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Pacific Northwest National Laboratory

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Low-Activity Waste Envelope Definitions for the TWRS Privatization Phase I Request for Proposal

GK Patello
L Lauerhass
RL Myers
KD Wiemers

November 1996

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Acronyms

AGING	Aging Waste (Neutralized Current Acid Waste [NCAW])
ANL	Argonne National Laboratory
CC	Complexant Concentrate
CP	Concentrated Phosphate
DF	Decontamination Factor
DN	Dilute Non-complexed
DOE	Department of Energy
DQO	Data Quality Objectives
DSS	Double-Shelled Slurry
DSSF	Double-Shelled Slurry Feed
DST	Double-Shelled Tank
HTCE	Historical Tank Content Estimate
ICF KH	ICF Kaiser Hanford Company -- referred to as Kaiser
IPT	Integrated Process/Product Team
LANL	Los Alamos National Laboratory
LAW	Low-Activity Waste
M&O	Maintenance and Operations
NCAW	Neutralized Current Acid Waste
NCPLX	Non-Complexed Waste
NCRW	Neutralized Cladding Removal Waste
PNNL	Pacific Northwest National Laboratory
RFP	Request for Proposal
SST	Single-Shelled Tank
TIC	Total Inorganic Carbon; also refers to carbonate (CO_3^{-2})
TOC	Total Organic Carbon
TRU	Transuranics
TWRS	Tank Waste Remediation System
WHC	Westinghouse Hanford Company

1.0 Introduction

1.1 Background

Radioactive waste has been stored in large underground storage tanks at the Hanford Site since 1944. Approximately 212 million liters of waste containing approximately 240,000 metric tons of processed chemicals and 177 mega-curies of radionuclides are now stored in 177 tanks. These caustic wastes are in the form of liquids, slurries, saltcakes, and sludge. In 1991, the Tank Waste Remediation System (TWRS) Program was established to manage, retrieve, treat, immobilize, and dispose of these wastes in a safe, environmentally sound, and cost-effective manner.

The Department of Energy (DOE) has believes that it is feasible to privatize portions of the TWRS Program. Under the privatization strategy embodied in the Request for Proposal (RFP), DOE will purchase services from a contractor-owned, contractor-operated facility under a fixed-price contract (DOE 1996a).

Phase I of the TWRS privatization strategy is a proof-of-concept/commercial demonstration-scale effort. The objectives of Phase I are to demonstrate the technical and business viability of using privatized facilities to treat Hanford tank waste; define and maintain required levels of radiological, nuclear, process, and occupational safety; maintain environmental protection and compliance; and substantially reduce life-cycle costs and time required to treat Hanford tank waste. Three low-activity waste (LAW) envelopes are identified for Phase I of the privatization contract and are representative of the range of Hanford double-shelled tank (DST) waste.

Phase II is a full-scale production phase, in which the facilities are configured so that the remaining waste from the single-shelled tanks (SST) can be treated by 2018. The objectives of Phase II are to implement the lessons learned from Phase I, process all tank wastes into forms suitable for final disposal, achieve price competition and cost savings, and meet or exceed the Tri-Party Agreement (TPA) benchmark performance milestones.

The TWRS Privatization Support Project Contract Support Team was responsible for preparing the Request for Proposal (RFP) for Phase I of the privatization strategy. The Waste Characterization Subtask of the TWRS Privatization Support Project was charged with supporting the RFP LAW facility feed specification preparation by collecting and assessing all characterization information for candidate wastes. The waste characterization data were to be presented in the form of an inventory containing best estimate and range for each analyte, radionuclide, and physical property of interest. This information along with information on process limits was used to develop bounding conditions (envelopes) for selected analytes and radionuclides.

The process of collecting waste characterization information, evaluating the information, determining the best estimate and range, and defining the RFP feed specifications are described in this document and in two companion documents: *TWRS Privatization Support Project Waste Characterization Database Development* (Johnson 1996) and *TWRS Privatization Phase I Waste Characterization Data Evaluation for the Request for Proposal* (Patello et al. 1996).

1.2 Objectives

The primary objective of this report is to document the basis used for the selection of the LAW envelopes included in the final RFP for the TWRS privatization effort. The approach to envelope development as well as an independent review of the limits are described.

A second objective is to compare envelope limits with compositional data and identify limitations and potential risks as related to the data needs for TWRS Privatization effort. The limitations and risks associated with the available data provides justification for continued data characterization efforts identified in the TWRS Privatization Data Quality Objectives (DQO) (Wiemers, et al. 1996).

2.0 Low Activity Waste Envelope Definition

The envelope concept for key components of DST waste specifies the use of definite limits or bounding values for key waste constituents, rather than tank-specific values. Bounding values are described by an upper limit in concentration of key constituents and are valid for a major fraction of DST waste. The four envelopes initially developed were based on a few selected composition discriminators related to primary waste processing requirements. These envelopes encompassed nearly all of the DST supernatant waste and most of the single-shelled tank (SST) supernatant and saltcake waste (McKee et al. 1995). Process definition required expansion and refinements of waste envelopes. The resulting envelope specifications were more comprehensive but applicable to only DST wastes. After review by the Maintanence and Operations (M&O) contractor and privatization contractor, three waste envelopes were agreed upon.

2.1 Evolution of Envelope Concept for Definition of Tank Wastes

The effort to compile and assess the characterization data initially attempted to identify specific tank wastes that could be used for the Phase 1 demonstration. However, existing waste composition uncertainty and the impacts of continuing and future tank farm operations required that characterization objectives be modified. Existing composition data often did not allow confident assessments of inventories for key constituents or even quantification of the uncertainty associated with the data. Tank farm operations such as evaporation, processing demonstrations, consolidation of tank contents into fewer tanks, and continuous addition of new wastes from ongoing cleanup operations, will constantly change the waste compositions, and thereby impede the identification of specific tank wastes[(a)] (McKee, et al. 1995).

A Tank Waste Characterization Review Workshop was held in August 1995 to decide if the tank waste data was sufficiently documented to support a draft RFP for the initial (Phase 1) treatment of liquid waste. Several scientists from the Pacific Northwest National Laboratory (PNNL), ICF Kaiser Hanford Company (Kaiser), Westinghouse Hanford Company (WHC), Tank Advisory Panel (TAP), Argonne National Laboratory (ANL), Los Alamos National Laboratory (LANL), and Department of Energy (DOE) reviewed the data and concluded that a large part (over half) of the tank composition data could not support the draft RFP. A recommendation was made to present the data from a specified set of high priority tanks as bounding values rather than tank-specific values for the key composition components[(a)]. This recommendation led to the establishment of a set of three envelopes, each of which defined a maximum limit for a set of components. These envelopes were chosen such that the limits would be encompassed by a majority of the DST waste.

2.2 Envelope Definition

The envelope limits for chemical species, radionuclides, and physical properties are given in Tables 2.1 through Table 2.3. The waste feed delivered to the private contractor will have a sodium concentration between 3 M and 14 M (DOE 1996a and 1996b). Also, the insoluble solids

(a) Hudson BC, Letter to Dr. DL Vieth. August 9, 1995.

fraction will not exceed 5 volume percent or % (v/v) of the waste transferred. Trace quantities of radionuclides, chemicals, and other impurities may be present in the waste feed. All feed provided will meet the Tank Farm Operations specifications of OSD-T-151-00007 (Harris 1992). The approach to developing the envelope limits is described in Section 3.0.

Besides the analytes and radionuclides listed in Tables 2.1 and 2.2, the analytes and radionuclides listed in Table 2.4 could be important to the privatization contractor. Limits were not developed for these constituents because of the lack of available characterization data. A summary table providing information on the data available for each analyte/radionuclide is provided in Appendix C (Table C.1). Any future analysis should include characterization and sampling of these constituents.

The envelope definitions were revised during contract negotiations between April and September 1996. The values affected were sulfate Envelope C, TRU Envelopes A, and B, and ^{90}Sr Envelopes A and B.

Table 2.1. LAW Chemical Composition for Envelope Limits

Chemical Analyte	Maximum Ratio, Analyte (mole) to Sodium (mole)		
	Envelope A	Envelope B	Envelope C
Al	1.9E-01	1.9E-01	1.9E-01
Ba	1.0E-04	1.0E-04	1.0E-04
Ca	4.0E-02	4.0E-02	4.0E-02
Cd	4.0E-03	4.0E-03	4.0E-03
Cl	3.7E-02	8.9E-02	3.7E-02
Cr	6.9E-03	2.0E-02	6.9E-03
F	9.1E-02	2.0E-01	9.1E-02
Fe	1.0E-02	1.0E-02	1.0E-02
Hg	1.4E-05	1.4E-05	1.4E-05
K	1.8E-01	1.8E-01	1.8E-01
La	8.3E-05	8.3E-05	8.3E-05
Ni	3.0E-03	3.0E-03	3.0E-03
NO_2	3.8E-01	3.8E-01	3.8E-01
NO_3	8.0E-01	8.0E-01	8.0E-01
OH	7.0E-01	7.0E-01	7.0E-01
Pb	6.8E-04	6.8E-04	6.8E-04
PO_4	3.8E-02	1.3E-01	3.8E-02
SO_4	9.7E-03	7.0E-02	2.0E-02[(2)]
TIC	3.0E-01	3.0E-01	3.0E-01
TOC[1]	6.0e-02	6.0e-02	5.0e-01
U	1.2E-03	1.2E-03	1.2E-03

Note:
1) For each atom of Carbon in TOC.
2) Envelope C limit for SO_4^{-2} was changed during contract negotiations.

Table 2.2. LAW Radionuclide Composition for Envelope Limits

Radionuclide[1]	Maximum Ratio, Radionuclide (Bq) to Sodium (mole)		
	Envelope A	**Envelope B**	**Envelope C**
TRU	4.8E+05[2]	4.8E+05[2]	3.0E+06
^{137}Cs	4.3E+09	6.0E+10	4.3E+09
^{90}Sr	4.4E+07	4.4E+07	8.0E+08
^{99}Tc	7.1E+06	7.1E+06	7.1E+06

Note
1) Some radionuclides, such as ^{90}Sr and ^{137}Cs, have daughters with relatively short half-lives. These daughters are not listed in this table. However, they are present in concentrations associated with the normal decay chains of the radionuclides.
2) Envelope A and B limits for TRU and ^{90}Sr were changed during contract negotiations.

Table 2.3. Other LAW Specifications for Envelope Limits

	Envelope A	**Envelope B**	**Envelope C**
Insoluble Solids Fraction	<5 vol %	<5 vol %	<5 vol %
Na	3M - 14M	3M - 14M	3M - 14M

Table 2.4. Other Important Species for Which Data are not Available

Chemical Analytes	Ag, As, B, Be, Bi, Cs total, Cu, Li, Mg, Mn, NH_3/NH_4, Re, S total, Sb, Se, Sr total, Te, Tl, V, Zn, Zr, and organic species.
Radionuclides	^{3}H, ^{14}C, ^{79}Se, and ^{129}I

3.0 Envelope Limit Development Approach

From their inception, envelope limits were developed in four stages. In the first stage, initial boundaries for a limited set of components were defined based on technical discriminators. In Stage II, waste compositional information was compared with the Stage I limits resulting in the draft RFP envelope limits. Limits were also established for a larger set of components. In Stage III, the limits were converted to a per mole sodium basis and further refined using waste composition information. The envelope limits were adjusted to mitigate issues identified during preparation of the preliminary feed staging plan (Certa et al. 1996a). This stage resulted in the limits published in the final RFP. In Stage IV, the envelope limits will continue to be adjusted, as necessary, based on subsequent negotiations between the DOE and the private contractors. Stage I through IV are depicted in Figure 3.1 and will be described in more detail in the following sections.

