contains 4.269×10^6 L (1,128 kgal) of supernatant liquid and no sludge, saltcake, or DSS.

7.2 Plutonium Tracking System

The plutonium inventory database was baselined to 112 g on January 1, 1994 (Miles 1994).

7.3 Average Supernatant Concentration Values

Apparently no sample data are available for this tank. In estimating the plutonium concentration of the major transfers into and out of Tank 241-AN-105 (Tank AN-105), it is assumed that the average concentration of dilute noncomplex waste is 3.0×10^{-6} g/L. In Table 7-1 the concentrations and volumes of the major input and output streams are estimated based on this concentration.

Table 7-1. Plutonium Concentration Estimates of Major Transfers into and out of Tank AN-105.

Date	Transfer	Initial Conc. (g/L)	Evap. Conc. Factor	Transfer Conc. (g/L)	Transfer Vol (kgal)	Tank Conc. (g/L)
12/24/82	AW-102 to AN-105	3.0E-06	0.693	4.3E-06	259	4.15E-06
01/25/83	AW-102 to AN-105	3.0E-06	0.420	7.1E-06	369	5.85E-06
03/04/84	AN-104 to AN-105	1.68E-04	1.0	1.68E-04	499	7.91E-05
02/05/85	AN-105 to AW-102	7.91E-05	1.0	7.9E-05	-954	7.91E-05
03/01/85	AW-102 to AN-105	7.91E-05	0.912	8.7E-05	239	8.39E-05
04/02/85	AW-102 to AN-105	3.0E-06	0.586	5.1E-06	732	3.27E-05

This table predicts a final March 1985 concentration of 3.27×10^{-5} g/L. Because only minor transfers into and out of Tank AN-105 have occurred since this date, the current concentration should also be 3.27×10^{-5} g/L. Therefore the current plutonium inventory is estimated to be:

$$(3.27\text{E-}05 \text{ g/L}) \times (1,128,000 \text{ gals}) \times (3.785 \text{ L/gal}) = 140 \text{ g.}$$

7.4 Discussion

The plutonium inventory estimate for this tank is questionable because it is based on a supernate average concentration value. Nevertheless, the recommended estimate of 140 g appears to be reasonable in light of the contents and past history of this tank.

7.5 Conclusions

The recommended current inventory estimate for Tank AN-105 is 140 g of plutonium. The recommended current supernate concentration estimate is 3.27×10^{-5} g/L.

8.0 TANK 241-AN-106 PLUTONIUM INVENTORY

8.1 Tank History

The fill history for Tank 241-AN-106 (Tank AN-106) indicates three major transfers have occurred to this tank: a 1983 transfer from Tank AW-102, a 1984 transfer from the same tank, and a 1994 transfer from Tank 241-AW-106 (Tank AW-106). The tank was essentially emptied in 1993. Therefore, Tank AN-106 should be characteristic of Tank AW-106. Currently the tank contains 1.525×10^6 L (403 kgal) of supernatant liquid and 6.435×10^4 L (17 kgal) of sludge.

8.2 Plutonium Tracking System

The plutonium inventory in Tank AN-106 was baselined on January 1, 1994 to 29 g (Miles 1994).

8.3 February 1990 Supernate Samples

Supernate samples were taken in Tank AN-106 in February 1990 (Welsh 1991). A plutonium concentration of $0.0378 \mu\text{Ci/L}$ is reported. Converting to g/L gives a plutonium concentration of:

$$(0.0378 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 6.10\text{E-}07 \text{ g/L}$$

Tank AN-106 contained 3.82×10^6 L (1,010 kgal) of supernate when the samples were taken. The total plutonium inventory in the supernate was:

$$(6.10\text{E-}07 \text{ g/L}) * (1,010,000 \text{ gal}) * (3.785 \text{ L/gal}) = 2.3 \text{ g Pu}$$

8.4 1994 Transfer From Tank AW-106

In September 1994 approximately 1.51×10^6 L (400 kgal) of slurry were transferred from Tank AW-106 into Tank AN-106. The reported plutonium concentration in Tank AW-106 was $<6.52 \times 10^{-4} \mu\text{Ci/mL}$ (Dodd 1994a). The value of $6.52 \times 10^{-4} \mu\text{Ci/mL}$ will be used to calculate the plutonium that was added to Tank AN-106.

$$(6.52\text{E-}01 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.05\text{E-}05 \text{ g/L}$$

$$(1.05\text{E-}05 \text{ g/L}) * (400,000 \text{ gal}) * (3.785 \text{ L/gal}) = 15.9 \text{ g Pu}$$

8.5 Discussion

No characterization data are available for the sludge. The average plutonium concentration for the DSSF found in Section 31 will be used for the plutonium concentration in the sludge. The concentration is $5.07\text{E-}03 \text{ g/L}$.

Using the current sludge volume of 6.435×10^4 L (17 kgal) gives a plutonium inventory in the sludge of:

$$(5.07\text{E-}03 \text{ g/L}) * ((17,000 \text{ gal}) * (3.785 \text{ L/gal})) = 326 \text{ g Pu in sludge}$$

The plutonium inventory is based on the estimated plutonium in the sludge and the plutonium transferred from Tank AW-106. Using the current supernate tank volume of 1.525×10^6 L (403 kgal), the estimated plutonium concentration in the supernate is:

$$(18 \text{ g}) / (403,000 \text{ gal}) / (3.785 \text{ L/gal}) = 1.18\text{E-}05 \text{ g/L for supernate}$$

The total calculated plutonium inventory for Tank AN-106 is 344 g.

8.6 Conclusions

The recommended current inventory estimate for Tank AN-106 is 344 g of plutonium. The recommended current concentrations for the supernate and sludge are 1.18×10^{-5} g/L and 5.07×10^{-3} g/L, respectively.

9.0 TANK 241-AN-107 PLUTONIUM INVENTORY

9.1 Tank History

Two major transfers have occurred to this tank: a 1982 transfer from Tank AN-102 and a 1984 transfer from Tank 241-AZ-102 (Tank AZ-102). No major transfers have occurred since early in 1984. Any samples taken since then should provide good characterization information on the current inventory. Currently the tank contains 3.505×10^6 L (926 kgal) of supernatant liquid and 5.072×10^5 L (134 kgal) of sludge.

9.2 Plutonium Tracking System

This system is incomplete, showing very few transfers. The plutonium inventory was baselined on March 10, 1985, to 8,270 g (Bratzel 1985a). It was rebaselined on January 1, 1994, to 7,220 g plutonium (Miles 1994).

9.3 February 1993 Supernate Samples

Five bottle-on-a-string samples were taken from Tank 241-AN-107 (Tank AN-107) on February 7, 1993 (Herting 1993). Three samples were taken from the supernate and two were taken from the sludge. The two sludge samples were not analyzed because the bottles contained too few solids to qualify the samples as representative of the sludge layer. Table 9-1 shows the supernate sample results.

Table 9-1. Tank AN-107 Sample Results.

<u>Sample</u>	<u>Pu Concentration</u>
R-2686	0.035 $\mu\text{Ci/mL}$
R-3154	0.033 $\mu\text{Ci/mL}$
R-3155	0.034 $\mu\text{Ci/mL}$

The highest concentration reported will be used for further analysis. Converting this value to g/L gives a plutonium concentration of:

$$(0.035 \mu\text{Ci/mL}) \cdot (1.0\text{E}-06 \text{ Ci}/\mu\text{Ci}) \cdot (1000 \text{ mL/L}) / (0.062 \text{ Ci/g}) = 5.65\text{E}-04 \text{ g/L}$$

When this sample was taken, Tank AN-107 contained 3.54×10^6 L (934 kgal) of supernate. Using this value and the plutonium concentration in the supernate, the total plutonium inventory in the supernate can be calculated:

$$(5.65\text{E}-04 \text{ g/L}) \cdot (934,000 \text{ gal}) \cdot (3.785 \text{ L/gal}) = 1,997 \text{ g Pu in supernate}$$

9.4 March 1994 Sludge Samples

Three sludge samples were taken from Tank AN-107 on May 13, 1994 (Herting 1994a). Two of the samples were analyzed to determine the composition of the bulk sludge and of the solid phase in the sludge. Plutonium concentrations of 0.08 $\mu\text{Ci/g}$ and 0.09 $\mu\text{Ci/g}$ were reported. A sludge density of 1.47 g/mL also was reported. The higher plutonium concentration will be used for further calculations. Using the sludge density, the plutonium concentration is converted to g/L.

$$(0.09 \mu\text{Ci/g}) * (1470 \text{ g/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.13\text{E-}03 \text{ g/L}$$

When this sample was taken, Tank AN-107 had a sludge volume of 5.07×10^5 L (134 kgal). Using this value with the plutonium concentration the plutonium inventory in the sludge can be calculated:

$$(2.13\text{E-}03 \text{ g/L}) * (134,000 \text{ gal}) * (3.785 \text{ L/gal}) = 1,080 \text{ g Pu in sludge}$$

9.5 Discussion

No major transfers have occurred in Tank AN-107 since the supernate and sludge samples were taken. Therefore, these plutonium inventories should be good estimates of what is currently in Tank AN-107. Using the total plutonium inventory calculated to be in the supernate and sludge, along with the current volumes of the supernate and sludge, the plutonium concentrations can be calculated:

$$(1,997 \text{ g Pu}) / ((926,000 \text{ gal}) * (3.785 \text{ L/gal})) = 5.70\text{E-}04 \text{ g/L in supernate}$$

$$(1,080 \text{ g Pu}) / ((134,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.13\text{E-}03 \text{ g/L in sludge}$$

The total plutonium inventory in the tank is:

$$1,997 \text{ g} + 1,080 \text{ g} = 3,077 \text{ g Pu}$$

9.6 Conclusions

Based on the 1993 supernate samples and the 1994 sludge samples, the current recommended inventory for Tank AN-107 is 3,077 g, with 1,997 g in the supernatant liquid and 1,080 g in the sludge. Estimated supernate and sludge plutonium concentrations are 5.70×10^{-4} g/L and 2.13×10^{-3} g/L, respectively.

10.0 TANK 241-AP-101 PLUTONIUM INVENTORY

10.1 Tank History

The fill history indicates three major transfers into Tank 241-AP-101 (Tank AP-101): a 1988 transfer of dilute noncomplexed waste from PUREX Ammonia Scrubber Feed (ASF), a 1989 transfer from PUREX ASF and Tank 241-AP-103 (Tank AP-103), and a 1994 transfer from Tank 241-AP-108 (Tank AP-108). Three major transfers out also have occurred. These were a December 1988 transfer to Tanks AW-102 and AP-103, an August 1994 transfer to Tank AW-102, and an October transfer to Tank AW-102. Characterization data from before July 1986 is not considered valuable in estimating the current tank inventory. Currently the tank contains 5.64×10^5 L (149 kgal) of supernatant liquid.

10.2 Plutonium Tracking System

The plutonium inventory tracking system shows no transfer data before October 1994 for Tank AP-101. The inventory of no fissile material in the tank was established on March 4, 1992 (Vail 1992b). The plutonium inventory was baselined on January 1, 1994 to 24 g (Miles 1994).

10.3 July 1993 Supernatant Samples

Tank AP-101 was first sampled on July 20, 1993. Six samples were taken from three vertical risers in the tank (De Lorenzo 1994a). The reported average plutonium concentration is $<0.213 \mu\text{Ci/L}$. A plutonium concentration of $0.213 \mu\text{Ci/L}$ will be used in the following calculations. Converting the reported plutonium concentration to g/L yields:

$$(0.213 \mu\text{Ci/L}) \cdot (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 3.44\text{E-}06 \text{ g/L}$$

When this sample was taken, Tank AP-101 contained 4.02×10^6 L (1,061 kgal) of supernatant. Using this value, the total plutonium inventory can be calculated:

$$(3.44\text{E-}06 \text{ g/L}) \cdot (1,061,000 \text{ gal}) \cdot (3.785 \text{ L/gal}) = 13.8 \text{ g Pu}$$

10.4 August 1994 Transfer from AP-101 to AW-102

In August 1994, 2.82×10^6 L (744 kgal) of supernate were transferred from Tank AP-101 to Tank AW-102. Using the plutonium concentration from the July 1993 sample, the total plutonium transferred to Tank AW-102 can be calculated:

$$(3.44\text{E-}06 \text{ g/L}) \cdot (744,000 \text{ gal}) \cdot (3.785 \text{ L/gal}) = 9.7 \text{ g Pu}$$

The total plutonium left in Tank AP-101 is:

$$13.8 \text{ g} - 9.7 \text{ g} = 4.1 \text{ g Pu}$$

10.5 October 1984 Transfer of Tank AP-108 to Tank AP-101

In October 1994 1.07×10^6 L (284 kgal) of supernate were transferred from Tank AP-108 to Tank AP-101 (Koreski 1994). A sample taken from Tank AP-108 in March 1994 had a plutonium concentration of $<5.10 \times 10^{-4}$ $\mu\text{Ci/mL}$ (Miller 1994a). A plutonium concentration of 5.10×10^{-4} $\mu\text{Ci/mL}$ will be used in further calculations. Converting this value to g/L yields:

$$(5.01\text{E-}04 \mu\text{Ci/mL}) * (1000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 8.23\text{E-}06 \text{ g/L}$$

Using the transfer volume, the total plutonium inventory transferred is:

$$(8.23\text{E-}06 \text{ g/L}) * (284,000 \text{ gal}) * (3.785 \text{ L/gal}) = 8.8 \text{ g Pu}$$

This leaves a total plutonium inventory in Tank AP-101 of:

$$4.1 \text{ g} + 8.8 \text{ g} = 12.9 \text{ g Pu}$$

The volume in Tank AP-101 after this transfer was 2.27×10^6 L (600 kgal). Using this volume and the total plutonium, the plutonium concentration can be calculated:

$$(12.9 \text{ g Pu}) / ((600,000 \text{ gal}) * (3.785 \text{ L/gal})) = 5.68\text{E-}06 \text{ g/L}$$

10.6 October 1994 Transfer from AP-101 to AW-102

In October 1994, 1.71×10^6 L (451 kgal) of supernate were transferred from Tank AP-101 to Tank AW-102. Using the plutonium concentration in Tank AP-102 calculated after the transfer from Tank AP-108, the plutonium inventory is calculated:

$$(5.68\text{E-}06 \text{ g/L}) * (451,000 \text{ gal}) * (3.785 \text{ L/gal}) = 9.7 \text{ g Pu}$$

The total amount of plutonium in Tank AP-101 is:

$$12.9 \text{ g} - 9.7 \text{ g} = 3.2 \text{ g Pu}$$

10.7 Discussion

Tank AP-101 currently contains 5.64×10^5 L (149 kgal) of supernate. Using this value with the total amount of plutonium calculated after the 1994 transfers yields a plutonium concentration of:

$$(3.2 \text{ g Pu}) / ((149,000 \text{ gal}) * (3.785 \text{ L/gal})) = 5.67\text{E-}06 \text{ g/L}$$

10.8 Conclusions

The recommended current inventory estimate for Tank AP-101 is 3.2 g of plutonium. The recommended current concentration for the supernate is 5.67×10^{-6} g/L.