3.1 Stage I

Three LAW envelopes (A through C) containing 11 components were defined during Stage I; a fourth envelope (D) was optional for private contractors to consider (McKee et al. 1995). Each envelope represented a treatment issue or challenge for the private contractor. Table 3.1 presents the treatment issues, the technical challenge presented by the issue, any uncertainty associated with the challenge, the envelope and the waste type representing the treatment issue, the tanks currently containing the waste type, and the tank waste assigned to the respective envelopes based on the LLW feed staging plan (Certa et al. 1996b). During Stage I, Envelope A represented waste that will test the production capacity and fission-product removal efficiency of the plants and will produce a final product in which waste loading will be limited by sodium. Envelope B waste is similar to Envelope A, except that it was defined so that the waste loading in the final product will be limited by minor component concentrations. Cesium removal was initially envisioned as an issue or challenge for Envelope B, however, the LAW concentration specification for cesium-137 in the final waste product has changed from 1 Ci/m^3 to 3 Ci/m^3. Therefore, the estimated decontamination factor (DF) requirements are now so low that there is no need for an envelope devoted to the treatment of waste with cesium-137 decontamination requirements beyond the range covered by Envelope A (McKee et al. 1995). The private contractor will, however, be challenged by working in a high activity/high heat environment. Envelope C represented waste with complexing agents that may interfere with strontium-90 or TRU decontamination and therefore require demonstration of organic destruction or another acceptable mitigation technology. Envelope D represents noncomplexed waste that requires strontium-90 or TRU decontamination by solid/liquid separation to prevent carryover into the final product. This envelope included less than 1% of the DST and SST waste, was listed by McKee (1995) as optional, and was not included in the final RFP LAW feed specification (DOE 1996a, 1996b).

The development of the compositional limits for the envelopes is described by McKee (1995). The basis for the limits was existing process technology for the conversion of a waste stream to a solidified immobilized low-activity waste (ILAW) product (a silicate glass). The product specifications were used to set the composition requirements and decontamination factors for the feedstock waste stream. The values were converted to the feed solution concentration waste stream to a solidified ILAW product (a silicate glass). The values were converted to the feed

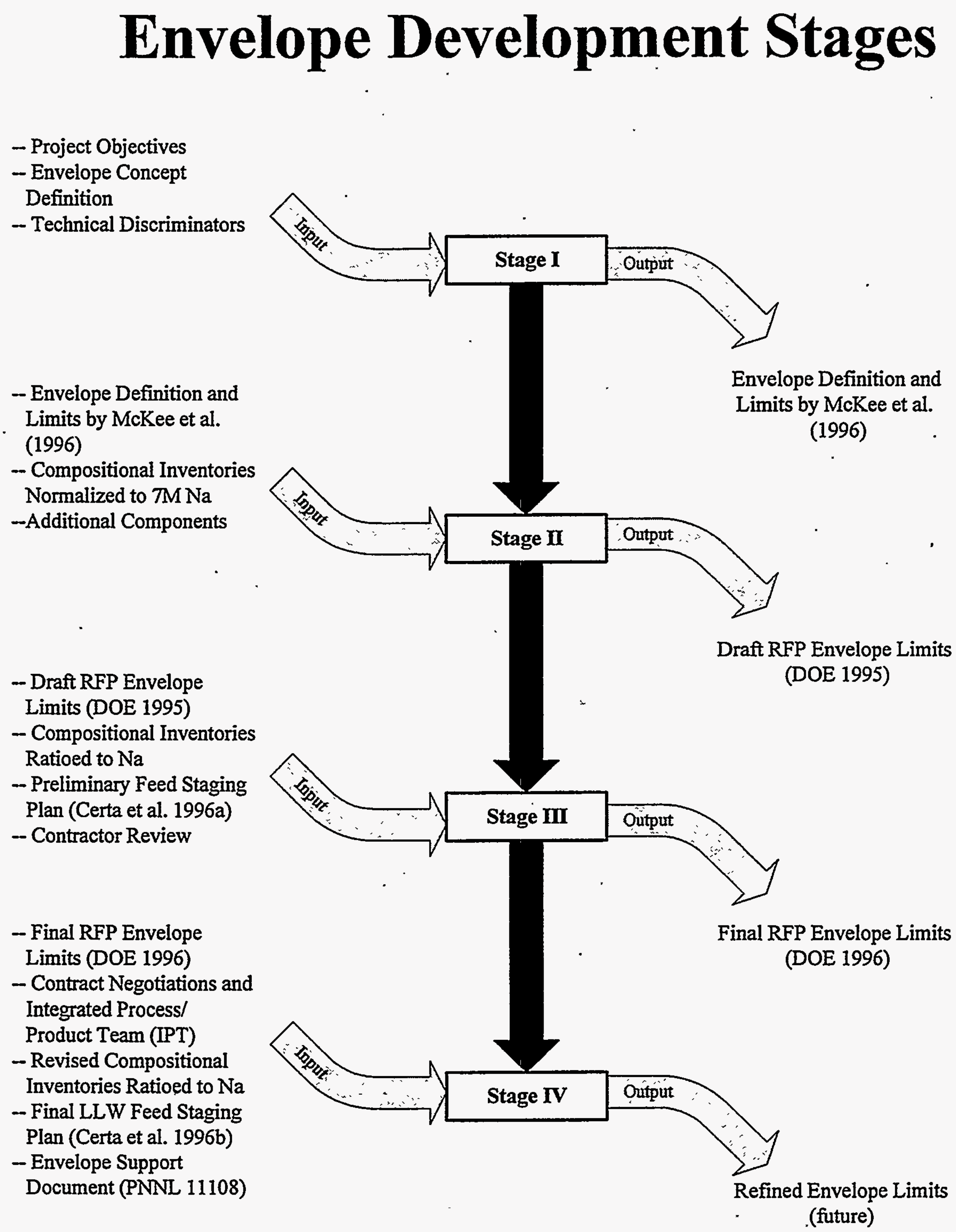

Figure 3.1. Stages Describing Tank Waste Compositional Envelope Development

Table 3.1. Technical Issues and Challenges Associated with Waste Envelopes and Waste Types[a]

Issue	Challenge	Uncertainty	Envelope	Waste Type	Tank FY95[2]	Tank FY02[3]
Production Throughput (Stage I-IV)	Demonstrate the ability to run a radioactive facility with a proven process		A	DSSF	AN104 AN105 AN106 AP105 AW101	AN104 AN105 AP106 AW101
				DSS	AN103	AN103
				DN	AN101 AP101 AP103 AP104 AP106 AP107 AP108 AW104 AY102	AP104
Minor Components (Stage I-IV)	Demonstrate the ability to maintain production capacity when waste-loading of final product is limited by minor components.		B	NCAW	AZ101 AZ102	AY101
				DN		AP103
Cesium Removal[1]	Demonstrate the ability to remove Cs with a proven process		B	NCAW	AZ101 AZ102	AY101
				DN		AP103
High Activity Environment (Stage I-IV)	Demonstrate the ability to operate with high radiation/heat levels during waste processing		B	NCAW	AZ101 AZ102	AY101
				DN		AP103
Organic Impact (Stage I-IV)	Demonstrate the ability to develop and design an organic destruction process sufficient to decomplex the waste when the degree of destruction required is unknown.	Degree of destruction required is unknown. No process has been demonstrated	C	CC	AN102 AN107A SY101 SY101	AN102 AN106 AN107 AP101 AP102 AP105 AP107 AP108 AW104 SY102
TRU Carryover (Stage I-II)	Demonstrate the ability to separate solids.	Effect of particle size on retrieval. Undemonstrated technology.	D (Optional)	NCRW	AW103 AW105	
				NCPLX	C109	

(1) No longer an issue associated with Envelope B.
(2) Tanks were assigned to envelopes based on waste type as determined by Hanlon (1995).
(3) Based on LLW Feed Staging Plan in which all waste is projected to FY2002 (Certa et al. 1996b).

(a) Originated by NG Colton and WG Richmond.

Table 3.2. Stage I Envelope Descriptions Based on a 7 M Na Feedstock Solution (McKee et al. 1995)

Constituent	Envelope A	Envelope B	Envelope C	Envelope D
^{137}Cs	$\leq$ 1.3 Ci/L	$\leq$ 2.6 Ci/L[a]	$\leq$ 1.3 Ci/L	$\leq$ 2.6 Ci/L[a]
^{90}Sr	$\leq$ 8.7E-3 Ci/L	$\leq$ 1.72E-2 Ci/L[a]	$\leq$ 8.7E-2 Ci/L	$\leq$ 1.7E-1 Ci/L[a]
TRU	$\leq$ 1.1E-4 Ci/L	$\leq$ 2.2E-4 Ci/L[a]	$\leq$ 5.5E-4 Ci/L	$\leq$ 1.1E-3 Ci/L[a]
^{99}Tc	$\leq$ 1.3E-3 Ci/L	$\leq$ 2.6E-3 Ci/L[a]	$\leq$ 1.3E-3 Ci/L	$\leq$ 2.6E-3 Ci/L[a]
Cl	$\leq$ 11 g/L	11-22 g/L[b]	$\leq$ 11 g/L	$\leq$ 22 g/L
CrO_4	$\leq$ 8 g/L	8-16 g/L[b]	$\leq$ 8 g/L	$\leq$ 16 g/L
F	$\leq$ 18 g/L	18-36 g/L[b]	$\leq$ 18 g/L	$\leq$ 36 g/L
PO_4	$\leq$ 44 g/L	44-88 g/L[b]	$\leq$ 44 g/L	$\leq$ 88 g/L
SO_4	$\leq$ 13 g/L	13-26 g/L[b]	$\leq$ 13 g/L	$\leq$ 26 g/L
Cd	$\leq$ 24 g/L	24-48 g/L[b]	$\leq$ 24 g/L	$\leq$ 48 g/L
TOC	< 10 g/L	<10 g/L[b]	$\geq$ 10 g/L	< 10 g/L

(a) Maximum allowable concentrations must be adjusted depending on the actual concentration of the "limiting minor component." For example, multiply the ratio of actual/maximum allowed "limiting minor component" times this concentration to determine the actual limiting concentration of each radionuclide.
(b) Only one minor component needs to be in the established ranges for the waste to be classified as Envelope B type waste. The minor component that produces the largest product volume is the "limiting case."

solution concentration requirements at a standardized sodium molarity of 7.0. The components and compositions defining these envelopes as given by McKee (1995) are shown in Table 3.2. The table is based on a 7 M Na feedstock solution with components given in Ci/L for radionuclides and g/L for analytes.

3.2 Stage II

Comparing the Stage I limits to waste composition information resulted in refined envelope definitions. The waste characterization information was from the TWRS Baseline Flowsheet Inventory (Shelton 1995a, Certa et al. 1996a), the Historical Tank Content Estimate (HTCE) (Brevick 1995), and the TWRS Privatization Support Project waste characterization inventory (Patello et al. 1996). These inventory sources are described in Appendix A. This information and input from the draft Preliminary Feed Staging Plan (Certa et al. 1996a) were used to develop envelope limits for the draft RFP (Tables 3.3 - 3.5). Details on development of the limits for the draft RFP will not be documented in this report.

Table 3.3. Draft RFP Envelope A Definition

Chemical Analyte	Minimum, g/L	Maximum, g/L
Al	0	35
Ba	NE	0.1
Ca	NE	5
Cd	NE	0.1
Cl	0	9
Cr	0	2.5
F	0	12
Fe	NE	1
Hg	NE	0.02
K (note 1)	0	50
La	NE	0.08
Na (note 1)	69	160
Ni	NE	1
NO_2^-	10	120
NO_3^-	5	200
OH	4	70
Pb	NE	1
PO_4^{-3}	0	25
SO_4^{-2}	0	7
TIC	0	15
TOC (note 2)	0	<10
U	NE	2

Radionuclide	Minimum, Bq/L	Maximum, Bq/L
TRU	NE	3E+06
Cs-137	NE	3E+10
Sr-89/90	NE	4E+08
Tc-99	NE	5E+07

Physical Property	Minimum	Maximum
Density, g/mL	1.3	1.6
pH	12.5	13.5
vol% solids (note 3)	NE	5
wt%H2O	60	80

Notes:

Feedstock provided for this envelope will contain components within the range specified. Components listed in this table summarize the major constituents in the LLW plant feed. Components in addition to those defined in these tables may be present in the feedstock. All feed provided will meet Tank Farm Operations specifications given in WHC-SD-WM-OCD-015, April 24, 1995.

NE: value not estimated

NA: insufficient information to provide estimate.

1. The sum of Na and K must be less than or equal to 7M.
2. Additional information regarding organic content is available in support materials.
3. Vol% solids refers to insoluble solids fraction.