11.0 TANK 241-AP-102 PLUTONIUM INVENTORY

11.1 Tank History

The fill history indicates three major transfers into Tank 241-AP-102 (Tank AP-102). Two of these involved dilute noncomplexed waste; the last addition in November 1992 involved concentrated phosphate waste from Tank AN-106. The two noncomplexed waste transfers were water in 1987 and from Tank 241-AP-104 (Tank AP-104) in 1988. Three major losses (transfers out) have occurred: a transfer to Tank AW-102 in 1988, a loss to Grout in 1988, and another loss to Grout in 1989. The plutonium inventory of this tank is likely to be dominated by the last major addition, the concentrated phosphate waste transferred in December 1992. Therefore, characterization data gathered before 1993 is not considered valuable in estimating the current tank inventory. Currently the tank contains 4.17×10^6 L (1,101 kgal) of supernatant liquid.

11.2 Plutonium Tracking System

The plutonium inventory tracking system contains no information about transfers of Tank AP-102 waste. On March 4, 1992, it was determined that no fissile material was in Tank AP-102 (Vail 1992b). The plutonium inventory was baselined on January 1, 1994 to 13 g (Miles 1994).

11.3 April 1993 Samples

Eighteen bottle-on-a-string samples were taken from Tank AP-102 April 28 through 30, 1994. To ensure sampling homogeneity, the tank was mixed for 53 days before sampling occurred (De Lorenzo 1994b). The plutonium concentration from the composite sample was reported as $<0.0748 \mu\text{Ci/L}$. A concentration of $0.0748 \mu\text{Ci/L}$ will be used in further calculations. Converting the concentration to g/L yields:

$$(0.0748 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.21\text{E-}06 \text{ g/L}$$

Using the tank volume when the samples were taken yields a total plutonium inventory of:

$$(1.21\text{E-}06 \text{ g/L}) * (1,108,000 \text{ gal}) * (3.785 \text{ L/gal}) = 5.1 \text{ g Pu}$$

11.4 Discussion

Because no major transfers have occurred since December 1992, the data from the April 1993 sample should give a good estimate of the current plutonium inventory in Tank AP-102. Tank AP-102 currently contains 4.17×10^6 L (1,101 kgal) of supernatant. Using this volume and the plutonium inventory from the April 1993 samples gives a plutonium concentration of:

$$(5.1 \text{ g Pu}) / ((1,101,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.22\text{E-}06 \text{ g/L}$$

11.5 Conclusions

The current recommended plutonium concentration for Tank AP-102 is 1.22×10^{-6} g/L. The estimated plutonium inventory is 5.1 g.

12.0 TANK 241-AP-103 PLUTONIUM INVENTORY

12.1 Tank History

The fill history indicates four major transfers of dilute noncomplexed waste into Tank 241-AP-103 (Tank AP-103). These transfers include: PUREX ASF in 1988, a transfer from Tank AP-101 in 1988, a transfer from Tank 241-AY-102 (Tank AY-102) in 1990, and a transfer from Tank AY-102 in 1991. Two major transfers out have occurred. One was in 1988 when the tank was essentially emptied by a transfer to Tank AW-102. The other was in 1994 when the tank was again emptied to Tank AW-102. Characterization data from before 1990 is not considered valuable in estimating the current tank inventory. Currently the tank contains 1.02×10^5 L (27 kgal) of supernatant liquid.

12.2 Plutonium Tracking System

This system shows no transfers. It was determined that no fissile material existed in Tank AP-103 on March 4, 1992 (Vail 1992b). The plutonium inventory was baselined on January 1, 1994 to 21 g (Miles 1994).

12.3 1991 Bottle-On-A-String Samples

Bottle-on-a-string samples were taken from Tank AP-103 in September, October, and November 1991 (De Lorenzo 1994c). The reported plutonium concentration is $<6.97 \times 10^{-5}$ $\mu\text{Ci/L}$. Subsequent calculations will use 6.97×10^{-5} $\mu\text{Ci/L}$ as the plutonium concentration. Converting the plutonium concentration to g/L yields:

$$(6.97\text{E-}03 \mu\text{Ci/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.12\text{E-}07 \text{ g/L}$$

When these samples were taken, Tank AP-103 contained 4.30×10^6 L (1,136 kgal) of supernate. Using this value with the plutonium concentrations yields a plutonium inventory of:

$$(1.12\text{E-}07 \text{ g/L}) * (1,136,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.5 \text{ g Pu}$$

12.4 May 1994 Transfer from Tank AP-103 to Tank AW-102

In May 1994, 4.17×10^6 L (1,102 kgal) of supernate were transferred from Tank AP-103 to Tank AW-102. The total plutonium transferred from Tank AP-103 is:

$$(1.12\text{E-}07 \text{ g/L}) * (1,102,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.47 \text{ g Pu}$$

The plutonium remaining in Tank AP-103 is:

$$0.5 \text{ g} - 0.47 \text{ g} = 0.03 \text{ g Pu}$$

12.5 Discussion

Using the current tank volume of 1.02×10^5 L (27 kgal) and the plutonium inventory calculated after the 1994 transfer yields a plutonium concentration of:

$$(0.03 \text{ g Pu}) / ((27,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.94\text{E-}07 \text{ g/L}$$

12.6 Conclusions

The recommended plutonium inventory for Tank AP-103, based on the most recent sample and the May 1994 transfer, is 0.03 g. The suggested plutonium concentration is 2.94×10^{-7} g/L.

13.0 TANK 241-AP-104 PLUTONIUM INVENTORY

13.1 Tank History

The fill history indicates only one major transfer into Tank 241-AP-104 (Tank AP-104) of dilute noncomplexed waste from 100 N (sulfate and phosphate). This transfer occurred in 1987. Only one major transfer out has occurred. This was a transfer to Tank AP-102 in April 1988, when the tank was essentially emptied. Characterization data gathered before the first major transfer, May 1987, is not considered valuable in estimating the current tank inventory. The tank currently contains 6.81×10^4 L (18 kgal) of supernatant liquid.

13.2 Plutonium Tracking System

The plutonium tracking system contains no information about transfers involving Tank AP-104. On March 4, 1992 it was determined that no fissile material was in Tank AP-104 (Vail 1992b). The plutonium inventory was baselined on January 1, 1994, to <0.1 g (Miles 1994).

13.3 March 1988 Supernate Samples

Supernate samples were taken from Tank AP-104 in March 1988 (Winters 1988). Samples were analyzed by Westinghouse Hanford Company (WHC) and PNL laboratories. Plutonium supernate sample concentrations were reported as 9.41×10^{-4} $\mu\text{Ci/L}$ from WHC and 1.54×10^{-3} $\mu\text{Ci/L}$ from PNL. Converting these concentrations to g/L yields:

$$\text{WHC: } (1.54\text{E-}03 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.48\text{E-}08 \text{ g/L}$$

$$\text{PNL: } (9.41\text{E-}04 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.52\text{E-}08 \text{ g/L}$$

When this sample was taken, Tank AP-104 contained 4.06×10^6 L (1,073 kgal) of supernate. Using the higher of the two plutonium concentration values with this volume yields a plutonium inventory of:

$$(2.48\text{E-}08 \text{ g/L}) * (1,073,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.1 \text{ g Pu}$$

13.4 April 1988 Transfer from Tank AP-104 to Tank AP-102

In April 1988, 3.98×10^6 L (1,051 kgal) of supernate were transferred from Tank AP-104 to Tank AP-102. The amount of plutonium transferred from Tank AP-104 is:

$$(2.48\text{E-}08 \text{ g/L}) * (1,051,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.099 \text{ g Pu}$$

The plutonium inventory in Tank AP-104 is:

$$0.1 \text{ g} - 0.099 \text{ g} = 0.001 \text{ g Pu}$$

13.5 Discussion

Using the current volume of Tank AP-104 with the inventory calculated after the April 1988 transfer yields a plutonium concentration of:

$$(0.001 \text{ g Pu}) / ((18,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.47\text{E-}08 \text{ g/L}$$

These data should be characteristic of the sulfate and phosphate waste transferred in 1987 from 100 N Area. Therefore, they can be used to estimate the plutonium inventory of this tank.

13.6 Conclusions

The plutonium supernate concentration for this tank was estimated as 1.47×10^{-8} g/L and yielded a plutonium inventory estimate of 0.001 g.

14.0 TANK 241-AP-105 PLUTONIUM INVENTORY

14.1 Tank History

The fill history indicates three major transfers into Tank 241-AP-105 (Tank AP-105). The first two, in 1988 and 1989, involved dilute noncomplexed waste consisting of DSSF from Tank AW-102 and the last, in July 1989, involved DSSF from Tank 241-AP-106 (Tank AP-106). One major transfer out occurred in July 1988 to Tank AW-102 when the tank was emptied. Characterization data gathered before this transfer or before about October 1988 are not considered to be of value in estimating the current tank inventory. Currently the tank contains 3.10×10^6 L (819 kgal) of supernatant liquid.

14.2 Plutonium Inventory Tracking System

The plutonium inventory tracking system contains no transfer information about Tank AP-105. It was determined on March 4, 1992, that no plutonium was in Tank AP-105 (Vail 1992b). The plutonium inventory was baselined on January 1, 1994, to 35 g (Miles 1994).

14.3 March 1993 Samples

Tank AP-105 was sampled March 1993 using the bottle-on-a-string method. According to the sampling plan, the waste was assumed to consist of two distinct layers (De Lorenzo 1994d). Therefore, samples were taken from each layer. The average plutonium concentration is reported as 0.158 $\mu\text{Ci/L}$. Converting this value to g/L yields:

$$(0.158 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.55\text{E-}06 \text{ g/L}$$

When Tank AP-105 was sampled, it contained 3.11×10^6 L (821 kgal) of supernate. The plutonium inventory was:

$$(2.55\text{E-}06 \text{ g/L}) * (821,000 \text{ gal}) * (3.785 \text{ L/gal}) = 8 \text{ g Pu}$$

14.4 Discussion

No major transfers involving Tank AP-105 occurred after the March 1993 sample was taken. Using the current tank volume of 3.10×10^6 L (819 kgal), the current plutonium concentration is:

$$(8 \text{ g Pu}) / ((819,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.58\text{E-}06 \text{ g/L}$$

14.5 Conclusions

It is suggested that the current plutonium inventory for Tank AP-105 be set at 2.58×10^{-6} g/L. The current recommended plutonium inventory for Tank AP-105 is 8 g.

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15.0 TANK 241-AP-106 PLUTONIUM INVENTORY

15.1 Tank History

The fill history for Tank 241-AP-106 (Tank AP-106) indicates three major transfers of dilute noncomplexed waste into Tank AP-106. These transfers included one in 1988 from Tank AW-106, and, in 1989, one each from Tank AY-102 and Tank AW-106. Two major transfers out occurred. These were both in 1989 when about 3.79×10^5 L (100 kgal) out of nearly 2.27×10^6 L (600 kgal) were transferred to Tank AW-102 and about 1.32×10^6 L (350 kgal) were transferred to Tank AP-105. Characterization data gathered before the first major transfer into this tank in May 1988 are not considered valuable in estimating the current tank inventory. Currently Tank AP-106 contains 4.26×10^6 L (1,126 kgal) of supernatant liquid.

15.2 Plutonium Inventory Tracking System

This system contains no information regarding transfers of Tank AP-106 waste. On March 4, 1992, it was determined that Tank AP-106 contained no fissile material (Vail 1992b). The plutonium inventory was baselined on January 1, 1994, to 18 g (Miles 1994).

15.3 March 1993 Bottle-On-A-String Samples

Bottle-on-a-string supernate samples were taken from Tank AP-106 in March 1993 (De Lorenzo 1994e). The reported average plutonium concentration was $<0.136 \mu\text{Ci/L}$. All further calculations will use $0.136 \mu\text{Ci/L}$ as the plutonium concentration. Converting this concentration to g/L yields:

$$(0.136 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.19\text{E-}06 \text{ g/L}$$

When these samples were taken, Tank AP-106 contained 4.27×10^6 L (1,129 kgal) of supernate. Using this value, the plutonium inventory can be calculated.

$$(2.19\text{E-}06 \text{ g/L}) * (1,129,000 \text{ gal}) * (3.785 \text{ L/gal}) = 9 \text{ g Pu}$$

15.4 November 1994 Grab Samples

Three liquid grab samples were taken from Tank AP-106 November 14 through 17, 1994 (Miller 1994b). These samples have not been analyzed for plutonium.

15.5 Discussion

Because the November 1994 samples were not analyzed for plutonium, the plutonium concentration reported from the March 1993 samples will be used. No transfers into Tank AP-106 have occurred since the March 1993 samples were

taken. Using the current tank volume of 4.26×10^6 (1,126 kgal) and plutonium inventory of 9 g gives a plutonium concentration of:

$$(9 \text{ g Pu}) / ((1,126,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.11\text{E-}06 \text{ g/L}$$

15.6 Conclusions

The recommended current inventory estimate for Tank AP-106 is 9 g of plutonium. The recommended plutonium concentration is 2.11×10^{-6} g/L.

16.0 TANK 241-AP-107 PLUTONIUM INVENTORY

16.1 Tank History

The fill history indicates two major transfers into Tank 241-AP-107 (Tank AP-107). The transfers were of dilute noncomplexed waste, one from PUREX Ammonia Scrubber Feed in January 1990 and one from Tank 241-AW-103 (Tank AW-103) in October 1994. Two major transfers out) have occurred. Both were transfers to Tank AW-102, one each in September and October 1994. These transfers essentially emptied Tank AP-107. Characterization data gathered before the second major transfer into this tank in October 1994 are not considered to be of value in estimating the current tank inventory. Tank AP-107 currently contains 6.09×10^5 L (161 kgal) of supernatant liquid.

16.2 Plutonium Inventory Tracking System

This system contains no transfer data. It was determined that no fissile material existed in Tank AP-107 on March 4, 1992 (Vail 1992b). The plutonium inventory was baselined to 25 g on January 1, 1994 (Miles).

16.3 August 1993 Bottle-on-a-String Samples

Tank AP-107 was sampled using the bottle-on-a-string method August 1, 1993. (De Lorenzo 1994f). The reported average plutonium concentration from these samples was $<0.534 \mu\text{Ci/L}$. All further calculations will be done using a plutonium concentration of $0.534 \mu\text{Ci/L}$. Converting this to g/L gives a plutonium concentration of:

$$(0.534 \mu\text{Ci/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 8.61\text{E-}06 \text{ g/L}.$$

When these samples were taken, Tank AP-107 contained 4.22×10^6 L (1,115 kgal) of supernate. Using this volume, the plutonium inventory can be calculated:

$$(8.61\text{E-}06 \text{ g/L}) * (1,115,000 \text{ gal}) * (3.785 \text{ L/gal}) = 36 \text{ g Pu}$$

16.4 Transfers from Tank AP-107 to Tank AW-102

Since the August 1993 sample was taken, approximately 4.09×10^6 L (1,080 kgal) of supernate have been transferred out of Tank AP-107 leaving a volume of 1.06×10^5 L (28 kgal) after the second transfer to Tank AW-102. The plutonium transferred out of Tank AP-107 was:

$$(8.61\text{E-}06 \text{ g/L}) * (1,080,000 \text{ gal}) * (3.785 \text{ L/gal}) = 35 \text{ g Pu}$$

This leaves a plutonium inventory in Tank AP-107 of:

$$36 \text{ g} - 35 \text{ g} = 1 \text{ g Pu}$$

16.5 October 1994 Transfer from Tank AW-103

Approximately 5.00×10^5 (132 kgal) were transferred from Tank AW-103 to Tank AP-107 in October 1994. Samples from Tank AW-103 were taken September 30, 1994 (Dodd 1994d). The plutonium concentration reported was 1.16×10^{-5} $\mu\text{Ci/mL}$. Converting this concentration to g/L yields:

$$(1.16\text{E-}05 \mu\text{Ci/mL}) * (1,000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.87\text{E-}07 \text{ g/L}$$

Using this concentration with the volume of waste from Tank AW-103 transferred into Tank AP-107 gives a transferred plutonium value of:

$$(1.87\text{E-}07 \text{ g/L}) * (132,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.09 \text{ g Pu transferred}$$

The total plutonium in Tank AP-107 after the transfer is:

$$1 \text{ g} + 0.09 \text{ g} = 1.1 \text{ g Pu}$$

16.6 Discussion

Tank AP-107 currently contains 6.09×10^5 L (161 kgal) of supernate. Using this volume and the total plutonium inventory, the plutonium concentration can be calculated:

$$(1.1 \text{ g Pu}) / ((161,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.81\text{E-}06 \text{ g/L}$$

16.7 Conclusions

The recommended plutonium inventory for Tank AP-107 is 1.1 g. The recommended plutonium concentration is 1.81×10^{-6} g/L.

17.0 TANK 241-AP-108 PLUTONIUM INVENTORY

17.1 Tank History

The fill history indicates three major transfers of dilute noncomplexed waste into Tank 241-AP-108 (Tank AP-108). These transfers occurred in 1990 from PUREX miscellaneous, in 1991 from Tank AY-102 and PUREX miscellaneous, and in November and December 1994 from Tank 241-AW-105 (Tank AW-105). Two major transfers out occurred in October 1994, one to Tank AP-101 and the other to Tank AP-102. These transfers essentially emptied Tank AP-108. Characterization data gathered before the 1994 transfers are not considered valuable in estimating the current tank inventory. Currently Tank AP-108 contains 3.00×10^6 L (793 kgal) supernatant liquid.

17.2 Plutonium Inventory Tracking System

The plutonium inventory tracking system contains very little transfer data about Tank AP-108. The plutonium inventory was baselined to 26.8 g on March 4, 1992 (Vail 1992b). The inventory was rebaselined on January 1, 1994, to 10 g (Miles 1994).

17.3 March 1994 Sample

In March 1994 bottle-on-a-string samples were taken from Tank AP-108 (Miller 1994a). The reported plutonium concentration is $<5.10 \times 10^{-4}$ $\mu\text{Ci/mL}$. A concentration of 5.10×10^{-4} $\mu\text{Ci/mL}$ will be used for all further calculations. Converting this value to g/L gives a plutonium concentration of:

$$(5.10\text{E-}04 \mu\text{Ci/mL}) * (1,000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 8.23\text{E-}06 \text{ g/L}$$

When this sample was taken, Tank AP-108 contained 4.28×10^6 L (1,131 kgal) of supernatant liquid. The plutonium inventory at the time these samples were taken was:

$$(8.23\text{E-}06 \text{ g/L}) * (1,131,000 \text{ gal}) * (3.785 \text{ L/gal}) = 35.2 \text{ g Pu}$$

17.4 October 1994 Transfers from AP-108

In October 1994, 4.17×10^6 L (1,102 kgal) of supernate were transferred out of Tank AP-108 to Tank AP-101 and Tank AW-102, leaving a volume of 1.10×10^5 L (29 kgal). Using this value gives a plutonium amount transferred from Tank AP-108 of:

$$(8.23\text{E-}06 \text{ g/L}) * (1,102,000 \text{ gal}) * (3.785 \text{ L/gal}) = 34.3 \text{ g Pu}$$

This leaves a plutonium inventory in Tank AP-108 of:

$$35.2 \text{ g} - 34.3 \text{ g} = 0.9 \text{ g Pu}$$

17.5 Transfers from Tank AW-105 to Tank AP-108

Approximately 2.89×10^6 L (764 kgal) of waste were transferred from Tank AW-105 to Tank AP-108 between November 11 and December 3, 1994. Tank AW-105 was last sampled in August 1994. Since then, several transfers have been made from PUREX tanks F18, U3, and U4. According to the plutonium inventory tracking system (Vail 1994), the plutonium concentration of the material added to Tank AP-108 was 2.00×10^{-6} g/L. Using this concentration and the amount of waste transferred gives the amount of plutonium transferred:

$$(2.00\text{E-}06 \text{ g/L}) * (764,000 \text{ gal}) * (3.785 \text{ L/gal}) = 5.8 \text{ g Pu transferred.}$$

The plutonium inventory after the transfer was:

$$0.9 \text{ g} + 5.8 \text{ g} = 6.7 \text{ g Pu}$$

17.6 Discussion

Using the total inventory calculated after the tank transfers and the current tank volume of 3.00×10^6 L (793 kgal) gives a plutonium concentration of:

$$(6.7 \text{ g}) / ((793,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.23\text{E-}06 \text{ g/L}$$

17.7 Conclusions

The recommended plutonium concentration for Tank AP-108 is 2.23×10^{-6} g/L. The recommended plutonium inventory is 7 g.

18.0 TANK 241-AW-101 PLUTONIUM INVENTORY

18.1 Tank History

Tank history indicates multiple significant transfers into Tank 241-AW-101 (Tank AW-101) from January 1981 until July 1986. The transfers into this tank were primarily from Tank AW-102, Tank SY-102, Tank 241-AW-104 (Tank AW-104), PUREX miscellaneous, and DSSF from the evaporator. All supernate was transferred to Tank AW-102 in May of 1986 and then the tank was refilled with DSSF from the evaporator. This indicates that the supernate currently in the tank should be typical of DSSF from the evaporator and the sludge should be characteristic of waste from SY-102, 100 Area, and PUREX miscellaneous waste. Good sludge characterization data from 1984 on and supernatant characterization after 1986 would provide reliable information to estimate the plutonium inventory. Currently this tank contains 3.93×10^6 L (1,039 kgal) of supernatant liquid and 3.18×10^5 L (84 kgal) of sludge.

18.2 Plutonium Tracking System

This system has records from March 1986 to September 1987 showing that 4,130 g of plutonium have been transferred into Tank AW-101. The plutonium inventory was baselined to 3,470 g on January 1, 1994 (Miles 1994).

18.3 Fiscal Year 1986 Tank AW-101 Heel Samples

The sample of the heel in Tank AW-101 was taken late in fiscal year 1986 (Weiss 1987). The reported plutonium concentration of the heel was 92.1 nCi/g. Assuming a solids density of 1,200 g/L (Vail 1994b) and converting this value to g/L gives a concentration of:

$$(92.1 \text{ nCi/g}) * (1.0\text{E-}09 \text{ Ci/nCi}) * (1200 \text{ g/L}) / (0.062 \text{ Ci/g}) = 1.783\text{E-}03 \text{ g/L}$$

Using the calculated plutonium concentration of the solids and the solids volume in the tank give a solids plutonium inventory of:

$$(1.78\text{E-}03 \text{ g/L}) * (84,000 \text{ gal}) * (3.785 \text{ L/gal}) = 566 \text{ g Pu}$$

18.4 1990 Bottle-on-a-String Samples

Twelve bottle-on-a-string samples were taken in June 1990 from Tank AW-101 (Hendrickson 1991). The reported mean plutonium concentration is 1.145 $\mu\text{Ci/L}$. Converting this value to g/L gives a supernatant plutonium concentration of:

$$(1.15 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.85\text{E-}05 \text{ g/L}$$

When this sample was taken, Tank AW-101 contained 3.40×10^6 L (1,053 kgal) of supernate. Using the supernatant plutonium concentration and the supernatant liquid volume give plutonium inventory of:

$$(1.85\text{E-}05 \text{ g/L}) * (1,053,000 \text{ gal}) * (3.785 \text{ L/gal}) = 74 \text{ g Pu}$$

18.5 Discussion

The calculations in Section 18.4 indicate a total plutonium inventory in Tank AW-101 of:

$$566 \text{ g} + 74 \text{ g} = 640 \text{ g Pu}$$

The estimates of 4,130 g from the plutonium inventory database and the estimate of 640 g are both based on good information. Determining which is more accurate is difficult. This tank contains little sludge, so perhaps a large percentage of the plutonium transferred into this tank has also been transferred out. On the other hand, the concentration value reported for the sludge is lower than expected. Approximately 3.49×10^7 L (9,231,900 gal) have been transferred out of this tank. Assuming an average supernate concentration of 1.85×10^{-5} g/L during this time, the amount of plutonium transferred out of this tank was:

$$(1.85\text{E-}05 \text{ g/L}) * (9,231,900 \text{ gals}) * (3.785 \text{ L/gal}) = 646 \text{ g}$$

This does not represent enough plutonium to justify the difference between the two estimates. However, it does represent a needed correction in the estimate given by the plutonium tracking system. Therefore, the recommended plutonium inventory is:

$$4,130 \text{ g} - 640 \text{ g} = 3,490 \text{ g Pu}$$

Assuming the supernate concentration of 1.85×10^{-5} g/L is correct, this inventory yields a supernate plutonium content of:

$$(1.85\text{E-}05 \text{ g/L}) * (1,039,000 \text{ gal}) * (3.785 \text{ L/gal}) = 73 \text{ g}$$

with the remaining 3,417 g in 3.18×10^5 L (84 kgal) of sludge, which yields a sludge concentration of:

$$(3,417 \text{ g}) / ((84,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.07\text{E-}02 \text{ g/L}$$

18.6 Conclusions

The recommended estimate of the plutonium inventory for Tank AW-101 is 3,490 g. The recommended supernate and sludge concentration estimates are 1.85×10^{-5} g/L and 1.07×10^{-2} g/L, respectively.

19.0 TANK 241-AW-102 PLUTONIUM INVENTORY

19.1 Tank History

Because Tank AW-102 is an evaporator feed tank, the tank history indicates numerous transfers from January 1981 until November 1994. Characterization data gathered before November 1994 cannot be considered reliable in estimating the current inventory. Currently the tank contains 3.22×10^5 L (85 kgal) of supernate and 3.79×10^3 L (1 kgal) of sludge. Typically this tank has been used as an evaporator feed tank and the concentration of the supernate is expected to be less than 5.0×10^{-6} g/L going into the evaporator and less than 5.0×10^{-5} g/L coming out of the evaporator.

19.2 Plutonium Tracking System

The plutonium inventory was baselined on January 1, 1994 to 41.8 g (Miles 1994).

19.3 November 1994 Supernatant Sample

A supernatant sample was taken November 18, 1993, at the end of the 94-2 evaporator campaign (WHC 1994h). According to the analytical results of sample T-1649, the plutonium concentration in Tank AW-102 was $0.1 \mu\text{Ci/L}$. Converting this value to g/L gives a plutonium concentration of:

$$(0.1 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.61\text{E-}06 \text{ g/L}$$

Using this concentration and the current supernatant liquid volume gives a plutonium inventory of:

$$(1.61\text{E-}06 \text{ g/L}) * (85,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.5 \text{ g Pu}$$

19.4 Discussion

The sludge has not been sampled, but its concentration should be similar to the 1.07×10^{-2} g/L concentration value calculated for Tank AW-101. Using this value, the sludge plutonium inventory is:

$$(1.07\text{E-}02 \text{ g/L}) * (1,000 \text{ gal}) * (3.785 \text{ L/gal}) = 40.5 \text{ g}$$

Therefore the total plutonium inventory estimate is 41 g.