Table 3.4. Draft RFP Envelope B Definition

Chemical Analyte	Minimum, g/L	Maximum, g/L
Al	0	35
Ba	NE	0.1
Ca	NE	5
Cd	NE	0.1
Cl	0	22
Cr	0	5.0
F	0	36
Fe	NE	1
Hg	NE	0.02
K (note 1)	0	50
La	NE	0.08
Na (note 1)	69	160
Ni	NE	1
NO_2^-	10	120
NO_3^-	5	200
OH	4	70
Pb	NE	1
PO_4^{-3} (see note)	0	88
SO_4^{-2} (see note)	0	26
TIC	0	15
TOC (note 2)	0	<10
U	NE	2

Radionuclide	Minimum, Bq/L	Maximum, Bq/L
TRU	1E+03	3E+06
Cs-137	1E+09	3E+11
Sr-89/90	1E+06	4E+08
Tc-99	1E+06	5E+07

Physical Property	Minimum	Maximum
Density, g/mL	1.3	1.6
pH	12.5	13.5
vol% solids (note 3)	NE	5
wt%H2O	60	80

Notes:

Feedstock provided for this envelope will require a cesium DF of greater than or equal to 1000 (Cs concentration in feed will be greater than or equal to 4.88E10 Bq/L (1.3Ci/L)) @ 7M Na and/or one (or more) silicate glass limiting constituents. The silicate glass limiting constituents must be equal to or greater than those concentrations defined below. The limits provided are based on a 7M Na feed and a 20 wt% Na_2O silicate glass.

Maximum Feed Concentration @ 7M Na		Maximum Silicate Glass Solubility @ 20wt% Na2O	
Cl	11g/L	Cl	1wt%
Cr	3.71 g/L	Cr_2O_3	0.5wt%
F	11g/L	F	1wt%
PO_4^{-3}	4.6g/L	P_2O_5	3wt%
SO_4^{-2}	6.6g/L	SO_3	0.5wt%

Other components will be delivered within the specified ranges. Components listed in this table summarize the major constituents in the LLW plant feed. Components in addition to those defined in these tables may be present in the feedstock. All feed provided will meet Tank Farm Operations specifications given in WHC-SD-WM-OCD-015, April 24, 1995.

NE: value not estimated
NA: insufficient information to provide estimate.
1. The sum of Na and K must be less than or equal to 7M.
2. Additional information regarding organic content is available in support materials.
3. Vol% solids refers to insoluble solids fraction.

Table 3.5. Draft RFP Envelope C Definition

Chemical Analyte	Minimum, g/L	Maximum, g/L
Al	0	35
Ba	NE	0.1
Ca	NE	5
Cd	NE	0.1
Cl	0	9
Cr	0	2.5
F	0	12
Fe	NE	1
Hg	NE	0.02
K (note 1)	1	50
La	NE	0.08
Na	69	160
Ni	NE	1
NO_2^-	10	120
NO_3^-	5	200
OH	4	70
Pb	NE	1
PO_4^{-3}	0	25
SO_4^{-2}	0	7
TIC	0	15
TOC (note 2)	=>10	40
U	NE	2

Radionuclide	Minimum, Bq/L	Maximum, Bq/L
TRU	1E+03	2E+07
Cs-137	1E+09	3E+10
Sr-89/90	1E+06	3E+09
Tc-99	1E+06	5E+07

Physical Property	Minimum	Maximum
Density, g/mL	1.3	1.6
pH	12.5	13.5
vol% solids (note 3)	NE	5
wt%H2O	60	80

Notes:

Feedstock provided for this envelope will contain components within the range specified. Components listed in this table summarize the major constituents in the LLW plant feed. Components in addition to those defined in these tables may be present in the feedstock. All feed provided will meet Tank Farm Operations specifications given in WHC-SD-WM-OCD-015, April 24, 1995.

NE: value not estimated

NA: insufficient information to provide estimate.

1. The sum of Na and K must be less than or equal to 7M.
2. Additional information regarding organic content is available in support materials.
3. Vol% solids refers to insoluble solids fraction.

It was necessary to develop limits for components other than those listed in Stage I in order to bound the waste envelopes more completely for potential private contractors and to take into consideration the balance of the plant. The selection of the chemical and radionuclide components is discussed by Patello et al. (1996).

Also, an additional limit defining the solid volume percent was developed for the draft RFP. The solids content reported for DST supernatant samples typically ranges between 0.1 and 0.8 wt% and between 2 and 5 vol%. The volume percent determinations are based on visual estimates of the volume of settled solids. Two volume percent solids is equivalent to 0.8 wt% solids by applying the assumptions:

- centrifugation will compress 2 vol% solids to 1 vol%
- density of centrifuged solids is 1.7 g/L (as measured in AZ101)
- wt% centrifuged solids is 59% (as measured in AZ101)
- density of the supernate is 1.2 g/mL (as measured in AZ101).

The maximum reported value, 5 vol% solids was selected for the envelope maximum limit[a].

3.3 Stage III

As part of the review process and in response to private contractor comments on the draft RFP, the unit basis used for envelope limits was changed to values expressed as a ratio of the component value in moles or becquerels (Bq) to the sodium value in moles. Thus, the data used to adjust or develop limits also had to be ratioed to sodium as described in the following section. An important result of the Stage III was to eliminate the lower envelope limits because they caused unnecessary constraints. The final RFP envelope limits (Table 2.1-2.3 in Section 2.2) resulted from Stage III.

3.3.1 Data Calculation Approach

The inventory estimates from the HTCE and the TWRS Baseline Flowsheet Inventory consisted of single values for each analyte in the inventory. The ratio was easily calculated by dividing each chemical analyte value in moles/L by the sodium value in moles/L. Radionuclide estimates in Bq/L were divided by the sodium value in moles/L to achieve a ratio expressed in Bq/mole sodium.

The inventory estimates from the TWRS Privatization Support Project inventory were derived from analytical data current as of August 1995 and were in the form of minimum, maximum, and best estimate concentrations in g/L (chemical analytes) or Bq/L (radionuclides). The method by which these concentrations were determined is described in detail by Patello et al. (1996). The minimum and maximum analytical values were first converted to moles/L. The minimum sodium ratio values were then obtained by dividing the minimum analyte concentration

(a) Geeting, JGH. 1995. *Estimate of Amount of Entrained Solids Incidentally Retrieved with Supernatant from DSTs*. Letter to WR Richmond and ML Elliott dated August 30, 1996, Pacific Northwest Laboratory, Richland Washington.

(moles/L) or radionuclide value (Bq/L) by the minimum sodium concentration (moles/L). The maximum sodium ratio values were obtained by dividing the maximum analyte concentration or radionuclide values (Bq/L) by the maximum sodium concentration. The resulting units were moles (analyte) or Bq (radionuclide)/mole sodium. Details of the calculations as well as the file structure of the supporting spreadsheets and the quality assurance performed on the calculation can be found in Appendix B. The ratioed values were used for refine envelope limits as described in the next section.

One potentially confusing result of using the above method is that a maximum concentration ratio may be smaller that the minimum concentration ratio. This occurred for some analytes, $Al(OH)_4$ in tank AW101, for example, and radionuclides when the difference between the sodium minimum and maximum concentrations was larger than the difference between the analyte minimum and maximum concentrations.

The approach to the calculation of the ratioed analytical data was used because time constraints did not permit for a more involved determination. Two alternative approaches can be used to determine the ratios. The first alternative approach is to determine the minimum and maximum values and ratio these values to the corresponding sodium value for that sampling event. Occasionally, sodium values for a particular sampling event are not available, and the nearest sampling event containing a sodium value must be used. This approach is more time consuming than the approach described above because of the need to go back to the original sampling data (Johnson 1996). The second alternative approach requires even more time. In this approach, all the analytical data would be ratioed to the corresponding sodium value for the particular sampling event, and minimum and maximum values would be selected. Using the second alternative approach might result in the sampling event from which the minimum and maximum are chosen to change. When this approach was tested on the analytical data for two tank wastes, AN107 and AZ102, occasionally, a sample event that produced a maximum or minimum changed. The numbers generally increased as a result of the new approach, however, the position of the data relative to the envelope limits did not change. Analytes that exceeded the limits still exceeded the limits in the new approach. Analytes that were below the limits remained below the limits.

3.3.2 Stage III Envelope Refinement

Limits for the existing components were reviewed and adjusted as necessary to provide simplicity and conservatism to the envelope definition where good engineering judgement allowed. The following logic was applied in developing and adjusting envelope limits:

- If the technical discriminator value (McKee et al. 1995) was much greater than the maximum value reflected by a large fraction of waste composition information for a given set of tank waste targeted for the envelope, the boundary was decreased to preclude higher than necessary bids.

- If the composition information for a large fraction of the targeted waste was near the technical discriminator boundary, the limit was increased to provide more flexibility for feed delivery by the M&O.

To assist in the envelope limit refinement, data plots with the HTCE, TWRS Flowsheet inventory, and the Privatization inventory ratioed values were developed (Appendix C). The original envelope bounds were superimposed on the plots for comparison purposes. Technical experts from PNNL, WHC, and DOE used the plots and the above cited logic to develop and refine the envelope limits.

3.4 Stage IV

In Stage IV, the envelope limits were reviewed and adjusted in response to issues identified during preparation of the LLW Feed Staging Plan (Certa et al. 1996b) and contract negotiations. The feed staging plan is described in Appendix A. Limits for three components were changed during this stage as described in Section 2.0

4.0 Independent Review of Envelope Limits

This section describes an independent review of the envelope limits by comparing process limits found in various sources with the RFP envelope limit. Time constraints precluded an exhaustive literature search to find process limits. An assessment of the risk associated with the envelope limit is based on the process limit and on a comparison of available inventory estimates with the relevant process limit and envelope limit.

The compositional information is provided by three inventories: Privatization, TWRS, and HTCE (as described in Appendix A). The estimates in the Privatization and HTCE inventories were current to August 1995 and January 1994 respectively; the TWRS estimates were projected to FY 2002. The difference in time basis for the inventories affected the assessment because subsequent and future transfers had and will changed the waste type and composition in some tanks. To put comparisons on an equal basis, the tanks wastes were assessed within their relevant envelopes. The envelope to which a waste was assigned was based on the waste type for the Privatization and HTCE inventories and on the Low-Level Feed Staging plan (Certa et al. 1996b) for the TWRS inventory. Some waste had not been assigned to an envelope and was therefore considered in all envelopes. In the case of the Privatization and HTCE inventories, the envelope assignments were made for the purpose of the assessment only and should not be interpreted or used outside of this context. The assignments are shown in Table 4.1.

For the assessment, only tanks in which the sodium inventory is greater than 50 MT (see Table 4.1) are considered. Tanks AW102 and AW106 are evaporator feed and product tanks are also excluded from the assessment.

Tables 4.2 and 4.3 provides a summary of the assessment. The tables are organized by analyte and provide the RFP envelope limit, the selected process limit, and the maximum compositional value for each envelope. For the purpose of comparison and consistency with the RFP, the RFP envelope limit, the process limit, and tank compositions are all expressed as mole analyte per mole sodium. The conversions of process limits to these compositional units are shown in Appendix E. Although the same process limit for a particular analyte applies to all three LAW waste envelopes, the value of this process limit expressed per mole sodium will differ between waste envelopes because different waste envelopes assumed different minimum LAW loadings of sodium. For Envelope A and Envelope C wastes, the assumption of 15.5 wt% Na_2O glass is based on the RFP maximum of 100 cm^3 container volume/mole Na feed and a container that is 80% full of glass at a density of 2.5 g/cm^3. For Envelope B waste, 6.2 wt% Na_2O glass is assumed, consistent with the RFP specified maximum of 250 cm^3 container volume/mol Na feed for Envelope B waste (80% of the container volume is assumed to be glass with a density of 2.5 g/cm^3).

The maximum tank waste composition value is the maximum value from three sources of inventory estimates (Privatization inventory estimate, TWRS inventory estimate, and HTCE inventory estimate) within each envelope. These sources are described in Appendix A. Inventory values are in Appendix C.

Table 4.1. Envelope Assignments for Waste Represented by Inventory Estimates

Tank	Privatization (8/95)		HTCE (1/94)		TWRS (FY2002)	
	Envelope	MT Na*	Envelope	MT Na	Envelope	MT Na
AN101			A	283	U	219
AN102	C	1420	C	1420	C	1003
AN103			A	1040	A	1216
AN104			A	897	A	834
AN105			A	1780	A	1185
AN106			A	15	C	1486
AN107	C	1060	C	1060	C	778
AP101			A	70	C	601
AP102	C	572	C	572	C	424
AP103			A	152	B	1
AP104			A	1	A	236
AP105	A	676	A	676	C	33
AP106			A	325	A	1002
AP107			A	6	C	1456
AP108			A	151	C	1
AW101	A	1370	A	1370	A	906
AW102			U	482	U	RT
AW103			D**	10	U	11
AW104			A	53	C	10
AW105			D**	231	U	0
AW106			U	561	U	RT
AY101			C	257	B	436
AY102	A	81	A	81	U	8
AZ101	B	199	B	199	U	14
AZ102	B	101	B	101	U	8
SY101			C	1440	U	1187
SY102			U	39	C	2
SY103			U	741	U	712
	A = Envelope A					
	B = Envelope B					
	C = Envelope C					
	D = Envelope D (as defined by McKee et al. (1995))					
	U = Unassigned					

* Same as HTCE.