19.5 Conclusions

The recommended estimate of the plutonium inventory for Tank AW-102 is 41 g. The recommended supernate and sludge concentration values are 1.61×10^{-6} g/L and 1.07×10^{-2} g/L, respectively.

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20.0 TANK 241-AW-103 PLUTONIUM INVENTORY

20.1 Tank History

The history indicates about 10 significant transfers into Tank 241-AW-103 (Tank AW-103) from January 1981 until January 1989. Most of these transfers were PUREX decladding waste. Very little transfer-in activity has taken place since January 1989; one transfer out occurred. This was a transfer of about 5.00×10^5 L (132 kgal) to Tank AP-107 in October 1994. Therefore, and characterization data following January 1989 would be considered to be excellent in estimating the current tank inventory. Currently the tank contains 5.75×10^5 L (152 kgal) of supernatant liquids and 1.37×10^6 L (363 kgal) of sludge.

20.2 Plutonium Tracking System

This tracking system appears to be fairly complete with records of about 400 separate transfers between July 1985 and September 1988. No basis is given for the starting inventory of about 2,800 g in July of 1985. This system estimates an inventory of 5,354 g of plutonium in January 1991. The plutonium inventory was baselined on January 1, 1994 to 21,000 g (Miles 1994).

20.3 January 1989 Core Sample

A 10-segment core sample of PUREX Neutralized Cladding Removal Waste (NCRW) was taken from Tank AW-103 the week of January 23, 1989 (Wanner 1989). Because of equipment problems, Segments 4 and 5 had to be retaken. Table 20-1 lists each segment analyzed and describes the segment.

Table 20-1. NCRW Sampling Results for Tank AW-103.

<u>Sample No.</u>	<u>Description</u>
1L & 2L	Supernate from Segments 1 and 2
4S-1	Solids from first quarter of Segment 4
4S-2	Solids from second quarter of Segment 4
4S-3	Solids from third quarter of Segment 4
4S-4	Solids from fourth quarter of Segment 4
5RS-1	Solid fraction from first quarter of resample of Segment 5
5RS-2	Solid fraction from second quarter of resample of Segment 5
5RS-3	Solid fraction from third quarter of resample of Segment 5
5RS-4	Solid fraction from fourth quarter of resample of Segment 5
4L-1/2	Liquid fraction from original Segment 4
4L-3/4	Liquid fraction from original Segment 4
5RL-1/2	Liquid fraction from resample of Segment 5
5RS-3/4	Liquid fraction from resample of Segment 5
103AW-COMP	Composite of Segments 6 through 10

The core was analyzed by both the WHC Process Chemistry Laboratory (PCL) and PNL (Weiss 1990a and McGrail 1990). The results of these analyses are listed in Table 20-2.

Table 20-2. Results of Core Analyses for Tank AW-103.

Sample	PCL Pu Conc.	PNL Pu Conc.
4S-1	1,780 nCi/g (1.46 g/mL)	1,360 nCi/g
4S-2	1,680 nCi/g (1.53 g/mL)	1,310 nCi/g
4S-3	18.2 μ Ci/g (1.43 g/mL)	1,300 nCi/g
4S-4	1,160 nCi/g (1.49 g/mL)	1,060 nCi/g
5RS-1	2,050 nCi/g (1.49 g/mL)	850 nCi/g
5RS-2	1,480 nCi/g (1.46 g/mL)	927 nCi/g
5RS-3	1,090 nCi/g (1.19 g/mL)	795 nCi/g
5RS-4	833 nCi/g (1.39 g/mL)	1,200 nCi/g
103AW-COMP	502 nCi/g	370 nCi/g
1L & 2L	<0.081 μ Ci/L	

The PNL document only reports one density for the Tank AW-103 waste. The reported density is 1.75 g/mL. Converting the plutonium concentrations listed in Table 20-2 to g/L yields:

PCL:

$$\begin{aligned}
 4S-1 & (1780 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1460 \text{ g/L}) / (0.062 \text{ Ci/g}) = 4.19E-02 \text{ g/L} \\
 4S-2 & (1680 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1530 \text{ g/L}) / (0.062 \text{ Ci/g}) = 4.15E-02 \text{ g/L} \\
 4S-3 & (1160 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1490 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.79E-02 \text{ g/L} \\
 4S-4 & (1100 \text{ } \mu\text{Ci/g}) * (1E-09 \text{ Ci/} \mu\text{Ci}) * (1430 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.54E-02 \text{ g/L} \\
 5RS-1 & (2050 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1490 \text{ g/L}) / (0.062 \text{ Ci/g}) = 4.93E-02 \text{ g/L} \\
 5RS-2 & (1480 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1460 \text{ g/L}) / (0.062 \text{ Ci/g}) = 3.49E-02 \text{ g/L} \\
 5RS-3 & (1090 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1190 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.09E-02 \text{ g/L} \\
 5RS-4 & (833 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1390 \text{ g/L}) / (0.062 \text{ Ci/g}) = 1.87E-02 \text{ g/L} \\
 1L/2L & (0.081 \text{ } \mu\text{Ci/L}) * (1E-06 \text{ Ci/} \mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.31E-06 \text{ g/L}
 \end{aligned}$$

PNL:

$$\begin{aligned}
 4S-1 & (1360 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 3.84E-02 \text{ g/L} \\
 4S-2 & (1310 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 3.70E-02 \text{ g/L} \\
 4S-3 & (1300 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 3.67E-02 \text{ g/L} \\
 4S-4 & (1060 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.99E-02 \text{ g/L} \\
 5RS-1 & (850 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.40E-02 \text{ g/L} \\
 5RS-2 & (927 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.62E-02 \text{ g/L} \\
 5RS-3 & (795 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 2.24E-02 \text{ g/L} \\
 5RS-4 & (1200 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 3.39E-02 \text{ g/L} \\
 COMP & (370 \text{ nCi/g}) * (1E-09 \text{ Ci/nCi}) * (1750 \text{ g/L}) / (0.062 \text{ Ci/g}) = 1.04E-02 \text{ g/L}
 \end{aligned}$$

The results from both sources seem to be comparable. However, because the PCL results are slightly higher, they will be used to get a conservative plutonium inventory in the tank. The average of the Segments 4 and 5 concentrations is 3.26×10^{-2} g/L. This concentration will be used for the sludge. The plutonium concentration for Segments 1 and 2 will be used for the supernate concentration. In January 1989 the supernate volume was

2.49×10^6 L (657 kgal) and the sludge volume was 1.37×10^6 L (363 kgal). The plutonium inventory when this sample was taken was:

$$(1.31\text{E-}06 \text{ g/L}) * (657,000 \text{ gal}) * (3.785 \text{ L/gal}) = 3.3 \text{ g Pu in supernate}$$

$$(3.26\text{E-}02 \text{ g/L}) * (363,000 \text{ gal}) * (3.785 \text{ L/gal}) = 44,791 \text{ g Pu in sludge}$$

20.4 February and March 1989 Transfers from Tank AW-103 to Tank AW-102

In February and March 1989 approximately 4.77×10^5 L (126 kgal) of waste were transferred from Tank AW-103 to Tank AW-102. It is assumed that the waste transferred to Tank AW-102 was supernate. Using the supernate plutonium concentration, the total plutonium transferred can be calculated:

$$(1.31\text{E-}06 \text{ g/L}) * (126,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.6 \text{ g Pu transferred}$$

The total plutonium left in the supernate was:

$$3.3 \text{ g} - 0.6 \text{ g} = 2.7 \text{ g Pu}$$

20.5 September 1994 Grab Samples

On September 29, 1994, three supernatant grab samples were taken from Tank AW-103. Plutonium was analyzed in two of the samples. The plutonium concentration in Sample R-6492 was $<1.34 \times 10^{-5}$ $\mu\text{Ci/mL}$ (WHC 1994e). The plutonium concentration in Sample R-6493 was 9.86×10^{-6} $\mu\text{Ci/mL}$ (WHC 1994f). To be conservative, the concentration from Sample R-6492 will be used for further calculations. Converting the plutonium concentration to g/L yields:

$$(1.34\text{E-}05 \mu\text{Ci/mL}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1000 \text{ mL/L}) / (0.062 \text{ Ci/g}) = 2.16\text{E-}07 \text{ g/L}$$

When this sample was taken, Tank AW-103 contained 1.07×10^6 L (283 kgal) of supernate. The plutonium inventory in the supernate was:

$$(2.16\text{E-}07 \text{ g/L}) * (283,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.2 \text{ g Pu}$$

20.6 Discussion

The plutonium inventory tracking system results are questionable because the core sample indicates a considerably higher inventory. In addition, no basis is given for the starting inventory in July of 1985. It is suggested that the plutonium results from the 1989 core sample be used for the inventory in the sludge and the September 1994 grab sample results be used for the plutonium inventory in the supernate. The total plutonium inventory in Tank AW-103 is:

$$44,791 \text{ g} + 0.2 \text{ g} = 44,791 \text{ g Pu}$$

Using the current volume in Tank AW-103 gives plutonium concentrations in the sludge and supernate of:

$$(0.2 \text{ g Pu}) / ((152,000 \text{ gal}) * (3.785 \text{ L/gal})) = 3.48\text{E-}07 \text{ g/L in supernate}$$

$$(44,791 \text{ g Pu}) / ((363,000 \text{ gal}) * (3.785 \text{ L/gal})) = 3.26\text{E-}02 \text{ g/L in sludge}$$

20.7 Conclusions

The recommended plutonium inventory in Tank AW-103 is 44,791 g. The recommended supernate and sludge concentration values are 3.48×10^{-7} g/L and 3.26×10^{-2} g/L, respectively.

21.0 TANK 241-AW-104 PLUTONIUM INVENTORY

21.1 Tank History

This history indicates over 15 major transfers into Tank 241-AW-104 (Tank AW-104) between January 1981 and January 1991. These transfers were from Tank AW-102, Tank AY-101, and PUREX miscellaneous waste. Since January 1991 this tank has had no significant activity. The tank was essentially emptied many times except for the sludge; the last time was in early 1989. Since then it has received primarily PUREX miscellaneous waste. Therefore, the supernate concentration should be characteristic of supernate from PUREX miscellaneous waste with settled solids. Samples obtained since early 1989 should be excellent in characterizing the sludge and even the supernate. In addition, samples of the sludge as far back as 1986 should provide good sludge data. Currently this tank contains 3.15×10^6 L (833 kgal) of supernatant liquids, 6.78×10^5 L (179 kgal) of sludge, and 4.20×10^5 L (111 kgal) of saltcake.

21.2 Plutonium Tracking System

The records are incomplete. They start in January 1991 with an inventory of 5,350 g and end in April 1991 with an inventory of 5,360 g. No basis is given for the starting inventory estimate. However, in checking the backup data, it was discovered that the transfer data do exist and are fairly complete going back to 1982. The plutonium inventory was baselined on January 1, 1994, to 5,360 g (Miles 1994).

21.3 September 1994 Grab Samples

Three grab samples were taken from Tank AW-104 on September 28, 1994 (Dodd 1994d). The average concentration of plutonium in the samples was 1.63×10^{-5} $\mu\text{Ci/mL}$. Converting this value to g/L gives a plutonium concentration in the supernate of:

$$(1.63\text{E-}05 \mu\text{Ci/mL}) * (1000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.63\text{E-}07 \text{ g/L}$$

When this sample was taken, Tank AW-104 contained 3.15×10^6 L (832 kgal) of supernate. Using this value, the plutonium content in the supernate can be calculated:

$$(2.63\text{E-}07 \text{ g/L}) * (832,000 \text{ gal}) * (3.785 \text{ L/gal}) = 0.8 \text{ g Pu}$$

21.4 Discussion

Characterization data are available for this tank, but most of the sampling occurred before 1991. There appears to be no characterization of the

sludge in Tank AW-104. In the absence of sludge and saltcake data, average values from Section 31 for these can be used to give an idea of what might be expected in the tank. This type of estimate is given in Table 21-1.

Table 21-1. Hypothesis of Tank AW-104 Contents.

<u>Volume</u>	<u>Average Concentration</u>
179 kgal of sludge	1.75E-02 g/L
111 kgal of saltcake	6.95E-06 g/L

The plutonium inventory estimate is given by:

$$\begin{aligned} (1.75\text{E-}02 \text{ g/L}) * (179,000 \text{ gal}) * (3.785 \text{ L/gal}) &= 11,857 \text{ g Pu in sludge} \\ (6.95\text{E-}06 \text{ g/L}) * (111,000 \text{ gal}) * (3.785 \text{ L/gal}) &= 3 \text{ g Pu in saltcake} \end{aligned}$$

These estimates for sludge and saltcake plutonium concentrations do not have a good basis. However, the plutonium tracking system was checked and it was found to be complete going back to the initial transfer in November 1982. Some work needs to be done to completely check out the records of this system and put them in order, but the inventory estimates appear to be reliable.

Using the supernate plutonium inventory of 0.8 g and the current supernatant volume of $3.15 \times 10^6 \text{ L}$ (833 kgal) give a supernatant plutonium concentration of:

$$(0.8 \text{ g Pu}) / ((833,000 \text{ gal}) * (3.785 \text{ L/gal})) = 2.54\text{E-}07 \text{ g/L}$$

Now, assuming the saltcake concentrations of $6.95 \times 10^{-6} \text{ g/L}$ and a total inventory of 5,360 g yields a sludge inventory of:

$$5360 - 0.8 - 3 = 5,356 \text{ g Pu}$$

and a sludge concentration of:

$$(5,356 \text{ g}) / ((179,000 \text{ gal}) * (3.785 \text{ L/gal})) = 7.91\text{E-}03 \text{ g/L}$$

21.5 Conclusions

The plutonium tracking system estimate of 5,360 g is the recommended inventory for Tank AW-104. This value indicates that the expected sludge concentration is $7.91 \times 10^{-3} \text{ g/L}$ for this tank. The recommended supernate plutonium concentration is $2.54 \times 10^{-7} \text{ g/L}$ based on September 1994 samples and the recommended saltcake concentration value is $6.95 \times 10^{-6} \text{ g/L}$.

22.0 TANK 241-AW-105 PLUTONIUM INVENTORY

22.1 Tank History

The history indicates that more than 15 major transfers into Tank 241-AW-105 (Tank AW-105) occurred between January 1981 and the present. These transfers were from various sources including Tanks AW-102, AW-103, and AW-104. In addition, several transfers occurred from PUREX miscellaneous waste, PUREX decladding waste, and from dilute noncomplexed and complexed waste from hot semiworks. It appears that the sludge in this tank built up considerably between January 1984 and July 1987. In July 1987, the tank was emptied except for about 1.12×10^6 L (297 kgal) of sludge. Since then the amount of sludge has remained essentially constant. The sludge level was remeasured in November 1994. The current sludge level is 9.84×10^5 L (260 kgal). Several additional transfers were made from Purex after July 1987 and one major transfer was made from Tank AW-105. Approximately 2.89×10^6 L (764 kgal) of waste was transferred from Tank AW-105 to Tank AP-108 at the end of November 1994. Therefore, relevant sludge data samples are considered to be those taken after July 1987 and relevant supernatant samples are considered to be those taken after January 1990. Currently this tank contains 3.10×10^5 L (82 kgal) of supernatant liquids and 9.84×10^5 L (260 kgal) of sludge.

22.2 Plutonium Tracking System

The plutonium inventory in Tank AW-105 was baselined to 15,808 g on July 21, 1992 (Vail 1992e). The inventory was rebaselined to 15,180 g on January 1, 1994 (Miles 1994). Since then the records seem to be complete. According to the tracking system Tank AW-105 contains 17,230 g of plutonium.

22.3 Core Sample Taken July 2, 1986

On July 2, 1986 a 10-segment core sample was taken from Tank AW-105 (Peters 1986). The first three segments contained only supernatant. The fourth segment was found to be empty when an attempt was made to extrude it. The fifth segment contained only 2 in. of white NCRW solids with the remainder supernatant. Segments 6 through 9 were found to contain white NCRW solids. Segment 10 contained black solids with the remainder NCRW solids. The plutonium concentrations of Segments 5 through 10 are listed in Table 22-1. The composite sample was prepared by mixing equal portions of Segments 6 through 10.

Table 22-1. Plutonium Concentrations from Tank AW-105 Core Samples.

Segment	Density (g/cc)	Concentration (nCi/g)	Concentration (μ Ci/L)
5	1.22	226	276
6	NA	524	639
6	1.34	520	697
7	1.28	1137	1455
8	1.36	382	520
8	1.35	368	497
9	1.41	666	939

Table 22-1. Plutonium Concentrations from Tank AW-105 Core Samples.

Segment	Density (g/cc)	Concentration (nCi/g)	Concentration (μ Ci/L)
10	1.44	527	759
10	1.39	546	759
comp.	1.39	636	884

Converting the plutonium concentration of the composite solid sample to g/L give a concentration of:

$$(884 \mu\text{Ci/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 1.43\text{E-}02 \text{ g/L}$$

At the time this sample was taken the solids depth was 2.46 m (97 in.), which is approximately $1.01 \times 10^6 \text{ L}$ (267 kgal). The total volume of waste in the tank was $2.23 \times 10^6 \text{ L}$ (589 kgal). Using the volume of the solids and the composite plutonium concentration of 884 $\mu\text{Ci/L}$ gives a plutonium inventory in the solids of:

$$(1.43\text{E-}02 \text{ g/L}) * (267,000 \text{ gal}) * (3.785 \text{ L/gal}) = 14,452 \text{ g Pu}$$

No references indicated that the supernate was evaluated for plutonium.

22.4 Supernate Samples of April and July 1988

Two supernate samples were taken in April and July 1988 (WHC 1988a and WHC 1988b). The Sample Status Reports for Samples T-7966 and T-805 indicate that the supernate has a plutonium concentration of $1.57 \times 10^{-4} \text{ g/L}$ and $4.94 \times 10^{-4} \text{ g/L}$, respectively. The supernate volumes in the tank when these samples were taken were $7.91 \times 10^5 \text{ L}$ (209 kgal) in April 1988 and $1.11 \times 10^6 \text{ L}$ (292 kgal) in July 1988. Using these values to compute the plutonium inventory estimate yields:

$$(1.57\text{E-}04 \text{ g/L}) * (209,000 \text{ gal}) * (3.785 \text{ L/gal}) = 124 \text{ g Pu in T-7966}$$

$$(4.94\text{E-}04 \text{ g/L}) * (292,000 \text{ gal}) * (3.785 \text{ L/gal}) = 546 \text{ g Pu in T-805}$$

22.5 Core Sample taken May 1990

A seven-segment core sample of neutralized cladding removal waste from the PUREX plant that is now in Tank AW-105 was taken in May 1990 (DiCenso and Simpson 1994, Tingey and Simpson 1994). The first two core segments contained supernate with no visible solids. The remaining five segments contained solids with no drainable liquids. Segment 3 was a slurry and the bottom, Segment 7, a hard solid. The weight percent solids in Segments 3 and 4 was 31.2 percent and in Segment 7 was 58.5 percent. Segments 3 through 7 had an average plutonium concentration of $2.18 \mu\text{Ci/g}$ and a density of 1.42 g/mL . Segments 1 and 2 had an average plutonium concentration of $0.152 \mu\text{Ci/L}$. Converting the plutonium concentration values to g/L yields:

$$(2.18 \mu\text{Ci/g}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1420 \text{ g/L}) / (0.062 \text{ Ci/g}) = 4.99\text{E-}02 \text{ g/L in solids}$$

$$(0.152 \mu\text{Ci/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.45\text{E-}06 \text{ g/L in supernate}$$

When this sample was taken, Tank AW-105 contained 1.12×10^6 L (297 kgal) of sludge and 2.29×10^6 L (605 kgal) of supernate. Using these values, the total plutonium inventory in the supernate and the sludge is given by:

$$(4.99\text{E-}02 \text{ g/L}) * (297,000 \text{ gal}) * (3.785 \text{ L/gal}) = 56,095 \text{ g Pu in solids}$$

$$(2.45\text{E-}06 \text{ g/L}) * (605,000 \text{ gal}) * (3.785 \text{ L/gal}) = 5.6 \text{ g Pu in supernate}$$

Therefore, based on this core sample, an inventory of 56,101 g is estimated.

22.6 Supernate and Sludge Samples Taken August 1994

On August 24, 1994 four supernate and two sludge grab samples were taken from Tank AW-105 (Dodd 1994b). Table 22-2 shows the reported plutonium concentrations of the samples taken.

Table 22-2. Plutonium Concentrations of Samples Taken August 24, 1994.

Sample(type)	Pu Concentration
R-6228(supernate)	<2.95E-05 $\mu\text{Ci/mL}$
R-6229(supernate)	<1.28E-05 $\mu\text{Ci/mL}$
R-6230(sludge)	5.69E-04 $\mu\text{Ci/mL}$
R-6231(supernate)	2.95E-05 $\mu\text{Ci/mL}$
R-6232(supernate)	4.25E-04 $\mu\text{Ci/mL}$

The less-than plutonium concentrations will not be used in further calculations. The average plutonium concentration in the supernate is $3.66 \times 10^{-4} \mu\text{Ci/mL}$. The value $1.24 \times 10^{-4} \mu\text{Ci/mL}$ will be used for all further calculations. The average plutonium concentration in the sludge is $9.10 \times 10^{-4} \mu\text{Ci/mL}$. Converting these values to g/L yields:

$$(2.27\text{E-}04 \mu\text{Ci/mL}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1000 \text{ mL/L}) / (0.062 \text{ Ci/g}) = 3.66\text{E-}06 \text{ g/L in supernate}$$

$$(9.10\text{E-}04 \mu\text{Ci/mL}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1000 \text{ mL/L}) / (0.062 \text{ Ci/g}) = 1.47\text{E-}05 \text{ g/L in sludge}$$

When these samples were taken, Tank AW-105 contained 2.88×10^6 L (760 kgal) supernate and 1.12×10^6 L (297 kgal) of sludge. Using these values, the plutonium inventory can be calculated:

$$(3.66\text{E-}06 \text{ g/L}) * (760,000 \text{ gal}) * (3.785 \text{ L/gal}) = 10.5 \text{ g Pu in supernate}$$

$$(1.47\text{E-}05 \text{ g/L}) * (297,000 \text{ gal}) * (3.785 \text{ L/gal}) = 16.5 \text{ g Pu in sludge}$$

22.7 Discussion

The plutonium inventories estimated from the samples presented in Table 22-2 vary widely. Because the records in the plutonium inventory tracking

system seem to be complete, the total plutonium in Tank AW-105 estimated in it will be used as the baseline plutonium inventory. The supernate concentration measured in the August 1994 samples will be assumed to be the current supernate concentration. The sludge plutonium concentration will be calculated:

$$(17,230 \text{ g} - 10.5 \text{ g}) / ((260,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.75\text{E-}02 \text{ g/L Pu}$$

22.8 Conclusions

The recommended plutonium inventory estimate for Tank AW-105 is 17,230 g. The recommended supernate and sludge concentration values are 3.66×10^{-6} g/L and 1.75×10^{-2} g/L, respectively.

23.0 TANK 241-AW-106 PLUTONIUM INVENTORY

23.1 Tank History

The history indicates that more than 20 major transfers into Tank AW-106 occurred between January 1981 and December 1994. These transfers have been primarily from transfers between the evaporator feed Tank AW-102 and the evaporator receiver Tank AW-106. In addition, Tank AW-106 received transfers from B Plant in 1982, dilute noncomplexed waste from unknown sources in 1981, a transfer of waste from Tank AW-103 in 1983, a transfer from Tank AP-105 in 1988, a transfer from Tank AY-102 in 1989, and transfers from the evaporator mini run in 1993. Currently this tank contains 1.38×10^6 L (364 kgal) of supernatant liquid, 7.99×10^5 L (211 kgal) of sludge, and 3.22×10^5 L (85 kgal) of saltcake.

23.2 Plutonium Tracking System

This system shows no plutonium transfer information, but was assigned a baseline inventory of 43 g on August 5, 1992 (Pitkoff 1992). The plutonium inventory was rebaselined to 304 g on January 1, 1994 (Miles 1994).

23.3 1994 Supernate Sample

A supernate sample was taken from Tank AW-106 on November 14, 1994 at the end of Evaporator Campaign 94-2 (WHC 1994g). The plutonium concentration reported by the laboratory was 4.31×10^{-1} $\mu\text{Ci/L}$. Converting this value to g/L gives:

$$(4.31\text{E-}01 \mu\text{Ci/L}) * (1\text{E-}6 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 6.95\text{E-}6 \text{ g/L}$$

When this sample was taken, Tank AW-106 contained 1.39×10^6 L (366 kgal) supernate, 7.99×10^5 L (211 kgal) sludge and 3.22×10^5 L (85 kgal) saltcake. Using the volume of supernate, the estimated inventory of plutonium in the supernate can be calculated.

$$(6.95\text{E-}06 \text{ g/L}) * (366,000 \text{ gal}) * (3.785 \text{ L/gal}) = 9.6 \text{ g Pu in supernate}$$

23.4 Discussion

No sludge or saltcake samples are available for Tank AW-106. Saltcake usually contains very little plutonium. To be conservative, the plutonium concentration in the saltcake will be assumed to be the same as the concentration in the supernate. This gives a total plutonium inventory in the saltcake of:

$$(6.95\text{E-}06 \text{ g/L}) * (85,000 \text{ gal}) * (3.785 \text{ L/gal}) = 2.2 \text{ g Pu in saltcake}$$

The plutonium concentration of the sludge in Tank AW-106 will be assumed to be similar to the sludge concentration in Tank AW-105. The plutonium

concentration in the sludge of Tank AW-105 is 1.75×10^{-2} g/L. The total plutonium in the sludge of Tank AW-106 is:

$$(1.75\text{E-}02 \text{ g/L}) * (211,000 \text{ gal}) * (3.785 \text{ L/gal}) = 13,976 \text{ g Pu in sludge}$$

The total estimated plutonium inventory in Tank AW-106 is:

$$9.6 \text{ g} + 2.2 \text{ g} + 13,976 \text{ g} = 13,988 \text{ g Pu}$$

23.5 Conclusions

The recommended plutonium inventory for Tank AW-106 is 13,988 g. The recommended concentration estimates for the supernate, sludge, and saltcake are 6.95×10^{-6} g/L, 1.75×10^{-2} g/L, and 6.95×10^{-6} g/L, respectively.

24.0 TANK 241-AY-101 PLUTONIUM INVENTORY

24.1 Tank History

The fill history indicates about seven major transfers or transfer periods to Tank 241-AY-101 (Tank AY-101). These include transfers of dilute noncomplexed waste from B Plant in 1981, dilute complexed waste from B Plant in 1983, waste from Tank AZ-102 in 1984, and miscellaneous smaller transfers from B plant, PUREX, saltwell pumping, and the 300 Area. Currently the tank contains 2.96×10^6 L (781 kgal) of supernatant liquid and 3.14×10^5 L (83 kgal) of sludge. Sample data from January 1987 to the present are expected to provide good characterization data.

24.2 Plutonium Inventory Tracking System

The plutonium tracking system shows data for only three transfers before 1994, one each in 1980, 1983, and 1984. This system was baselined on January 1, 1994 to 635 g (Miles 1994). Currently the plutonium inventory according to the database is 685 g.

24.3 Supernate and Solid Characterization Data from 1985

Two samples were taken from Tank AY-101 in 1985. One was taken from the bottom of the tank (R-3642) and the other was taken 15 ft from the bottom of the tank (R-3641) (Bratzel 1985a and Bratzel 1985b). The results of supernatant and centrate from the centrifuged solids slurry samples are shown in Table 24-1.

Table 24-1. Analyses Results of 1985 Samples from Tank AY-101.