** See Table 3.1 in Section 3.1

Table 4.2. Summary of RFP Limit and Process Limit Comparison with Tank Compositions for Chemical Analytes

Analyte	Envelope	Component limit (mole/mole Na)			Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1]				Source
		RFP limit	Process Limit	Max Tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
Al	A	1.9E-01	4.7E-01	1.7E-01	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Shade 1995
	B	1.9E-01	1.2E+00	1.7E-01	YES		NONE	N/A	low	N/A	
	C	1.9E-01	4.7E-01	1.7E-01	YES		NONE	N/A	low	N/A	
Ba	A	1.0E-04	2.6E-01	8.1E-06	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Kalia[a]
	B	1.0E-04	6.5E-01	8.1E-06	YES		NONE	N/A	low	N/A	
	C	1.0E-04	2.6E-01	5.0E-04	YES		AN107-P	Estimate is 5x greater than RFP limit	low	Unreliable estimate; 10x greater than similar waste type in AN102; not significant waste	
Ca	A	4.0E-02	4.3E-01	1.6E-02	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Lambert 1994
	B	4.0E-02	1.1E+00	3.3E-03	YES		NONE	N/A	low	N/A	
	C	4.0E-02	4.3E-01	3.5E-03	YES		NONE	N/A	low	N/A	
Cd	A	4.0E-03	3.9E-02	5.6E-05	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Shade 1995
	B	4.0E-03	9.7E-02	5.6E-05	YES		NONE	N/A	low	N/A	
	C	4.0E-03	3.9E-02	6.2E-05	YES		NONE	N/A	low	N/A	

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWVP-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Analyte	Envelope	Component limit (mole/mole Na)			Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1]				Source
		RFP limit	Process Limit	Max Tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
Cl	A	3.7E-02	2.8E-02	3.4E-02	NO	New process limit data more restrictive than previous[3]	AP104-T AP106-T AY102-P	These tanks within RFP limit but are within 20% of the process limit	medium	RFP limit exceeds Process Limit by 30%. Uncertainty in offgas impacts and corrosion factor	Li 1995
							SY101-T SY103-T	Within 20% of process limit, unassigned waste			
	B	8.9E-02	7.0E-02	2.8E-02	NO		NONE	N/A	low	Uncertainty in offgas impacts and corrosion factor	
	C	3.7E-02	2.8E-02	2.8E-02	NO		AP102-P	Below the RFP limit but within 20% of the process limit	low	Not significant waste; uncertainty in offgas impacts and corrosion factor;	
							SY101-T SY103-T	Within 20% of process limit, unassigned waste			
Cr	A	6.9E-03	1.3E-02	1.3E-02	YES	RFP limit set by tank waste composition	AN101-H	Within 20% of the RFP limit	medium (low)	(Waste in AN101-H will not exist in FY2002 due to transfers etc.)	Shade 1995
							SY103-T	Exceeds RFP limit by > 20%; unassigned waste			
	B	2.0E-02	3.3E-02	1.3E-02	YES		NONE	N/A	low	N/A	
	C	6.9E-03	1.3E-02	1.3E-02	YES		SY103-T	Exceeds RFP limit by > 20%; unassigned waste	low	Not significant waste	
F	A	9.1E-02	1.8E-01	5.9E-02	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Shade 1995
	B	2.0E-01	4.5E-01	2.4E-02	YES		NONE	N/A	low	N/A	
	C	9.1E-02	1.8E-01	3.5E-02	YES		NONE	N/A	low	N/A	

Analyte	Envelope	Component limit (mole/mole Na)			Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1]				Source
		RFP limit	Process Limit	Max Tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
Fe	A	1.0E-02	3.0E-01	<9.2E-02	YES	RFP limit set by tank waste composition	AY102-P	Less than detection limit value	low	Not significant waste	Shade 1995
	B	1.0E-02	7.5E-01	3.2E-03	YES		NONE	N/A	low	N/A	
	C	1.0E-02	3.0E-01	5.2E-03	YES		NONE	N/A	low	N/A	
Hg	A	1.4E-05	1.9E-05	5.5E-06	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Shade[a]
	B	1.4E-05	4.6E-05	1.3E-06	YES		NONE	N/A	low	N/A	
	C	1.4E-05	1.9E-05	1.3E-06	YES		NONE	N/A	low	N/A	
K	A	1.8E-01	1.4E-01	1.1E-01	NO	Conservative process limit	AP105-P	Within 20% of the Process limit; well below RFP limit	medium (low)	Ion exchange efficiency decreased (Waste in AP105-P will not exist in FY2002 due to transfers etc.)	Kurath 1994
	B	1.8E-01	1.4E-01	2.8E-02	NO		NONE	N/A	low	N/A	
	C	1.8E-01	1.4E-01	8.8E-02	NO		NONE	N/A	low	N/A	
La	A	8.3E-05	1.8E-02	4.7E-05	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Lambert 1994
	B	8.3E-05	4.6E-02	4.7E-05	YES		NONE	N/A	low	N/A	
	C	8.3E-05	1.8E-02	4.7E-05	YES		NONE	N/A	low	N/A	
Ni	A	3.0E-03	5.4E-02	8.2E-04	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Shade 1995
	B	3.0E-03	1.3E-01	5.3E-04	YES		NONE	N/A	low	N/A	
	C	3.0E-03	5.4E-02	9.9E-04	YES		NONE	N/A	low	N/A	

(a) Shade JW. 1995. E-mail message to K. D. Wiemers dated 9/28/95.

Analyte	Envelope	Component limit (mole/mole Na) RFP limit	Process Limit	Max Tank[1]	Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1] Tanks[2]	Explanation	Risk Factor	Explanation	Source
NO_2^-	A	3.8E-01	1.0E+00	2.6E-01	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Roberts 1962
	B	3.8E-01	1.0E+00	3.0E-01	YES		NONE	N/A	low	N/A	
	C	3.8E-01	1.0E+00	2.6E-01	YES		NONE	N/A	low	N/A	
NO_3^-	A	8.0E-01	1.0E+00	5.2E-01	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Roberts 1962
	B	8.0E-01	1.0E+00	4.3E-01	YES		NONE	N/A	low	N/A	
	C	8.0E-01	1.0E+00	4.4E-01	YES		NONE	N/A	low	N/A	

		Component limit (mole/mole Na)			Is RFP Limit ≤ Process Limit ?		RFP/Process Limit Violation[1]				
Analyte	Envelope	RFP limit	Process Limit	Max Tank[1]		Explanation	Tanks[2]	Explanation	Risk Factor	Explanation	Source
OH	A	7.0E-01	6.8E-01	8.3E-01	YES	Process/RFP limit within 5% of each other	AN101-H AN103-H AN104-H AN105-H AN106-H AP103-H AP106-H AP108-H AY102-H	HTCE values are overestimated when compared to analytical based estimates	low	HTCE estimates are not used for the assessment, other waste is not significant	Kurath 1994
							AN101-T SY103-H	within 20% of the RFP limit; unassigned waste			
							SY101-T	exceeds 120% of the RFP limit; unassigned waste			
	B	7.0E-01	6.8E-01	9.4E-01	YES		AZ102-H	exceeds 120% of the RFP limit	low	HTCE estimates are not used for the assessment, other waste is not significant	
							AN101-T SY103-H	within 20% of the RFP limit; unassigned waste			
							SY101-T	exceeds 120% of the process limit; unassigned waste			
	C	7.0E-01	6.8E-01	8.3E-01	YES		AP102-H AN102-H AN107-H	within 20% of the RFP limit	low	HTCE estimates are not used for the assessment, other waste is not significant	
							AN101-T SY103-H	within 20% of the RFP limit; unassigned waste			
							SY101-T	exceeds 120% of the process limit; unassigned waste			

Analyte	Envelope	Component limit (mole/mole Na)			Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1]				Source
		RFP limit	Process Limit	Max Tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
Pb	A	6.8E-04	1.8E-02	1.5E-04	YES	RFP limit set by tank waste composition	NONE	N/A	low	N/A	Shade[a]
	B	6.8E-04	4.5E-02	9.5E-05	YES		NONE	N/A	low	N/A	
	C	6.8E-04	1.8E-02	2.2E-04	YES		NONE	N/A	low	N/A	
PO_4^{-3}	A	3.8E-02	8.5E-02	4.4E-02	YES	RFP limit set by tank waste composition	AN101-T	Waste within 20% of RFP limit; unassigned waste	low	Not significant waste	Shade 1995
	B	1.3E-01	2.1E-01	4.4E-02	YES		NONE	N/A	low	N/A	
	C	3.8E-02	8.5E-02	4.4E-02	YES		AP102-P	Waste within 20% of RFP limit	low	Not significant waste	
							AN101-T	Waste within 20% of RFP limit; unassigned waste			

(a) Shade JW. 1995. E-mail message to K. D. Wiemers dated 9/28/95.

Analyte	Envelope	Component limit (mole/mole Na)			Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1]				Source
		RFP limit	Process Limit	Max Tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
SO_4^{-2}	A	9.7E-03	2.5E-02	2.2E-02	YES	RFP limit set by tank waste composition	AN101-H AN103-H AN104-H AN105-H AP101-H AP103-H AP105-H AP106-H AP108-H AW101-H AY102-H SY102-H	Solubility estimates are uncertain	low	HTCE estimates are not considered in assessment; AY102 is not significant waste for Envelope A.	Shade 1995
							AY102-P	Exceeds RFP limit by > 20%			
							AN101-T	Exceeds RFP limit by > 20%; unassigned waste			
	B	7.0E-02	6.3E-02	8.4E-02	NO	RFP limit 110% of process limit	AZ102-P	Exceeds process limit by > 20%; Within 20% of RFP limit	high (medium)	Uncertainty in offgas system design (Post consolidation estimate of NCAW in AY101 lowers risk)	
							AY101-T	Within 20% of process limit. More than 20% below the RFP limit			
	C	2.0E-02	2.5E-02	2.8E-02	YES	RFP limit set in contract negotiations	AN102-H	Within 20% of RFP limit	low	HTCE estimates are not considered in assessment; AN101-T is not significant waste	
							AN107-H AY101-H SY101-H SY103-H	Exceeds RFP limit by > 20%; solubility estimates are uncertain			
							AN101-T	Within 20% of RFP limit; unassigned waste			

Analyte	Envelope	Component limit (mole/mole Na) RFP limit	Process Limit	Max Tank[1]	Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1] Tanks[2]	Explanation	Risk Factor	Explanation	Source
TIC	A	3.0E-01	5.0E-01	3.9E-01	YES	RFP limit set by tank waste composition	AY102-P	Exceeds the RFP limit by > 20%	low	Not significant waste	Roberts 1962
	B	3.0E-01	5.0E-01	2.4E-01	YES		NONE	N/A	low	N/A	
	C	3.0E-01	5.0E-01	1.4E-01	YES		NONE	N/A	low	N/A	

Analyte	Envelope	Component limit (mole/mole Na) RFP limit	Process Limit	Max Tank[1]	Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1] Tanks[2]	Explanation	Risk Factor	Explanation	Source
TOC	A	6.0E-02	6.0E-02	1.5E-01	YES	RFP limit and Process limit are the same.	AN103-H AN104-H AN105-H AP101-H AP103-H AP105-H AP106-H AP108-H AW101-H SY103-H	Exceeds RFP limit by > 20%; Solubility estimates are uncertain	medium	AP104 waste is significant waste is within 20% of the RFP limit; HTCE estimates are not used for the evaluation	Le 1995
							AN101-H AW104-H	Waste within 20% of RFP limit; Solubility estimates are uncertain			
							AP104-T AY102-P	Waste within 20% of RFP limit			
							AN101-T	Waste within 20% of RFP limit; unassigned waste			
							SY101-T	Exceeds RFP limit by > 20%; unassigned waste			
	B	6.0E-02	6.0E-02	1.5E-01	YES		AZ102-P	Waste within 20% of RFP limit	medium (low)	NCAW within 20% of RFP limit (Post consolidation estimate of NCAW in AY101 does not violate criteria)	
							AN101-T	Waste within 20% of RFP limit; unassigned waste			
							SY101-T	Exceeds RFP limit by > 20%; unassigned waste			
	C	5.0E-01	3.8E-01	3.9E-01	NO	Process limit not well quantified	AN107-P	Waste within 20% of the process limit	low	Not significant waste	Kurath 1994