Laboratory	Supernate	Liquid from Centrifuged Solids
Analytical Laboratory	12.1 $\mu\text{Ci/L}$	6.91 $\mu\text{Ci/L}$
Analytical Process Development Unit	4.2 $\mu\text{Ci/L}$	2.4 $\mu\text{Ci/L}$

Converting these values to g/L yields:

$$\begin{aligned}
 (12.1 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) &= 1.95\text{E-}04 \text{ g/L} \\
 (4.2 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) &= 6.77\text{E-}05 \text{ g/L} \\
 (6.91 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) &= 1.11\text{E-}04 \text{ g/L} \\
 (2.4 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) &= 3.87\text{E-}05 \text{ g/L}
 \end{aligned}$$

It is assumed that all of these values should be averaged to obtain the most correct supernate concentration. Averaging these values yields a supernate concentration of 1.03×10^{-4} g/L. The supernate volume at the time of sampling was 2.32×10^6 L (612 kgal), which yields a plutonium supernate inventory of:

$$(1.03\text{E-}04 \text{ g/L}) * (612,000 \text{ gal}) * (3.785 \text{ L/gal}) = 239 \text{ g}$$

24.4 Supernate Samples taken October 1994

Three supernate grab samples were taken from Tank AY-101 on October 3, 1994 (Vogel 1994). The plutonium concentration, shown in Table 24-2, was analyzed for two of the samples.

Table 24-2. Plutonium Concentration in October 1994 Samples.

Sample #	Plutonium Concentration
R-6496	1.51E-02 $\mu\text{Ci/mL}$
R-6497	2.45E-02 $\mu\text{Ci/mL}$

Converting these values to g/L gives plutonium concentrations of:

$$(1.51\text{E-}02 \mu\text{Ci/mL}) * (1\text{E+}03 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.44\text{E-}04 \text{ g/L}$$

$$(2.45\text{E-}02 \mu\text{Ci/mL}) * (1\text{E+}03 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 3.95\text{E-}04 \text{ g/L}$$

Averaging these values gives a plutonium concentration of 3.21×10^{-4} g/L. Multiplying this concentration by the October 1994 supernatant volume of 2.95×10^6 L (780 kgal) gives a plutonium supernate inventory of:

$$(3.21\text{E-}04 \text{ g/L}) * (780,000 \text{ gal}) * (3.785 \text{ L/gal}) = 948 \text{ g Pu}$$

24.5 Sludge Samples taken December 1994

Two sludge samples were taken December 30, 1994. Analyses results have not yet been received.

24.6 Discussion

The supernate samples taken in October 1994 should represent the current plutonium inventory in the supernate. Using the current supernate volume, the plutonium concentration can be calculated:

$$(948 \text{ g Pu}) / ((781,000 \text{ gal}) * (3.785 \text{ L/gal})) = 3.21\text{E-}04 \text{ g/L Pu in supernate}$$

Because the December 1994 sludge samples have not been analyzed yet, the Tank AY-02 sludge plutonium concentration will be used as an estimate of the concentration of the sludge in Tank AY-101. The plutonium concentration of the sludge in Tank AY-102 is 7.13×10^{-2} g/L. This gives a plutonium inventory in the sludge of:

$$(7.13\text{E-}02 \text{ g/L}) * (83,000 \text{ gal}) * (3.785 \text{ L/gal}) = 22,399 \text{ g Pu in sludge}$$

The total plutonium inventory in Tank AY-101 is:

$$(948 \text{ g}) + (22,399 \text{ g}) = 23,347 \text{ g Pu}$$

24.7 Conclusions

The recommended estimate of the plutonium inventory for Tank AY-101 is 23,347 g. The recommended supernate and sludge concentration values are 3.21×10^{-4} g/L and 7.13×10^{-2} g/L, respectively.

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25.0 TANK 241-AY-102 PLUTONIUM INVENTORY

25.1 Tank History

The fill history indicates more than 25 major transfers of waste into Tank 241-AY-102 (Tank AY-102). This tank has functioned as a receiver tank for dilute noncomplexed miscellaneous waste. Most of the transfers out of this tank were sent to Tank AW-102. The current volumes of this tank consist of 2.92×10^6 L (772 kgal) of supernatant liquid and 1.21×10^5 L (32 kgal) of sludge. Good characterization of this tank would require recent supernate and sludge samples.

25.2 Plutonium Inventory Tracking System

The plutonium tracking system shows fairly complete but unorganized transfer data back to December 1987. However, this system is suspected to be somewhat incomplete, with missing transfer records. The system was rebaselined twice, once in March 1992 (Vail 1992c) and again in January 1994 (Miles 1994). This system shows a current plutonium inventory of 10.02 kg.

25.3 Core Sample Taken June 1987

A two-segment core sample was taken during June 1987 (Stegen 1987). The lower segment consisted of solids from the bottom of the tank and the top segment consisted of supernate from just above the sludge layer. The results of the radiochemical analysis of the solids are presented in Scott 1988. The plutonium concentration reported is 3.0×10^3 nCi/g. The reported density of the solids is 1.3 g/mL. Converting this value to g/L gives a solids plutonium concentration of:

$$(3.0\text{E}+03 \text{ nCi/g}) \cdot (1300 \text{ g/L}) \cdot (1\text{E}-09 \text{ Ci/nCi}) / (0.062 \text{ Ci/g}) = 6.29\text{E}-02 \text{ g/L}$$

Both the solids and supernate samples are reported in Peterson 1990b. The plutonium concentration in the supernate was 2.34×10^{-4} $\mu\text{Ci/mL}$. The plutonium concentration in the composite solids was 3.61 $\mu\text{Ci/g}$. The reported solids density is 1.4 g/mL. Converting both of these values to g/L gives plutonium concentrations of:

$$(2.34\text{E}-04 \text{ } \mu\text{Ci/mL}) \cdot (1000 \text{ mL/L}) \cdot (1\text{E}-06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 3.77\text{E}-06 \text{ g/L}$$

Pu in supernate

$$(3.61 \text{ } \mu\text{Ci/g}) \cdot (1400 \text{ g/L}) \cdot (1\text{E}-06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 8.15\text{E}-02 \text{ g/L Pu}$$

in solids

When this sample was taken, Tank AY-102 contained 3.29×10^6 L (869 kgal) of supernate and 1.06×10^5 L (28 kgal) of sludge. Using these volumes give plutonium inventories of:

$$(3.77\text{E}-06 \text{ g/L}) \cdot (869,000 \text{ gal}) \cdot (3.785 \text{ L/gal}) = 12 \text{ g Pu in supernate}$$

$$(8.15\text{E}-02 \text{ g/L}) \cdot (28,000 \text{ gal}) \cdot (3.785 \text{ L/gal}) = 8,637 \text{ g Pu in sludge}$$

25.4 June 1994 Supernate Samples

On June 10, 1994, three supernate samples were taken from Tank AY-102 (WHC 1994a, WHC 1994b, WHC 1994c and WHC 1994d). The analyses results are listed in Table 25-1.

Table 25-1. Analyses Results of Supernate Samples Taken June 10, 1994.

<u>Sample No.</u>	<u>Pu Concentration</u>
R-5392	<1.45E-05 $\mu\text{Ci/mL}$
R-5393	<1.35E-05 $\mu\text{Ci/mL}$
R-5394	<1.56E-05 $\mu\text{Ci/mL}$
R-5395	5.19E-05 $\mu\text{Ci/mL}$

To be conservative, the plutonium value for Sample R-5395 will be used. Converting this value to g/L gives a plutonium concentration of:

$$(5.19\text{E-}05 \mu\text{Ci/mL}) * (1000 \text{ mL/L}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 8.37\text{E-}07 \text{ g/L}$$

Using the June 1994 supernate volume of $2.64 \times 10^6 \text{ L}$ (698 kgal) gives a plutonium inventory of:

$$(8.37\text{E-}7 \text{ g/L}) * (698,000 \text{ gal}) * (3.785 \text{ L/gal}) = 2.2 \text{ g Pu in supernate}$$

25.5 December 1994 Solids Samples

Samples were taken in December 1994 of Tank AY-102 solids. Results of the analysis have not yet been received.

25.6 Discussion

Because the sludge sample taken in 1987 is the latest available, it will be used to determine the plutonium inventory in the sludge. Waste has been transferred from Tank AY-102 since this sample was taken, but it is believed that the current plutonium concentration in the sludge should be similar to that in 1987. The most recent supernate sample should be used for the supernate plutonium inventory. Therefore the plutonium inventory in Tank AY-102 is:

$$2.2 \text{ g} + 8,637 \text{ g} = 8,639 \text{ g Pu in AY-102}$$

The current volumes of supernate and sludge will be used to calculate the current plutonium concentrations of the supernate and sludge.

$$(2.2 \text{ g Pu}) / ((772,000 \text{ gal}) * (3.785 \text{ L/gal})) = 7.53\text{E-}07 \text{ g/L in supernate}$$

$$(8,639 \text{ g Pu}) / ((32,000 \text{ gal}) * (3.785 \text{ L/gal})) = 7.13\text{E-}02 \text{ g/L in sludge}$$

25.7 Conclusions

The recommended estimate of the plutonium inventory for Tank AY-102 is 8,639 g. The recommended plutonium supernate and sludge concentration values are 7.53×10^{-7} g/L and 7.13×10^{-2} g/L, respectively.

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26.0 TANK 241-AZ-101 PLUTONIUM INVENTORY

26.1 Tank History

The fill history of Tank 241-AZ-101 (Tank AZ-101) indicates several large transfers and many smaller transfers consisting of waste from Tank SY-102 in 1982, Tank AY-102 in 1983, and PUREX Aging Waste in 1985 and 1986. A large water addition occurred in 1989. In addition to these transfers, many small transfers of dilute noncomplexed waste have occurred. The tank currently contains 3.52×10^6 L (930 kgal) of supernatant liquid and 1.32×10^5 L (35 kgal) of sludge.

26.2 Plutonium Inventory Tracking System

This system indicates records for the transfer of 9,800 g of plutonium into Tank AZ-101. About 80 records show individual transfers from July 1985 to October 1990. However, the system was rebaselined to 17.0 kg on July 7, 1992 (Dodd 1992). The plutonium inventory was rebaselined again on January 1, 1994 to 13.6 kg (Miles 1994).

26.3 Core Sample Taken April and May 1989

Two core samples were taken from Tank AZ-101 in April and May 1989. The first core sample contained two segments consisting of both supernate and solids (Peterson 1989). A composite was made from the two segments and the supernate and solids were centrifuged. The reported plutonium concentration of the supernate is 4.3×10^{-7} mCi/g with a density of 1.2 g/mL. The solids have a plutonium concentration of 4.4×10^{-3} mCi/g with a density of 1.7 g/mL. Converting these values to g/L gives plutonium concentrations of:

$$(4.3\text{E-}07 \text{ mCi/g}) \cdot (1\text{E-}03 \text{ Ci/mCi}) \cdot (1200 \text{ g/L}) / (0.062 \text{ Ci/g}) = 8.32\text{E-}06 \text{ g/L in supernate}$$

$$(4.4\text{E-}03 \text{ mCi/g}) \cdot (1\text{E-}3 \text{ Ci/mCi}) \cdot (1700 \text{ g/L}) / (0.062 \text{ Ci/g}) = 0.12 \text{ g/L in solids}$$

The second core sample consisted of two segments containing supernate and solids (Gray et al. 1993a). The bottom segment contained solids and no drainable liquid. The top segment consisted of drainable liquid and solids. The plutonium concentrations of the solids and liquids were 101 $\mu\text{g/g}$ and 0.0154 $\mu\text{g/g}$, respectively. The density of the solids was 1.73 g/mL and the density of the liquids was 1.22 g/mL. Using this information, the plutonium concentration can be calculated in g/L.

$$(0.0154 \text{ } \mu\text{g/g}) \cdot (1220 \text{ g/L}) \cdot (1\text{E-}06 \text{ g/} \mu\text{g}) = 1.88\text{E-}05 \text{ g/L in supernate}$$

$$(101 \text{ } \mu\text{g/g}) \cdot (1730 \text{ g/L}) \cdot (1\text{E-}06 \text{ g/} \mu\text{g}) = 0.17 \text{ g/L in solids}$$

The average supernate plutonium concentration calculated from both core samples is 1.36×10^{-5} g/L. The average solids plutonium concentration is

0.145 g/L. When these samples were taken, Tank AZ-101 contained 2.93×10^6 L (773 kgal) of supernatant and 1.32×10^5 L (35 kgal) of sludge. Using these values gives the plutonium inventory at the time these samples were taken:

$$(1.36\text{E-}05 \text{ g/L}) * (773,000 \text{ gal}) * (3.785 \text{ L/gal}) = 40 \text{ g Pu in supernate}$$

$$(0.145 \text{ g/L}) * (35,000 \text{ gal}) * (3.785 \text{ L/gal}) = 19,209 \text{ g Pu in solids}$$

26.4 Discussion

Since these samples were taken the main transfers into and out of the tank have been water (Koreski 1994). Therefore the total inventory should be close to what it was in 1989:

$$(40 \text{ g in supernate}) + (19,209 \text{ g in solids}) = 19,249 \text{ g Pu}$$

Using the current volumes of sludge and supernate gives the current plutonium concentration in the sludge and supernate:

$$(40 \text{ g Pu}) / ((930,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.14\text{E-}05 \text{ g/L in supernate}$$

$$(19,209 \text{ g Pu}) / ((35,000 \text{ gal}) * (3.785 \text{ L/gal})) = 0.145 \text{ g/L in solids}$$

26.5 Conclusions

The recommended current inventory estimate for Tank AZ-101 is 19,249 g. The recommended supernate and sludge concentration values are 1.14×10^{-5} g/L and 0.145 g/L, respectively.

27.0 TANK 241-AZ-102 PLUTONIUM INVENTORY

27.1 Tank History

The fill history indicates eight major transfers to Tank 241-AZ-102 (Tank AZ-102). These all occurred before July 1989. These transfers were from Tank AY-101, Tank AN-104, Tank AW-105, Tank AN-101, Tank SY-102, PUREX miscellaneous, water addition, and PUREX aging waste. Currently the tank contains 3.22×10^6 L (851 kgal) of supernatant liquids and 3.60×10^5 L (95 kgal) of sludge. This waste consist of approximately 1.51×10^6 L (400 kgal) of aging waste, with the remainder consisting of dilute noncomplexed waste. This history indicates that supernate and sludge samples taken after July 1989 should provide good characterization data.