Analyte	Envelope	Component limit (mole/mole Na) RFP limit	Process Limit	Max Tank[1]	Is RFP Limit ≤ Process Limit ?	Explanation	RFP/Process Limit Violation[1] Tanks[2]	Explanation	Risk Factor	Explanation	Source
U	A	1.2E-03	5.9E-02	1.2E-03	YES	RFP limit set by tank waste composition	AN101-H AN103-H AN104-H AP101-H AP105-H AP106-H AP108-H AW101-H AY102-H SY103-H	Waste within 20% of RFP limit;	low	Solubility estimates are uncertain; more than 2 orders of magnitude above Privatization and TWRS values; HTCE estimates are not used for the assessment	Lambert 1994
	B	1.2E-03	1.5E-01	2.9E-03	YES		AZ102-P	Exceeds RFP limit by > 20%	high (low)	NCAW exceeds RFP limit by > 20% (Post consolidation estimate of NCAW in AY101 does not violate criteria)	
							AZ101-H AZ102-H	Waste within 20% of RFP limit			
	C	1.2E-03	5.9E-02	1.1E-03	YES		SY101-H	Waste within 20% of RFP limit	low	Not significant waste	

(1) DST waste with < 50 MT Na (see Table 4.1) and tank farm evaporator feed and product tanks (AW102 and AW106) are not considered (Certa et al. 1996b).
(2) The letter after the tank designation indicates which inventory estimate cause the violation: P = Privatization, H = HTCE, and T = TWRS
(3) Cl glass solubility limit selected is half of 1 wt% Cl glass limit of Shade (1995)

Table 4.3. Summary of RFP Limit and Process Limit Comparison with Tank Compositions for Radionuclides

Analyte	Envelope	Limit (Bq/mole Na)			Is RFP limit ≤ Process limit ?	Explanation	RFP/process limit violation(1)		Risk		Source
		RFP limit	Process	max tank(1)			Tanks(2)	Explanation	Risk Factor	Explanation	
TRU (^{241}Am, ^{237}Np, ^{238}Pu, and $^{239/240}$Pu)	A	4.8E+05	3.7E+06	2.5E+06	YES	RFP limit set in contract negotiations	AY102-P	Exceeds RFP limit by > 20%	low	Waste either not significant or unassigned	McKee 1995
							AN101-T	Exceeds RFP limit by > 20%; unassigned waste			
	B	4.8E+05	9.3E+06	2.5E+06	YES	RFP limit set in contract negotiations	AZ102-P	Exceeds RFP limit by > 20%	medium (low)	AZ102 estimate is a less than value, AN101 is unassigned waste (Post consolidation estimate of NCAW in AY101 does not violate criteria)	McKee 1995
							AN101-T	Exceeds RFP limit by > 20%; unassigned waste			
							AZ102-H	Within 20% of the RFP limit			
	C	3.0E+06	3.7E+06	3.6E+06	YES	RFP limit set by tank waste composition	AN107-P	Exceeds RFP limit by > 20%	low	Waste either not significant or unassigned	McKee 1995
							AN107-T	Within 20% of RFP limit			
							AN101-T	Within 20% of RFP limit; unassigned waste			

Analyte	Envelope	Limit (Bq/mole Na) RFP limit	Process	max tank[1]	Is RFP limit ≤ Process limit ?	Explanation	RFP/process limit violation[1] Tanks[2]	Explanation	Risk Risk Factor	Explanation	Source
^{137}Cs	A	4.3E+09	8.9E+09	4.1E+09	YES	RFP limit set by tank waste composition	AN101-T	Waste within 20% of RFP limit	low	Unassigned waste	McKee 1995
	B	6.0E+10	2.2E+10	3.2E+10	NO	Technological challenge	AZ101-H AZ102-H	Exceeds process limit by > 20%	very high (medium)	NCAW waste exceeds process limit by > 20% (Post consolidation estimate of NCAW in AY101 does not violate criteria)	
	C	4.3E+09	8.9E+09	4.1E+09	YES	RFP limit set by tank waste composition	AN101-T	Waste within 20% of RFP limit	low	Unassigned waste	

Analyte	Envelope	Limit (Bq/mole Na)			Is RFP limit ≤ Process limit ?	Explanation	RFP/process limit violation[1]		Risk		Source
		RFP limit	Process	max tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
^{90}Sr	A	4.4E+07	5.9E+08	5.2E+08	Yes	RFP limit set in contract negotiations	most HTCE data	Solubility estimates uncertain	low	Waste either not significant or unassigned	McKee 1995
							AY102-P	Exceeds RFP limit by > 20%			
							AN101-T SY103-T	Exceeds RFP limit by > 20%; unassigned waste			
	B	4.4E+07	1.5E+09	5.2E+08	YES	RFP limit set in contract negotiations	AZ101-H AZ102-H	Solubility estimates uncertain	medium (low)	NCAW Within 20% of RFP limit; HTCE estimates and unassigned waste not used for assessment (Post consolidation estimate of NCAW in AY101 does not violate criteria)	McKee 1995
							AZ102-P	Within 20% of RFP limit			
							AN101-T SY103-T	Exceeds RFP limit by > 20%; unassigned waste			
	C	8.0E+08	5.9E+08	5.7E+08	NO	Technological challenge	AN107-P AY101-H	Waste within 20% of process limit	low	Waste either not significant or unassigned; RFP limit exceeds process limit by less than 40%	McKee 1995
							AN101-T	Waste within 20% of process limit; unassigned waste			

Analyte	Envelope	Limit (Bq/mole Na)			Is RFP limit ≤ Process limit ?	Explanation	RFP/process limit violation[1]		Risk		Source
		RFP limit	Process	max tank[1]			Tanks[2]	Explanation	Risk Factor	Explanation	
^{99}Tc	A	7.1E+06	8.9E+06	2.3E+06	YES	RFP limit set based on DF of 10	NONE	N/A	low	N/A	McKee 1995
	B	7.1E+06	2.2E+07	3.4E+06	YES	RFP limit set based on DF of 10	NONE	N/A	low	N/A	
	C	7.1E+06	8.9E+06	2.3E+06	YES	RFP limit set based on DF of 10	NONE	N/A	low	N/A	

(1) DST waste with < 50 MT Na (see Table 4.1) and tank farm evaporator feed and product tanks (AW102 and AW106) are not considered (Certa et al. 1996b).
(2) The letter after the tank designation indicates which inventory estimate cause the violation: P = Privatization, H = HTCE, and T = TWRS

The "RFP limit ≤ Process limit" column flags possible analytes of concern. It is desirable for the RFP limit to be equal or less than the process limit. The RFP and Process limit are considered equal if they are within 5% of each other. When RFP limit is less than the process limit, the RFP limit may have been lowered in accordance with compositional inventory estimates to avoid higher than necessary private contractor bids. A "no" in this column flags a potential concern because risk increases when the RFP limit is greater than the process limit. Risk also increases if reliable compositional data exceeds the process limit but not the RFP limit. A brief explanation is provided in the table for the difference between the limits. More detail is provide in the sections for the specific analytes.

The next column identifies tank wastes that violate the RFP or process limit. As many lines as necessary are entered under a given analyte/envelope type to address separate groupings of tank wastes with a common violation of the limit. Tank wastes are assessed in the envelope in which they are assigned (Table 4.1). If tank waste containing more than 50 MT of Na has not been assigned to an envelope, it is assessed against all envelopes. The reliability of the data indicating a limit violation is summarized in the next column.

A risk factor of low, medium, high or very high is assigned to each envelope for each analyte. Table 2.4 shows the logic used to assign the risk factor. Designation of risk factor depends on the disparity between the RFP and process limit, the size of the compositional discrepancy, and MT Na in the waste or the waste type (for Envelope B) in violation of a limit. Risk is classified as medium if either 1) the RFP limit exceeds the process limit by more than 40% or 2) significant tank waste is within 20% of the process limit or RFP limit, whichever is lower. High risk is assigned if significant waste volume for a given envelope exceeds the lower of the two limits by more than 20%. Significant tank waste is defined as >200 MT Na for Envelope A, NCAW for Envelope B, and >5500 MT Na for Envelope C. The definition of significant waste is based on the difference, to the nearest hundred, between amount of waste available in each envelope and the minimum order quantities required for Phase I (Certa et al. 1996b). Unassigned waste whose composition is in violation of a limit will not be considered as significant waste. Also waste containing less than 50 MT Na is not considered in the assessment or assignment of risk factor. A brief explanation of the chosen risk factor is given in the table.

One influence on the Envelope B assessment is the planned consolidation of Neutralized Current Acid Waste (NCAW). Currently NCAW resides in tanks AZ101 and AZ102. In accordance with the findings of Shelton (1996), NCAW supernatant from AZ101 and AZ102 will be consolidated in AY101. In the Privatization or HTCE inventories, NCAW is considered to be in AZ101 and AZ102, and in the TWRS inventory, NCAW is considered to be in AY101. The final composition of NCAW after consolidation may differ slightly from the composition in either AZ101 or AZ102. When a component in AZ101 or AZ102 exceeds a limit as estimated by Privatization or HTCE, the post-consolidation value from TWRS AY101 is considered. Both ratings are shown; the post consolidation rating is in parentheses. If the consolidation of AZ101 and AZ102 does not occur, the risk of not meeting the Envelope B feed volume requirements is considerable.

Another consideration for the risk assessment is the variable nature of the waste compositions in some tanks due to frequent additions, transfers, and evaporator campaigns. In some cases, the waste that was in a particular tank when HTCE or Privatization compositions were estimated will not exist in FY2002; the beginning of Phase I and the time to which TWRS

Table 4.4. Risk Assessment Logic Matrix

		Envelope A Waste		Envelope B Waste		Envelope C Waste	
		≤ 200 MT Na	> 200 MT Na	Not NCAW	NCAW	≤ 5500 MT Na(1)	> 5500 MT Na
RFP Limit ≤ Process Limit	Comp ≤ 80% RFP Limit	Low	Low	Low	Low	Low	Low
	80% of RFP< Comp ≤ 120% RFP Limit	Low	Medium	Low	Medium	Low	Medium
	Comp > 120 % RFP Limit	Low	High	Low	High	Low	High
Process Limit <RFP Limit ≤ 140% Process Limit	Comp ≤ 80% Process Limit	Low	Low	Low	Low	Low	Low
	80% of Process Limit < Comp ≤ 120% Process Limit	Low	Medium	Low	Medium	Low	Medium
	Comp > 120 % Process Limit	Low	High	Low	High	Low	High
RFP Limit > 140% Process Limit	Comp ≤ 80% Process Limit	Medium	Medium	Medium	Medium	Medium	Medium
	80% of Process Limit < Comp ≤ 120% Process Limit	Medium	High	Medium	High	Medium	High
	Comp > 120 % Process Limit	Medium	Very High	Medium	Very High	Medium	Very High

(1) In the FY97 update to this report, it is recommended that the lower limit for significant Envelope C waste be decreased from 5500 MT Na to 1000 MT Na to reflect more conservatively, the impact of excluding projected waste (ie., waste whose location and composition depend on future tank farm transfers) or that waste which is borderline with respect to meeting the envelope specifications.

estimates were projected. If a Privatization or HTCE waste is expected to be nonexistent in FY2002, the second rating in parentheses excludes the waste from consideration.

The following sections describe the assessment of each analyte. Appendix C provides plots and data tables of the compositional values used for the assessments. Appendix E contains the conversions of the referenced process limits into units in common with the RFP envelope limits so that comparisons can be made.

4.1 Al

Process Limit

The selected process limit for aluminum is 12 wt% Al_2O_3 (A/C - 4.7 E-01 mol Al/mol Na, B - 1.2 mol Al/mol Na) in glass (Shade 1995). Aluminum can be a major constituent, added to increase glass durability and melt viscosity. Aluminosilicate crystallizes when Al_2O_3 content exceeds 12 wt%.

From the perspective of ion exchange fouling, the pH of LAW liquid containing soluble $Al(OH)_4^-$ must be controlled to avoid precipitation of $Al(OH)_3$. The pH control is the responsibility of the private contractor and is not appropriate for inclusion as a feed specification. This issue is discussed in the section addressing the analyte OH^-.

Comparison of Process Limit and RFP Limit

In Envelope A or C, the RFP limit for aluminum is 60% lower than the process limit. In Envelope B, the RFP limit is 84% lower than the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

The RFP limit is greater than all DST waste inventory values reported for aluminum (Figure C.2). The maximum composition estimate occurs in TWRS SY103, an unassigned tank, and is 12% below the RFP limit for all envelopes. No other estimates are within 20% of the RFP value in any envelope.