27.2 Plutonium Inventory Tracking System

This system indicates fairly complete records for the transfer of 8,790 g of plutonium into Tank AZ-102. The system has about 200 records from March 1986 to June 1993 of transfers into this tank. This system was baselined on November 16, 1992 to 8,772.7 g (Vail 1992f). It was also rebaselined to 31,307 g on January 1, 1994 (Miles 1994). Currently the tracking system shows a plutonium inventory in Tank AZ-102 of 31,307 g.

27.3 1985 Sludge Samples

A sludge sample was taken from the bottom of settled Tank AZ-102 on November 5, 1985 (Mauss 1986). Results from this sample indicate a plutonium concentration of 7.22×10^{-5} g/L for the supernate, 2.41×10^{-2} g/L for the centrifuged solids, 9.69×10^{-5} g/L for slurry, and 1.14×10^{-2} g/L for the calculated slurry.

The supernate contents have changed since these samples were taken, so the supernate concentration of 7.22×10^{-5} g/L is probably not representative of the present supernate in this tank. However, the centrifuged solids concentration of 2.41×10^{-2} g/L is likely to be representative of the sludge. Using the volume in the tank in May 1985 will give the inventory of plutonium when this sample was taken. There was 9.8×10^4 L (26 kgal) sludge and 8.71×10^5 L (230 kgal) supernate.

$$(7.22\text{E-}05 \text{ g/L}) \times (230,000 \text{ gal}) \times (3.785 \text{ L/gal}) = 63 \text{ g Pu in supernate}$$

$$(2.41\text{E-}02 \text{ g/L}) \times (26,000 \text{ gal}) \times (3.785 \text{ L/gal}) = 2,372 \text{ g Pu in sludge}$$

27.4 August 1989 Two Segment Core Sample

During July and August 1989 a core sample was taken from Tank AZ-102 (Gray et al. 1993b). This core sample consisted of two segments containing solids and drainable liquid. The supernate and solids from the two segments were combined to form a core composite sample. The plutonium concentration was measured on the centrifuged supernate and solids from the core composite.

The plutonium concentration in the supernate was 0.450 $\mu\text{g/g}$. The concentration of plutonium in the solids was 59.6 $\mu\text{g/g}$. The reported densities of the solids and supernate are 1.73 g/mL and 1.05 g/mL, respectively. Converting these concentrations to g/L gives plutonium concentrations of:

$$(0.450 \mu\text{g/g}) * (1\text{E-}06 \text{ g}/\mu\text{g}) * (1050 \text{ g/L}) = 4.73\text{E-}04 \text{ g/L Pu in supernate}$$

$$(59.6 \mu\text{g/g}) * (1\text{E-}06 \text{ g}/\mu\text{g}) * (1730 \text{ g/L}) = 1.03\text{E-}01 \text{ g/L Pu in sludge}$$

Correcting the solids concentration for 3.4 wt% dissolved solids yields:

$$(1.03\text{E-}01 \text{ g/L}) / (1.0 - 0.034) = 1.07\text{E-}01 \text{ g/L}$$

At the time these samples were taken, Tank AZ-102 contained 3.22×10^6 L (852 kgal) supernate and 3.33×10^5 L (88 kgal) sludge. Using these concentration values and the weight percent of solids that were centrifuged (72 wt%) in the sludge inventory estimate yields the following plutonium inventory estimates:

$$(4.73\text{E-}04 \text{ g/L}) * (852,000 \text{ gal}) * (3.785 \text{ L/gal}) = 1,525 \text{ g Pu in supernate}$$

$$(1.07\text{E-}01 \text{ g/L}) * (88,000 \text{ gal}) * (0.72) * (3.785 \text{ L/gal}) = 25,661 \text{ g Pu in sludge}$$

$$\text{Total plutonium inventory estimate} = 1,525 + 25,661 = 27,186 \text{ g Pu}$$

27.5 Discussion

The plutonium inventory tracking system estimate is viewed with the possibility that perhaps not all transfer data have been recorded. The 1985 characterization data are not representative of the current tank composition. This leaves the analysis of the 1989 characterization data. Using the total supernate and sludge plutonium inventories along with the current volumes of each in Tank AZ-102 will give the current plutonium concentrations:

$$(1,525 \text{ g}) / ((851,000 \text{ gal}) * (3.785 \text{ L/gal})) = 4.73\text{E-}04 \text{ g/L in supernate}$$

$$(25,661 \text{ g}) / ((95,000 \text{ gal}) * (3.785 \text{ L/gal})) = 7.14\text{E-}02 \text{ g/L in sludge}$$

27.6 Conclusions

The recommended current inventory estimate for Tank AZ-102 is 27,186 g. The recommended supernate and sludge concentration values are 4.73×10^{-4} g/L and 7.14×10^{-2} g/L, respectively.

28.0 TANK 241-SY-101 PLUTONIUM INVENTORY

28.1 Tank History

The fill history indicates four major transfers of waste into Tank 241-SY-101 (Tank SY-101). All of these occurred before 1982. These transfers were DSS from unknown sources in 1977, concentrated complexed waste in January 1978, concentrated complexed waste in July 1978, and DSS from unknown sources in 1981. Since 1982, this tank has experienced very little activity likely to have a significant effect on the plutonium inventory. Currently this tank contains 2.65×10^4 L (7 kgal) of supernatant liquid, 2.01×10^6 L (530 kgal) of DSS, and 2.12×10^6 L (560 kgal) of saltcake.

28.2 Plutonium Inventory Tracking System

The plutonium tracking system shows no transfers. The inventory was baselined at 910 g on April 3 1992 (Reynolds 1992a). It was rebaselined again on January 1, 1994 to the same total plutonium inventory (Miles 1994).

28.3 May 1991 Core Sample

In May 1991 a single full-depth core samples was taken of Tank SY-101. This sample contained 22 segments (Reynolds 1992b). In addition to this core sample, four other segments were taken from the tank. The plutonium was measured in the composites of the core segments. According to Reynolds (1992a) and Reynolds (1992b), the best estimate of the total plutonium inventory based on the core sample is 910 g. The basis of this estimate is taken from Reynolds (1992a) and listed in Table 28-1.

Table 28-1. May 1991 Core Sample.

Composite No.	Pu Conc. (g/gal)	Inches Represented	Gallons Represented (in*2750 gal/in)	Total Pu (g)
1	0.00010	95	261,000	26
2	0.00016	86	236,500	38
3	0.00134	86	236,500	317
4	0.00165	76	209,000	345

The amount of plutonium totals 726 g of plutonium in the 8.69 m (342 in.) represented by the composites. To estimate the total inventory, the missing segments were estimated at the same composition as the composite that they would fit into. The crust was measured as Composite 5 (Herting 1992). This was used for Segments 1, 2, and 3. A density for the crust was estimated as 1.4 g/mL. The three segments represent 1.12 m (44 in.) of waste. This would

represent 176 g of plutonium. The other missing segment is Segment 12, which is in the convective layer. It is estimated that the waste in this segment contains 8 g of plutonium. The best estimate of the total plutonium inventory based on this core sample is 910 g (Reynolds 1992a).

28.4 December 1991 Core Sample

A full-depth core sample was taken of Tank 241-SY-101 in December 1991 (Reynolds 1993). The sample was taken from riser 11B, which is on the opposite side of the tank from the sample taken in May 1991. The reported average plutonium concentration in the solid phase and bulk composite samples is 0.0128 $\mu\text{Ci/g}$. The average density for the tank calculated from measurements on whole tank composites is 1.67 g/mL. This value converts to a plutonium concentration in g/L of:

$$(0.0128 \mu\text{Ci/g}) * (1670 \text{ g/L}) * (1\text{E-}6 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 3.45\text{E-}04 \text{ g/L}$$

Using this value and volume of the tank at the time the samples were taken (1,127,500 gal) gives a total plutonium inventory of:

$$(3.45\text{E-}04 \text{ g/L}) * (1,127,500 \text{ gal}) * (3.785 \text{ L/gal}) = 1472 \text{ g Pu}$$

28.5 Discussion

The plutonium inventory estimates from both of the core samples are similar. The data from the May 1991 core sample were not as complete as the data from the December 1991 core sample. Because the December 1991 plutonium inventory estimate is more conservative, it is suggested that it is used. Using the current tank volume of $4.15 \times 10^6 \text{ L}$ (1097 kgal) gives a plutonium concentration of:

$$(1472 \text{ g Pu}) / ((1,097,000 \text{ gal}) * (3.785 \text{ L/gal})) = 3.55\text{E-}04 \text{ g/L}$$

28.6 Conclusions

The recommended estimate of the plutonium inventory for Tank SY-101 is 1,472 g. The recommended average plutonium concentration estimate is $3.55 \times 10^{-4} \text{ g/L}$.

29.0 TANK 241-SY-102 PLUTONIUM INVENTORY

29.1 Tank History

The fill history indicates 12 major transfers into Tank SY-102. All of these waste gains were dilute noncomplexed waste from West Area generators: T Plant, S Plant, 200 West Area single-shell tank (SST) stabilization, and PFP processing. The waste transfers out of this tank were to Tanks AW-101, AW-102, AZ-101, AN-102, AN-103, AZ-102, and AY-102. The tank has experienced a few gains since the end of 1989 but no major losses. Currently this tank contains 2.61×10^6 L (690 kgal) of supernatant liquid and 2.69×10^5 L (71 kgal) of sludge.

29.2 Plutonium Inventory Tracking System

This system has records covering a period from July 1989 to the present. It appears that some transfers may be missing. The plutonium inventory in July 1989 was 37,000 g. The inventory was rebaselined to 42,000 g on February 28, 1992 (Vail 1992a). The inventory was rebaselined again on January 1, 1994 to 64,900 g plutonium (Miles 1994).

29.3 October 1988 Four-Segment Core Sample

A four-segment core sample was taken from SY-102 in October 1988 (Peterson 1990a). The bottom 1.96 m (76 in.) of the tank are presented. Each sample was 0.48 m (19 in.) long and represents the bottom 7.91×10^5 L (209 kgal). These samples are identified along with the reported concentrations in Table 29-1.

Table 29-1. October 1988 Core Sample.

Sample ID	Description	Pu Conc. (Density)	Source
102-SY-1-2	Supernate, Composite of Segment 1 and 2	0.16 $\mu\text{Ci/L}$ (1.02 g/mL)	Weiss 1990b
102-SY-3C	Segment 3	9.73 $\mu\text{Ci/g}$ (1.29 g/mL)	Peterson 1990a
102-SY-3T4S	Centrifuged solids from the composite of Segment 3 and the top portion of Segment 4		
102-SY-3T4L	Centrifuged supernate from the composite of Segment 3 and the top portion of Segment 4	0.16 $\mu\text{Ci/L}$ (1.18 g/mL)	Weiss 1990b
102-SY-T4C	Top portion of Segment 4	2.82 $\mu\text{Ci/g}$ (1.52 g/mL)	Peterson 1990a
102-SY-4B	Bottom portion of Segment 4	0.13 $\mu\text{Ci/g}$ (1.89 g/mL)	Peterson 1990a

It will be assumed that the composite of Segments 1 and 2 is characteristic of the entire tank contents above 0.92 m (38 in.) or a volume of 2.35×10^6 L (620.4 kgal). Likewise, it is assumed that Segment 3 is characteristic of a total volume of 1.98×10^5 L (52.25 kgal), the top portion of Segment 4 is characteristic of 0.24 m (9.5 in.) or a volume of 9.89×10^4 L (26.125 kgal),

and the bottom portion of Segment 4 is characteristic of 9.89×10^4 L (26.125 kgal) at the bottom of the tank (Weiss 1990b). Converting the concentrations in Table 29-1 to g/L gives plutonium concentrations of:

$$\begin{aligned} 1-2: & (0.16 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.58\text{E-}06 \text{ g/L} \\ 3\text{C}: & (9.73 \mu\text{Ci/g}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1290 \text{ g/L}) / (0.062 \text{ Ci/g}) = 0.20 \text{ g/L} \\ 3\text{T4L}: & (0.16 \mu\text{Ci/L}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) / (0.062 \text{ Ci/g}) = 2.58\text{E-}06 \text{ g/L} \\ 4\text{C}: & (2.82 \mu\text{Ci/g}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1520 \text{ g/L}) / (0.062 \text{ Ci/g}) = 0.07 \text{ g/L} \\ 4\text{B}: & (0.13 \mu\text{Ci/g}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1890 \text{ g/L}) / (0.062 \text{ Ci/g}) = 3.96\text{E-}03 \text{ g/L} \end{aligned}$$

Using these concentration values to compute the plutonium inventory estimate yields:

$$\begin{aligned} (2.58\text{E-}06 \text{ g/L}) * (620,400 \text{ gal}) * (3.785 \text{ L/gal}) &= 6 \text{ g} \\ (0.20 \text{ g/L}) * (52,250 \text{ gal}) * (3.785 \text{ L/gal}) &= 39,553 \text{ g} \\ (0.07 \text{ g/L}) * (26,125 \text{ gal}) * (3.785 \text{ L/gal}) &= 6,657 \text{ g} \\ (3.96\text{E-}03 \text{ g/L}) * (26,125 \text{ gal}) * (3.785 \text{ L/gal}) &= 392 \text{ g} \end{aligned}$$

$$\text{Total inventory estimate} = 6 + 39,553 + 6,657 + 392 = 46,608 \text{ g}$$

29.4 February and March 1990 Core Sample

Tank SY-102 was sampled in February and March of 1990 using the push mode core sampling method (LATA 1995). Two core samples, each consisting of four segments, were obtained from the tank. Core 17 consisted of two segments of supernate, two segments of sludge and one empty segment. For Core 16, a 50-gram composite sample was derived from all four extruded segments. After this composite sample was centrifuged, the supernate was separated from the solids. LATA (1995) reports a summary of the data obtained from the analyses of the centrifuged solids samples derived from the sludge. The reported plutonium concentration is $6.11 \mu\text{Ci/g}$ with a density of 1.56 g/mL . Converting this concentration to g/L yields:

$$(6.11 \mu\text{Ci/g}) * (1.0\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1560 \text{ g/L}) / (0.062 \text{ Ci/g}) = 0.15 \text{ g/L Pu in sludge}$$

When these samples were taken, the tank contained 2.69×10^5 L (71 kgal) of sludge. Using this volume, the total plutonium inventory in the sludge can be calculated:

$$(0.15 \text{ g/L}) * (71,000 \text{ gal}) * (3.785 \text{ L/gal}) = 41,385 \text{ g Pu in sludge}$$

29.5 March 1994 Supernate Grab Sample

On March 10, 1994, a liquid grab sample was obtained from Riser 1A of Tank SY-102 (Sutey 1994). The sample was taken 10.19 m (401 in.) from the bottom of the tank. The reported plutonium concentration in the sample was $3.09\text{E-}4 \mu\text{Ci/mL}$. Converting this concentration to g/L gives a plutonium concentration of:

$$(3.09\text{E-}04 \mu\text{Ci/mL}) * (1\text{E-}06 \text{ Ci}/\mu\text{Ci}) * (1000 \text{ mL/L}) / (0.062 \text{ Ci/g}) = 4.98\text{E-}06 \text{ g/L in supernate}$$

The tank contained 1.89×10^6 L (500 kgal) of supernate when this sample was taken. Using this volume and the calculated plutonium concentration, a total plutonium inventory in the supernate can be calculated:

$$(4.98\text{E-}06 \text{ g/L}) * (506,000 \text{ gal}) * (3.785 \text{ L/gal}) = 9.5 \text{ g Pu in supernate}$$

29.6 Discussion

The most recent sludge and supernate samples taken should represent what is currently in Tank SY-102. Using the plutonium concentration from the core sample taken in March 1990 for the sludge inventory, the concentration from the March 1994 supernate sample and the current tank volume will give a current inventory and plutonium concentration in Tank SY-102. The total plutonium inventory in the tank is:

$$9.5 \text{ g} + 41,385 \text{ g} = 41,395 \text{ g Pu in SY-102}$$

The calculated concentration of plutonium in the supernate is:

$$(9.5 \text{ g}) / ((690,000 \text{ gal}) * (3.785 \text{ L/gal})) = 3.64\text{E-}06 \text{ g/L}$$

The calculated concentration of plutonium in the sludge is:

$$(41,385 \text{ g}) / ((71,000 \text{ gal}) * (3.785 \text{ L/gal})) = 0.15 \text{ g/L}$$

29.7 Conclusions

The recommended estimate of the plutonium inventory for Tank SY-102 is 41,395 g. The recommended estimates of plutonium supernate and sludge concentration values are 3.64×10^{-6} g/L and 0.15 g/L, respectively.

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30.0 TANK 241-SY-103 PLUTONIUM INVENTORY

30.1 Tank History

The fill history indicates four major transfers of waste into Tank 241-SY-103 (Tank SY-103) and no major transfers out of this tank. The transfers into the tank consisted of concentrated complexed and DSS from unknown sources before January 1980, DSS near the end of 1980, and 200 West Area complexed SWL in 1985 and 1988. This tank has experienced little activity since the end of 1988. Currently the tank contains 6.55×10^5 L (173 kgal) of supernatant liquid, 2.17×10^6 L (573 kgal) of DSS, and 1.51×10^4 L (4 kgal) of saltcake.

30.2 Plutonium Inventory Tracking System

The plutonium inventory tracking system shows no transfers before January 1994. The database was baselined on January 1, 1994 to 2,313 g of plutonium (Miles 1994).

30.3 Core Sample Taken August 1986

A 12-segment core sample of Tank SY-103 was taken in August 1986. At the time of this sample, the contents of this tank, including three types of waste, totaled 2.2×10^6 L (585,750 gal) (Fow et al. 1986). The bottom 1.14 m (45 in.) or 4.68×10^5 L (123,750 gal) contain CC, the middle 3.43 m (135 in.) or 1.41×10^6 L (371,250 gal) contain DSS, and the remaining 0.84 m (33 in.) or 3.43×10^5 L (90,750 gal) contain uranium sludge. Three segments (Segments 2, 7, and 12) were chosen as being representative samples of each waste layer. Segment 2 was considered a representative sample from the uranium sludge layer. Segment 7 is characteristic of the DSS layer. Segment 12 consists of the CC layer. The reported plutonium concentrations, along with the densities of each sample, are listed in Table 30-1.

Table 30-1. Plutonium Concentrations and Densities.

Sample No.	Pu Concentration	Density
2	$3.81\text{E-}05$ mCi/g	1.52 g/mL
7	$7.03\text{E-}05$ mCi/g	1.54 g/mL
12	$7.38\text{E-}05$ mCi/g	1.60 g/mL

Converting these values to g/L gives plutonium concentrations of:

$$(\mathbf{3.81\text{E-}05 \text{ mCi/g}}) * (\mathbf{1\text{E-}03 \text{ Ci/mCi}}) * (\mathbf{1520 \text{ g/mL}}) / (\mathbf{0.062 \text{ Ci/g}}) = \mathbf{9.34\text{E-}04 \text{ g/L}} \\ \text{in Segment 2}$$

$$(\mathbf{7.03\text{E-}05 \text{ mCi/g}}) * (\mathbf{1\text{E-}03 \text{ Ci/mCi}}) * (\mathbf{1540 \text{ g/mL}}) / (\mathbf{0.062 \text{ Ci/g}}) = \mathbf{1.75\text{E-}03 \text{ g/L}} \\ \text{in Segment 7}$$

$$(\mathbf{7.38\text{E-}05 \text{ mCi/g}}) * (\mathbf{1\text{E-}03 \text{ Ci/mCi}}) * (\mathbf{1600 \text{ g/mL}}) / (\mathbf{0.062 \text{ Ci/g}}) = \mathbf{1.90\text{E-}03 \text{ g/L}} \\ \text{in Segment 12}$$

Using these values with their associated waste volumes gives the total plutonium inventory when the samples were taken:

$$\begin{aligned}(9.34\text{E-}04 \text{ g/L}) * (90,750 \text{ gal}) * (3.785 \text{ L/gal}) &= 321 \text{ g Pu in U sludge} \\ (1.75\text{E-}03 \text{ g/L}) * (371,250 \text{ gal}) * (3.785 \text{ L/gal}) &= 2,459 \text{ g Pu in DSS} \\ (1.90\text{E-}03 \text{ g/L}) * (123,750 \text{ gal}) * (3.785 \text{ L/gal}) &= 890 \text{ g Pu in CC}\end{aligned}$$

$$\text{Total Pu} = 321 \text{ g} + 2,459 \text{ g} + 890 \text{ g} = 3,670 \text{ g Pu}$$

30.4 Core Sample Taken August and September 1994

A 15-segment core sample was taken from Tank SY-103 in August and September 1994 (Rice 1994). Analyses have begun on the samples, but results for plutonium concentrations have not been released.

30.5 Discussion

Because the August 1986 core sample is the latest sample taken from Tank SY-103, it will have to be used as the basis for the tank's inventory. As soon as the results are received, the August and September 1994 samples can be used to rebaseline the plutonium inventory. Using the current DSS volume of $2.17 \times 10^6 \text{ L}$ (573 kgal) gives a plutonium concentration in the DSS of:

$$(2,459 \text{ g Pu}) / ((573,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.13\text{E-}03 \text{ g/L}$$

It will be assumed that the remaining plutonium is in the supernate and saltcake. The combined volume of the supernate and saltcake is $6.70 \times 10^5 \text{ L}$ (177 kgal). Using this volume gives a plutonium concentration in the supernate and saltcake of:

$$(1,211 \text{ g Pu}) / ((177,000 \text{ gal}) * (3.785 \text{ L/gal})) = 1.81\text{E-}03 \text{ g/L}$$

30.6 Conclusions

The recommended estimate of the plutonium inventory for Tank SY-103 is 3,670 g. The recommended estimates of plutonium concentration in the supernate, DSS, and sludge are $1.81 \times 10^{-3} \text{ g/L}$, $1.13 \times 10^{-3} \text{ g/L}$, and $1.81 \times 10^{-3} \text{ g/L}$, respectively.

31.0 SINGLE-SHELL TANK INVENTORY ESTIMATES

This estimate uses a summary of the plutonium inventory in the DSTs as shown in Table 31-1. This table indicates the waste type; current volumes of supernate, DSS, sludge, and saltcake waste; estimated concentrations of each waste type; and the total plutonium inventory estimate. This table is the basis of estimates of expected average concentrations for supernate, sludge, and saltcake found in the SSTs. The estimates obtained are based on weighted averages of the different DST waste types. These estimates are presented in Table 31-2. The prediction of total SST inventory of 854 kg, which combined with the total inventory for the DSTs of 224 kg, yields a total tank inventory of 1,078 kg. This compares with the total plutonium inventory estimate of 981 kg obtained by subtracting the total recovered plutonium at the Hanford Site and a few known losses from the total plutonium production (Roetman et al. 1994). This agreement is excellent and indicates that while an estimate for a given tank may vary considerably from the actual plutonium content, the overall assessment should be fairly reliable.

Table 31-1. Double Shell Tank Plutonium Concentrations and Estimates.

Tank	Waste Type	Supernate Volume (kgal)	DSS Volume (kgal)	Sludge Volume (kgal)	Salt-cake Volume (kgal)	Supernate Conc. (g/L)	DSS Conc. (g/L)	Sludge Conc. (g/L)	Salt-cake Conc. (g/L)	Pu Inv. Est. (g)
AN-101	DN	859	0	0	0	5.14E-07	0	0	0	1.7
AN-102	CC	993	0	89	0	1.16E-03	0	2.40E-03	0	5,182
AN-103	DSS	15	937	0	0	1.94E-05	1.94E-05	0	0	70
AN-104	DSSF	797	0	264	0	1.68E-04	0	5.07E-03	0	5,573
AN-105	DSSF	1128	0	0	0	3.27E-05	0	0	0	140
AN-106	DSSF	403	0	17	0	1.18E-05	0	5.07E-03	0	344
AN-107	CC	926	0	134	0	5.70E-04	0	2.13E-03	0	3,077
Totals		5121	937	504	0					14,388
AP-101	DN	149	0	0	0	5.67E-06	0	0	0	3
AP-102	CP	1101	0	0	0	1.22E-06	0	0	0	5
AP-103	DN	27	0	0	0	2.94E-07	0	0	0	0.03
AP-104	DN	18	0	0	0	1.47E-08	0	0	0	0.001
AP-105	DSSF	819	0	0	0	2.58E-06	0	0	0	8
AP-106	DN	1126	0	0	0	2.11E-06	0	0	0	9
AP-107	DN	161	0	0	0	1.81E-06	0	0	0	1
AP-108	DN	793	0	0	0	2.23E-06	0	0	0	7
Totals		4194	0	0	0					33

Table 31-1. Double Shell Tank Plutonium Concentrations and Estimates.

Tank	Waste Type	Supernate Volume (kgal)	DSS Volume (kgal)	Sludge Volume (kgal)	Salt-cake Volume (kgal)	Supernate Conc. (g/L)	DSS Conc. (g/L)	Sludge Conc. (g/L)	Salt-cake Conc. (g/L)	Pu Inv. Est. (g)
AW-101	DSSF	1039	0	84	0	1.85E-05	0	1.07E-02	0	3,490
AW-102	DN	85	0	1	0	1.61E-06	0	1.07E-02	0	41
AW-103	DN/PD	152	0	363	0	3.48E-07	0	3.26E-02	0	44,791
AW-104	DN	833	0	179	111	2.54E-07	0	7.91E-03	6.95E-06	5,360
AW-105	DN/PD	82	0	260	0	3.66E-06	0	1.75E-02	0	17,230
AW-106	DN	364	0	211	85	6.95E-06	0	1.75E-02	6.95E-06	13,988
Totals		2555	0	1098	196					84,900
AW-101	DC	781	0	83	0	3.21E-04	0	7.13E-02	0	23,347
AY-102	DN	772	0	32	0	7.53E-07	0	7.13E-02	0	8,639
Totals		1553	0	115	0					31,986
AZ-101	AGING	930	0	35	0	1.14E-05	0	1.45E-01	0	19,249
AZ-102	AGING	851	0	95	0	4.73E-04	0	7.14E-02	0	27,186
Totals		1781	0	130	0					46,435

Table 31-1. Double Shell Tank Plutonium Concentrations and Estimates.

Tank	Waste Type	Supernate Volume (kgal)	DSS Volume (kgal)	Sludge Volume (kgal)	Salt-cake Volume (kgal)	Supernate Conc. (g/L)	DSS Conc. (g/L)	Sludge Conc. (g/L)	Salt-cake Conc. (g/L)	Pu Inv. Est. (g)
SY-101	CC	7	530	0	560	3.55E-04	3.55E-04	0	3.55E-04	1,472
SY-102	DN/PT	690	0	71	0	3.64E-06	0	1.50E-01	0	41,395
SY-103	CC	173	573	0	4	1.81E-03	1.13E-03	0	1.81E-03	3,670
Totals		833	1103	71	564					46,537
Grand Total										224,279

Table 31-2. Estimated Average Concentration for Various Waste Types.

Waste Type	Supernate Conc. (g/L)	DSS Conc. (g/L)	Sludge Conc. (g/L)	Saltcake Conc. (g/L)
DN	1.77E-06	N/A	1.75E-02	6.95E-06
CC	9.51E-04	7.58E-04	2.24E-03	3.65E-04
DSSF	4.89E-05	1.94E-05	5.07E-03	N/A
CP	1.22E-06	N/A	N/A	N/A
DC	3.21E-04	N/A	7.13E-02	N/A
AGING	2.32E-04	N/A	9.12E-02	N/A
PD/PN/PT	3.09E-06	N/A	3.91E-02	N/A

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²Document is titled incorrectly. Tank 241-AP-106 is a double shell tank.

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