Risk Assessment

The risk for this element is low because the RFP limit is below the process limit and all reported significant compositions are below the RFP limit by more than 20%.

4.2 Ba

Process Limit

The only reported process limit for barium is the Hanford Waste Vitrification Project (HWVP) constraint of 20 wt% BaO (A/C - 2.6 E-01 mol Ba/mol Na, B - 6.5 E-01 mol Ba/mol

Na) in glass[(a)]. This limit applies to the vitrification of high-level waste sludge, and most likely represents an upper concentration limit rather than a process limit. The HWVP limit is used as the basis for a rough order of magnitude comparison.

Barium carries several pretreatment process concerns, such as interference in the strontium removal process, and precipitation with phosphate in a caustic leaching process. These effects of barium may influence the choice, efficiency, and cost of separation processes by the private contractor. Process data on pretreatment processes were not sufficient to establish a limit.

Barium is a RCRA metal regulated for toxicity (40 CFR 261, WAC 173-303-090). The RCRA limit for barium was not used for developing the process limit selected for comparison with the envelope limit. The following discussion on the RCRA limit is provided for information in determinining the necessity of performing the Toxicity Characteristic Leaching Procedure (TCLP).

Barium's RCRA limit of 100 mg/L is applicable to leachate produced during the TCLP, from a small amount the final waste form (e.g. LAW glass). The waste feed which will be supplied to the private contractor for pretreatment has been designated under RCRA and will be processed significantly before production of the final waste form. Any knowledge regarding the waste feed may be important for process knowledge but will not otherwise be pertinent to RCRA designation of the treated waste form. It will be the responsibility of the private contractor to provide a final waste form that meets RCRA specifications for treated waste.

If process knowledge or testing can show that a particular waste form does not contain sufficient inventories of a TCLP analyte, then TCLP testing is not required under RCRA (SW-846, Method 1311). Given that the waste form inventories for the process feed and treated product are relative to sodium concentration, TCLP process limits of 2.9 E-03 mol Ba/mol Na for Envelope A or C and 7.3 E-03 mol Ba/mol Na for Envelope B were calculated (see Appendix E) and can be compared with waste composition to determine the need for performing the TCLP test on the LAW glass that meets specifications. Calculations of the process limits assumed that an amount of barium equal to the RCRA limit is present in the leachate and that the leachate is equal to 20 times the weight of the glass tested (SW-846, Method 1311). The TCLP testing for barium on the treated waste form will not be necessary if the Ba/Na mole ratio is below the calculated process limit. Note this does not preclude a need to verify or establish in some manner that the barium to sodium ratios comply with the established feed envelopes and that subsequent processing does not affect their relative concentrations.

Comparison of Process Limit and RFP Limit

The RFP limit is approximately three orders of magnitude less than the process limit for all envelopes.

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package*. WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

For Envelope A and B, the highest waste composition (TWRS AN101; an unassigned waste) is 92% below the RFP limit (Figures C.5-6).

For Envelope C, the tank AN107 Privatization inventory estimate is 3 times the RFP limit. The AN107 data point for barium is an order of magnitude beyond all other tanks and is not considered reliable; the memo providing the data has no traceability to a specific sampling event. TWRS and HTCE do not provide Ba estimates for AN107. The next highest barium value (1.1 E-05 from AN102 Privatization inventory) falls approximately 90% below the RFP limit.

Risk Assessment

Barium is a low risk for all envelopes.

4.3 Ca

Process Limit

The selected process limit for calcium is 12 wt% CaO (A/C - 4.3 E-01 mol Ca/mol Na, B - 1.1 mol Ca/mol Na) in glass. This constraint is based on the combined CaO and MgO limit of 12 wt% in glass as proposed by Shade (1995). The magnesium inventory is small relative to calcium (Orme 1995). The more restrictive glass limit of 1 wt% CaO (A/C - 3.6 E-02 mol Ca/mol Na, B - 8.9 E-02 mol Ca/mol Na) for glass approaching 3 wt% P_2O_5 (Lambert and Kim 1994) was not selected because most of the DST wastes will not be limited by phosphate.

Pretreatment concerns about calcium are the same as those discussed for barium: interference in the strontium removal process and precipitation with phosphate in a caustic leaching process. As with the treatment for barium, the data were insufficient for establishing a process limit based on pretreatment.

Comparison of Process Limit and RFP Limit

The RFP limit for calcium is an order of magnitude less than the selected process limit, which was based on 12 wt% CaO in glass. For high phosphate glass (approaching 3 wt% P_2O_5 in glass), the applicable 1 wt% CaO glass constraint corresponds to a process limit for Envelope A and C which is 11% less than the RFP limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

All DST waste inventory estimates in all envelopes are in compliance of the RFP limit by more than 20% (Figures C.9-10). The largest inventory estimate in Envelope A (HTCE AP101) is 61% below the RFP limit. The largest inventory estimate in Envelope B (HTCE AZ102) is 92% below the RFP limit. The largest inventory estimate in Envelope C (HTCE AP102) is 91% below the RFP limit. Furthermore, all DST waste inventory estimates are in compliance with the selected process limit (12 wt% CaO in glass) as well as the more restrictive limit corresponding to 1 wt% CaO in glass with a high phosphate content.

Risk Assessment

A low risk is assigned to calcium for all envelopes.

4.4 Cd

Process Limit

The process limit selected for cadmium is the minor component limit of 2.5 wt% CdO (A/C - 3.9 E-02, B - 9.7 E-02) in glass (Shade 1995).

In other work, a 3% loss of cadmium as a submicron aerosol from glass melter tests has been reported[(a)]. Although this solids carryover will have to be addressed in the design of the melter offgas system used in the Privatization effort, this issue was not used in establishing a waste feed specification.

Cadmium is a RCRA metal regulated for toxicity (40 CFR 261, WAC 173-303-090). The RCRA limit for cadmium was not used for developing the process limit selected for comparison with the envelope limit. The following discussion on the RCRA limit is provided for information in determinining the necessity of performing the Toxicity Characteristic Leaching Procedure (TCLP).

Cadmium's RCRA limit of 1 mg/L is applicable to leachate produced during the Toxicity Characteristic Leaching Procedure (TCLP), from a small amount the final waste form (e.g. LAW glass). The waste feed which will be supplied to the private contractor for pretreatment has been designated under RCRA and will be processed significantly before production of the final waste form. Any information about the waste feed may be important for process knowledge but is not pertinent to RCRA designation of the treated waste form. It will be the responsibility of the private contractor to provide a final waste form that meets RCRA specifications for treated waste.

If process knowledge or testing can show that a particular waste form does not contain sufficient inventories of a TCLP analyte, then TCLP testing is not required under RCRA (SW-846, Method 1311). Given that the waste form inventories for the process feed and treated product are relative to sodium concentration, TCLP process limits of 3.6 E-05 mol Cd/mol Na for Envelope A or C and 9.6 E-04 mol Cd/mol Na for Envelope B were calculated (see Appendix E) and can be compared with waste composition to determine the need for performing the TCLP test on the LAW glass that meets specifications. Calculations of the process limits assume that an amount of cadmium equal to the RCRA limit is present in the leachate and that the leachate is 20 times the weight of the glass tested (SW-846, Method 1311). The TCLP testing for cadmium on the treated waste form will not be necessary if the Cd/Na mole ratio is below the calculated process limit. Note this does not preclude a need to verify or establish in some manner that the cadmium to

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(a) Perez, JM, PJ Shafer, WC Buchmiller. 1994. *Test Results of Vitrifying TWRS DSSF Low-Level Waste Simulant. Small-Scale, High-Temperature Melter Test 3 (SSHTM-3).* PVTD-C95-03.01A, Pacific Northwest Laboratory, Richland, Washington.

sodium ratios comply with the established feed envelopes and that subsequent processing does not affect their relative concentrations.

Comparison of Process Limit and RFP Limit

The RFP limit is nearly an order of magnitude less than the process limits for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

The maximum tank inventory estimates for all envelopes are almost two orders of magnitude less than the RFP limit for cadmium (Figures C.11-12).

Risk Assessment

Cadmium presents a low risk in all envelopes.

4.5 Cl

Process Limit

The process limit selected for chlorine is 0.5 wt% (A/C - 2.8 E-02 mol Cl/mol Na, B - 7.0 E-02) in glass based on a recent solubility study (Li 1995). In this work, chlorine solubility was 0.49 wt% and 0.57 wt% in two LAW glass formulations. The noted loss of chlorine as offgas was consistent with another study, where glass from a small-scale, joule-heated melter retained only 80% (DF=5) of the chorine in the tank waste feed.[a]

The solubility limit is not a strict process limit because chlorine in the feed in excess of its solubility in glass forms a separate molten NaCl phase, which floats to the surface of the melter, or is released into the melter offgas (Li 1995). At additional facility cost, it may be possible to accommodate both of these pathways for excess chlorine: an altered melter design to permit removal of the molten salt phase and offgas processing to recover chlorine as a separate waste form (Orme 1995). Incorporating these processing alternatives into a plant facility design, would require significant engineering effort to refine the process design concepts; including testing and/or development work.

The HWVP limit of 0.3 g Cl/100 g total waste oxide equivalent (A/C - 4.2 E-03 mol Cl/mol Na, B - 1.1 E-02 mol Cl/mol Na) is approximately seven times more stringent than the 0.5 wt% chlorine glass solubility limit (based on HWVP specification of 25 wt% waste oxide

(a) Perez JM, PJ Shafer, WC Buchmiller. 1994. *Test Results of Vitrifying the TWRS DSSF Low-Level Waste Simulant. Small-Scale, High-Temperature Melter Test 3 (SSHTM-3).* PVTD-C95-0301A, Pacific Northwest Laboratory, Richland, Washington.

loading in glass).[a] This HWVP specification was probably not set by process limit considerations, but rather was based on the chlorine content of washed HLW sludge, which is much lower than the chlorine content of tank waste supernate. The limit is provided for a rough comparison. The LAW melter offgas systems can accommodate higher levels of chlorine, as suggested in the current TWRS process flowsheet (Orme 1995) which disposes of chlorine as a separate waste form.

Earlier work recommended less stringent glass solubility constraints of 1 wt% Cl (A/C - 5.6 E-02 mol Cl/mol Na, B - 1.4 E-01 mol Cl/mol Na) (Shade 1995) and 1 wt% NaCl (A/C - 3.4 E-02 mol Cl/mol Na, B - 8.5 E-02 mol Cl/mol Na) (Hrma and Piepel 1994).

Comparison of Process Limit and RFP Limit

The RFP limit for Envelopes A and C is 31% greater than the selected process limit.

The RFP limit for Envelope B is 26% greater than the selected process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, three waste composition estimates (TWRS AP104 and AP106, and Privatization AY102) are within 20% of the process limit (Figures C.14-15). The total amount of Na in these tanks exceeds the 200 MT Na criterion for significant waste. Two unassigned wastes (TWRS SY101 and SY103) are also within 20% of the process limit. None of these tanks exceed the RFP limit.

In Envelope B, the highest waste composition (TWRS SY103; unassigned waste) is 60% less than the process limit.

In Envelope C, the waste composition estimate for Privatization AP102 and the estimates for unassigned wastes in SY101 and SY103 (TWRS) are within 20% of the process limit. These wastes are considered to be insignificant.

Risk Assessment

Medium risk is assigned to the RFP limit for Envelope A even though all tank wastes comply with the RFP limit. The reason is that significant waste exceeds the process limit based on the glass solubility limit. There is some uncertainty in the limit because chlorine beyond the limit will be part of either a molten salt phase in the melter or melter offgas, which can be treated to dispose of the chlorine as a separate waste. The design of facilities to provide such enhanced chlorine treatment will affect process development costs and schedules. In addition, disposal issues for the resulting secondary waste stream will have to be resolved. Blending of the waste feed to avoid high chlorine feed content is an option that might minimize the facility costs for this specialized treatment and disposal of chlorine.

Low risk is associated with the chlorine RFP limit for Envelope B and C.

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWVP-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

4.6 Cr

Process Limit

The selected process limit for chromium is the minor component constraint of 0.5 wt% Cr_2O_3 (A/C - 1.3 E-02 mol Cr/mol Na, B - 3.3 E-02 mol Cr/mol Na) in glass (Shade 1995). This limit is in agreement with reported results from solubility experiments using LAW simulated glasses in which chromium solubility was in the range 0.46 to 1.0 wt% Cr_2O_3 (Li 1995). At higher content in HLW glass, chromium forms insoluble spinels with iron and nickel which can accumulate in the melter. The significantly lower levels of iron and nickel in LAW glass appears to enhance chromium solubility in LAW simulated glass.

Chromium is a RCRA metal regulated for toxicity (40 CFR 261, WAC 173-303-090). The RCRA limit for chromium was not used for developing the process limit selected for comparison with the envelope limit. The following discussion on the RCRA limit is provided for information in determinining the necessity of performing the Toxicity Characteristic Leaching Procedure (TCLP).

Chromium's RCRA limit of 5 mg/L is applicable to leachate produced during the Toxicity Characteristic Leaching Procedure (TCLP), from a small amount of the final waste form (e.g. LAW glass). The waste feed which will be supplied to the private contractor for pretreatment has been designated under RCRA and will be processed significantly before production of the final waste form. Any knowledge regarding the waste feed may be important for process knowledge but will not otherwise be pertinent to RCRA designation of the treated waste form. It will be the responsibility of the private contractor to provide a final waste form that meets RCRA specifications for treated wastes.

If process knowledge or testing can show that a particular waste form does not contain sufficient inventories of a TCLP analyte, then TCLP testing is not required under RCRA (SW-846, Method 1311). Given that the waste form inventories for the process feed and treated product are relative to sodium concentration, TCLP process limits of 3.9 E-04 mol Cr/mol Na for Envelope A or C and 9.6 E-04 mol Cr/mol Na for Envelope B were calculated (see Appendix E) and can be compared with waste composition to determine the need for performing the TCLP test on the LAW glass that meets specifications. Calculations of the process limits assumed that an amount of chromium equal to the RCRA limit is present in the leachate and that the leachate is equal to 20 times the weight of the glass tested (SW-846, Method 1311). The TCLP testing for chromium on the treated waste form will not be necessary if the Cr/Na mole ratio is below the calculated process limit. Note this does not preclude a need to verify or establish in some manner that the chromium to sodium ratios comply with the established feed envelopes and that subsequent processing does not affect their relative concentrations.

Comparison of Process Limit and RFP Limit

The RFP limit for Envelope A/C is 48% less than the process limit.

The RFP limit for Envelope B is 39% less than the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the HTCE estimate for AN101 is within 20% of the RFP limit (19% below the RFP limit) (Figures C.18-19). AN101 contains significant waste for Envelope A. However, transfers into and out of the tank will have changed the waste composition by the time the private contractors process the waste (Shelton 1996). The waste expected to be in this tank in FY2002 is not assigned to an envelope and is not scheduled to be processed during Phase I (Certa et al. 1996b). Also, the TWRS estimate reflecting the waste composition in AN101 in FY2002 is below the RFP limit by more than 20%. The TWRS estimate for SY103 (unassigned waste) exceeds the RFP limit by 88%. This waste is not scheduled to be processed during Phase I and is not considered to be significant.

In Envelope B, the highest waste composition (TWRS SY103, unassigned waste) is 35% below the RFP limit.

In Envelope C, the waste in SY103 (TWRS, unassigned) exceeds the RFP limit by 88%. No waste compositions are within 20% of the Envelope C RFP limit.

Risk Assessment

Medium risk is assigned to chromium in Envelope A because of the HTCE estimate for waste in AN101. However, a low risk results when the TWRS estimate for waste in AN101 in FY2002 is considered.

Low risk is assigned to chromium in Envelope B and C.

4.7 F

Process Limit

The selected process limit for fluorine is the minor component limit of 1.7 wt% F (A/C - 1.8 E-01 mol F/mol Na, B - 4.5 E-01 mol F/mol Na) in glass (Shade 1995).

Volatility of fluorine is a concern from an offgas system corrosion standpoint. In small-scale joule-heated melter operation, 33% (DF=3) of the fluorine in the melter feed was lost in the offgas[a]. No waste feed limit based on fluorine offgas losses was quantified.

Comparison of Process Limit and RFP Limit

The RFP limit for Envelopes A/C waste is 49% below the process limit. The RFP limit for Envelope B waste is 55% below the process limit.

(a) Perez JM, PJ Shafer, WC Buchmiller. 1994. *Test Results of Vitrifying the TWRS DSSF Low-Level Waste Simulant. Small-Scale, High-Temperature Melter Test 3 (SSHTM-3).* PVTD-C95-0301A, Pacific Northwest Laboratory, Richland, Washington.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the largest waste composition estimate (TWRS AP106) is 36% below the RFP limit. In Envelope B, the largest waste composition estimate (Privatization AZ102) is 88% below the RFP limit and in Envelope C, the largest waste composition estimate (TWRS AP101) is 62% below the RFP limit (Figures C.20-21).

Risk Assessment

Fluorine is given a low risk rating in all envelopes.

4.8 Fe

Process Limit

The selected process limit for iron is the recommended limit of 12 wt% Fe_2O_3 (A/C - 3.0 E-01 mol Fe/mol Na, B - 7.5 E-01 mol Fe/mol Na) in glass. (Shade 1995). Iron can be a major constituent in glass, reducing melt viscosity. However, beyond 12 wt% Fe_2O_3 in glass, crystallinity increases and phase separation reduces glass durability. Such high iron concentrations would not be expected in LAW facility feed.

Comparison of Process Limit and RFP Limit

The RFP limit for iron is an order of magnitude less than the process limits for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the RFP limit exceeds all DST iron inventory estimates, except for tank AY102 (Privatization) (Figure C.23). Investigation of the AY102 estimate reveals that the value is a detection limit: A more recent (9/95) sampling of waste from this tank yielded a less than detection limit iron content two orders of magnitude smaller than the current estimate, and that is well within the RFP limit. Also, the waste in AY102 is not considered significant waste because it contains less than 200 MT Na and the composition in AY102 will significantly change before FY2002 (Shelton 1996).

In Envelope B and C, the largest waste composition values are respectively approximately 68% (TWRS SY103) and 48% (Privatization AN107) below the RFP limit.

Risk Assessment

Low risk is associated with the RFP limit for iron for all envelopes.

4.9 Hg

Process Limit

The selected process limit for mercury is 20 ppm HgO (A/C - 1.9 E-05 mol Hg/mol Na, B - 4.6 E-05 mol Hg/mol Na) in glass. This value is in the lower portion of the estimated glass solubility range of 10 to 100 ppm[(a)].

Mercury is a volatile metal, which must be considered in offgas system design. No quantifiable process limit was identified based on offgas system impact.

Mercury is a RCRA metal regulated for toxicity (40 CFR 261, WAC 173-303-090). The RCRA limit for mercury was not used for developing the process limit selected for comparison with the envelope limit. The following discussion on the RCRA limit is provided for information in determinining the necessity of performing the Toxicity Characteristic Leaching Procedure (TCLP).

Mercury's RCRA limit of 0.2 mg/L is applicable to leachate produced during the Toxicity Characteristic Leaching Procedure (TCLP), from a small amount of the final waste form (e.g. LAW glass). The waste feed which will be supplied to the private contractor for pretreatment has been designated under RCRA and will be processed significantly before production of the final waste form. Any knowledge regarding the waste feed may be important for process knowledge but will not otherwise be pertinent to RCRA designation of the treated waste form. It will be the responsibility of the private contractor to provide a final waste form that meets RCRA specifications for treated waste.

If process knowledge or testing can show that a particular waste form does not contain sufficient inventories of a TCLP analyte, then TCLP testing is not required under RCRA (SW-846, Method 1311). Given that the waste form inventories for the process feed and treated product are relative to sodium concentration, TCLP process limits of 4.0 E-06 mol Hg/mol Na for Envelope A and 1.0 E-05 mol Hg/mol Na for Envelope B were calculated (see Appendix E) and can be compared with waste composition to determine the need for performing the TCLP test on the LAW glass that meets specifications. Calculations of the process limits assumed that an amount of mercury equal to the RCRA limit is present in the leachate and that the leachate is equal to 20 times the weight of the glass tested (SW-846, Method 1311). The TCLP testing for mercury on the treated waste form will not be necessary if the Hg/Na mole ratio is below the calculated process limit. Note this does not preclude a need to verify or establish in some manner that the mercury to sodium ratios comply with the established feed envelopes and that subsequent processing does not affect their relative concentrations.

(a) Shade JW. 1995. E-mail message to K. D. Wiemers dated 9/28/95.

Comparison of Process Limit and RFP Limit

The RFP limit for mercury is 24% below the process limit for Envelopes A and C. In Envelope B, the RFP limit is 70% below the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the largest inventory estimate (TWRS AN102) is 61% below the RFP limit. In Envelope B and C, the largest inventory estimate (TWRS AN101, unassigned) is 91% below the RFP limit (Figures C.24-25).

Risk Assessment

The RFP limit for mercury has low risk in all envelopes. However the amount of compositional information is limited. Additional analytical data should be collected to verify inventory estimates.

4.10 K

Process Limit

The process limit for potassium of 0.14 mole K/mole Na is based on the composition of DSSF simulant used in cesium ion exchange column tests (Kurath 1994). These tests compared column performance of DSSF (molar ratio K/Na =0.14) and NCAW (molar ratio K/Na =0.024) simulants. The volume of simulated waste treated before 50% cesium breakthrough was 20% less for the DSSF simulant (resorcinol-formaldehyde resin). The lower cesium capacity when potassium content of the waste is high, reflected by these results, will translate into more frequent column regeneration (approximately 20% shorter resin loading period) by the private contractor when processing DSSF feed.

In addition to limitations defined by interference with cesium ion exchange, the combined oxide limit for potassium and sodium is 20 wt% in glass[a].

Comparison of Process Limit and RFP Limit

The RFP limit is 33% greater than the process limit for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

The largest inventory estimate (Privatization AP105) in Envelope A is within 20% of the process limit (16% below) (Figure C.26). AP105 constitutes significant waste for Envelope A. However, the waste composition will be changing due to transfers into and out of the tank between the time the Privatization estimate was made and the time the private contractors will process the

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(a) Shade JW. 1995. E-mail message to K. D. Wiemers dated 9/28/95.

waste (Shelton 1996), so that the waste characterized by the Privatization inventory will no longer exist in FY2002.

The largest inventory estimate (Privatization AZ101) in Envelope B is 79% below the process limit. The largest inventory estimate (TWRS AP101) in Envelope C is 35% below the process limit.

Risk Assessment

Envelope A is assigned medium risk because significant waste is within 20% of the process limit. However, if the Privatization AP105 estimate is not considered because the composition in AP105 will dramatically change, the rating is low. Envelope B and C are both assigned low risk.

4.11 La

Process Limit

The selected process limit for lanthanum is 2 wt% La_2O_3 (A/C - 1.8 E-02 mol La/mol Na, B - 4.6 E-02 mol La/mol Na) in glass (Shade 1995). This constraint is based on the combined rare earth oxide (La, Ce, Nd) limit of 2 wt% in glass proposed by Shade (1995). The more restrictive limit of 1.5 wt% La_2O_3 (A/C - 2.5 E-02 mol La/mol Na, B - 6.1 E-02 mol La/mol Na) in glass is applicable to high phosphate glasses (Lambert and Kim 1994) and was not selected because most of the DST wastes will not be limited by phosphate.

Comparison of Process Limit and RFP Limit

The RFP limit is more than 2 orders of magnitude less than the process limit for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelopes A, B, and C, the largest inventory estimates is from the unassigned tank AN101 (TWRS) which is 43% below the RFP limit (Figures C.27-28).

Risk Assessment

Low risk is associated with the lanthanum for all envelopes. Note that no assessment has been made on how the total rare earth concentration compares with the process limit.

4.12 Ni

Process Limit

The selected process limit for nickel is an estimate of 2 wt% NiO (A/C - 5.4 E-02 mol Ni/mol Na, B - 1.3 E-01 mol Ni/mol Na) solubility in glass (Shade 1995). No other limits were identified.

Comparison of Process Limit and RFP Limit

The RFP limit is approximately an order of magnitude less than the process limit for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the largest inventory estimate (HTCE AP105) is 73% below the RFP limit. In Envelope B, the largest inventory estimate (HTCE SY103) is 83% below the RFP limit. In Envelope C, the largest inventory estimate is 67% (Privatization AN107) below the RFP limit (Figures C.35-36).

Risk Assessment

Low risk is associated with nickel for all envelopes.

4.13 NO_2^-

Process Limit

The process limit is conservatively based on batch distribution measurements (Dowex 1 X-8 resin) of technetium as pertechnetate (TcO_4^-) in simulated PUREX waste (Roberts et al. 1962). The effect of nitrite concentration on pertechnetate sorption was investigated for nitrite concentrations in the range of 0 to 3 M (sodium concentration range 3 to 8 M). Depending on nitrate and carbonate concentrations, variations in nitrite concentration either halved or doubled the technetium K_d. The selected process limit of 1 mole nitrite per mole of sodium is the maximum molar ratio of nitrite to sodium for simulants used in the study.

Nitrates and nitrites in tank waste supernatant will be converted to NO_x in the LAW glass melter. The NO_x generation affects the sizing of downstream offgas equipment and will require offgas treatment. Conversion requirements for NO_x from melter offgas may exceed 99% to meet the 40 tons per year site limit specified by 40 CFR 51.166[(a)]. Since 80% to 90% conversion is typical for a single NO_x conversion unit (Hill 1981), multiple conversion units in series will be necessary to meet the high removal requirements.

The maximum NO_x limit for the HWVP reference feed is 36 wt% NO_3^- (0.23 mol NO_3^- /mol Na) of total feed as waste oxides[(b)]. This limit was most likely based on the highest nitrite/nitrate content of washed HLW sludge anticipated and was specified to allow sizing of a

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(a) Peurrung LM, TJ Deforest, JR Richards. 1995. *Process System Evaluation - Consolidated Letter Reports. Volume 1 - Alternatives for the Off-Gas Treatment System for the Low-Level Waste Vitrification Process*. PVTD-C95-03.02A, Vol. 1, Pacific Northwest Laboratory, Richland, Washington.

(b) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWVP-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

HLW melter offgas system. In a similar fashion, the NO_x specification for the LAW melter offgas system should be based on the nitrate/nitrate content of the supernatant feed. The HWVP specification is given for relative comparison when defining LAW process limits for nitrite.

The maximum limit for nitrite permitted by the tank corrosion specifications is 5.5 M for observed values of nitrate and hydroxide of 1 M (WHC 1994a). This limit is not anticipated to be constraining.

Comparison of Process Limit and RFP Limit

The RFP limit is 62% below the selected process limit for nitrite for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelopes A and C, the largest inventory value (TWRS SY103; an unassigned waste) is 31% below the RFP limit. In Envelope B, the largest inventory value (Privatization AZ101) is 20% below the RFP limit (Figure C.37).

Risk Assessment

Low risk is associated with nitrite for all envelopes.

4.14 NO_3^-

Process Limit

The process limit is conservatively based on batch distribution measurements (Dowex 1 X-8 resin) of technetium as pertechnetate (TcO_4^-) in simulated PUREX waste (Roberts et al. 1962). The effect of nitrate concentration on pertechnetate sorption was investigated for nitrate concentrations in the range of 0 to 3 M (sodium concentration range 3 to 8 M). Despite an order of magnitude reduction in technetium K_d as nitrate concentration was increased from 0 to 3 M, acceptable separation was achieved. The process limit of 1 mole nitrate per mole of sodium is the maximum molar ratio of nitrate to sodium for simulants used in the study.

Nitrates and nitrites in tank waste supernatant will be converted to NO_x in the LAW glass melter. The NO_x generation affects the sizing of downstream offgas equipment and will require offgas treatment. Conversion requirements for NO_x from melter offgas may exceed 99% to meet the 40 tons per year site limit specified by 40 CFR 51.166[a]. Since 80% to 90% conversion is typical for a single NO_x conversion unit (Hill 1981), multiple conversion units in series will be necessary to meet the high removal requirements.

(a) Peurrung LM, TJ Deforest, JR Richards. 1995. *Process System Evaluation - Consolidated Letter Reports. Volume 1 - Alternatives for the Off-Gas Treatment System for the Low-Level Waste Vitrification Process*. PVTD-C95-03.02A, Vol. 1, Pacific Northwest Laboratory, Richland, Washington.

The maximum NO_x limit for the HWVP reference feed is 36 wt% NO_3^- (0.23 mol NO_3^- /mol Na) of total feed as waste oxides[(a)]. This limit was probably based on the highest nitrite/nitrate content of washed HLW sludge anticipated and was specified to allow sizing of a HLW melter offgas system. In a similar fashion, the NO_x specification for the LAW melter offgas system should be based on the nitrate/nitrate content of the supernatant feed. The HWVP specification is given for relative comparison when defining process limits for nitrite.

The maximum limit for nitrate permitted by the tank corrosion specifications is 5.5 M for observed values of nitrite and hydroxide of 1 M (WHC 1994a). This limit is not anticipated to be constraining.

Comparison of Process Limit and RFP Limit

The RFP limit for nitrate is 20% below the selected process limit for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

The largest inventory value in Envelope A (HTCE AP101) is 35% below the RFP limit. The largest inventory value for Envelopes B (HTCE SY103; an unassigned waste) is 46% below the RFP limit. In Envelope C, the largest inventory value (HTCE SY101) is 45% below the RFP limit (Figure C.38).

Risk Assessment

The risk assigned to nitrate is low for all envelopes.

4.15 OH

Process Limit

The process limit for hydroxide is conservatively defined as NCAW simulant successfully treated for cesium removal by ion exchange with resorcinol-formaldehyde resin (Kurath 1994). This waste had the highest ratio of hydroxide to sodium (3.4 M:5 M=0.68).

In batch distribution measurements (Dowex 1 X-8 resin) of technetium as pertechnetate (TcO_4^-) in PUREX waste, the addition of hydroxide increased pertechnetate absorption on the resin. The maximum ratio of hydroxide to sodium in feeds used in this study was 3 M to 6.7 M Na, or 0.48.

Hydroxide strongly affects aluminum solubility and is therefore of concern in cesium ion exchange where precipitation of solids would foul the resin. Maximum aluminum solubility occurs at 1.75 M free hydroxide and drops dramatically as free hydroxide falls below 1 M (Barney 1976).

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package*. WHC-SD-HWVP-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

It is important to specify whether hydroxide is reported on a free or total basis (Kurath 1994), e.g. hydroxide bound to aluminum in solution as $Al(OH)_4^-$ contributes to total hydroxide but not free hydroxide.

The tank waste corrosion constraint for hydroxide is not expected to be limiting. The specifications can be found in OSD-T-151-00007 (WHC 1994a).

Comparison of Process Limit and RFP Limit

The RFP and selected process limit are within 3% of each other and can be considered essentially the same.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, nine HTCE inventory values are within 20% of the RFP limit (Figure C.39). The HTCE estimates overestimate the hydroxide quantity when compared to inventories based on analytical data like the TWRS and Privatization because the HTCE include hydroxide bound in complexes with Al, Cr, Fe, Mn, etc. Therefore, the HTCE estimates for hydroxide are not considered in the risk assessment. Two unassigned wastes (TWRS AN101, HTCE SY102) are within 20% of the RFP limit. The unassigned waste (TWRS SY101) exceeds the RFP limit by more than 20%.

In Envelope B, the HTCE estimate for AZ102 exceeds the RFP limit by more than 20%. The estimate for post-consolidation NCAW in AY101 is more than 20% below the RFP limit. Two unassigned wastes (TWRS AN101, HTCE SY103) are within 20% of the RFP limit. The unassigned waste (TWRS SY101) exceeds the RFP limit by more than 20%.

In Envelope C, the HTCE estimates for AN102 and AN107 are within 20% of the RFP limit. Two unassigned wastes (TWRS AN101, HTCE SY102) are within 20% of the RFP limit. The unassigned waste (TWRS SY101) exceeds the RFP limit by more than 20%.

Risk Assessment

Medium risk is assigned to Envelope A. Envelope B is assigned high risk, however this risk is low if the post-consolidation estimates for NCAW are considered. Envelope C is assigned low risk for hydroxide.

4.16 Pb

Process Limit

The selected process limit for lead is 2 wt% PbO (A/C - 1.8 E-02 mol Pb/mol Na, B - 4.5 E-02 mol Pb/mol Na) solubility in glass (Shade 1995).

Lead is a RCRA metal regulated for toxicity (40 CFR 261, WAC 173-303-090). The RCRA limit for lead was not used for developing the process limit selected for comparison with the envelope limit. The following discussion on the RCRA limit is provided for information in determinining the necessity of performing the Toxicity Characteristic Leaching Procedure (TCLP).

Lead's RCRA limit of 5 mg/L is applicable to leachate produced during the Toxicity Characteristic Leaching Procedure (TCLP), from a small amount of the final waste form (e.g. LAW glass). The waste feed which will be supplied to the private contractor for pretreatment has been designated under RCRA and will be processed significantly before production of the final waste form. Any knowledge regarding the waste feed may be important for process knowledge but will not otherwise be pertinent to RCRA designation of the treated waste form. It will be the responsibility of the private contractor to provide a final waste form that meets RCRA specifications for treated waste.

If process knowledge or testing can show that a particular waste form does not contain sufficient inventories of a TCLP analyte, then TCLP testing is not required under RCRA (SW-846, Method 1311). Given that the waste form inventories for the process feed and treated product are relative to sodium concentration, TCLP process limits of 9.7 E-05 mol Pb/mol Na for Envelope A or C and 2.4 E-04 mol Pb/mol Na for Envelope B were calculated (see Appendix E) and can be compared with waste composition to determine the need for performing the TCLP test on the LAW glass that meets specifications. Calculations of the process limits assumed that an amount of lead equal to the RCRA limit is present in the leachate and that the leachate is equal to 20 times the weight of the glass tested (SW-846, Method 1311). The TCLP testing for lead on the treated waste form will not be necessary if the Pb/Na mole ratio is below the calculated process limit. Note this does not preclude a need to verify or establish in some manner that the lead to sodium ratios comply with the established feed envelopes and that subsequent processing does not affect their relative concentrations.

Comparison of Process Limit and RFP Limit

The RFP limit for lead is more than an order of magnitude smaller than the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the largest inventory estimate for lead (TWRS AW101) is 79% below the RFP limit. In Envelope B, the largest inventory estimate (Privatization AZ101) is 86% below the RFP limit. In Envelope C, the largest inventory estimate (Privatization AN107) is 68% below the RFP limit (Figures C.40-41).

Risk Assessment

Lead has been assigned low risk in all envelopes.

4.17 PO_4^{-3}

Process Limit

The selected process limit for phosphate is set by the glass minor component constraint of 3 wt% P_2O_5 (A/C - 8.5 E-02 mol PO_4^{-3}/mol Na, B - 2.1 E-01 mol PO_4^{-3}/mol Na) (Shade 1995).

This recommended value is in agreement with a recent report of P_2O_5 glass solubility in the range 1.94 to 5.72 wt% in two LAW glass formulations (Li et al. 1995).

Although less than 1% loss of phosphorous in melter offgas was observed in a small-scale joule-heated melter[(a)], no constraint based on melter offgas behavior was identified.

Comparison of Process Limit and RFP Limit

The RFP limits for Envelopes A and C are 55% below the process limit. The RFP limit for Envelope B is 38% below the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the waste composition estimate for TWRS AN101 is within 20% of the RFP limit, however this waste is unassigned to an envelope and considered insignificant (Figures C.42-43).

All Envelope B waste compositions are below the RFP limit. The largest composition estimate (TWRS AN101; an unassigned waste) is 66% below the RFP limit.

In Envelope C, the waste in AP102 (Privatization) is within 20% of the RFP limit but does not exceed the limit. Also, the waste composition estimate for TWRS AN101 (an unassigned waste) is within 20% of the RFP limit. Both of these wastes are considered insignificant.

Risk Assessment

Low risk for phosphate is assigned to all envelopes.

4.18 SO_4^{-2}

Process Limit

The selected process limit for sulfate is set by the glass minor component constraint of 1.0 wt% SO_3 (A/C - 2.5 E-02 mol SO_4^{-2}/mol Na, B - 6.3E-02 mol SO_4^{-2}/mol Na) (Shade 1995). This recommended value is slightly above the SO_3 glass solubility range of 0.47% to 0.75 wt% reported in a recent study of two LAW glass formulations (Li et al. 1995). This solubility limit is not a strict process limit because levels of sulfate in the feed that exceed its solubility in glass results in formation of a separate molten sulfur-rich phase, which floats to the surface of the melter and increased levels of SO_2 in melter offgas. At additional facility cost, it may be possible to accommodate both of these pathways for excess sulfate: an altered melter design to permit removal of the molten salt phase and offgas processing to recover sulfate as solid sulfur (Orme 1995).

(a) Perez JM, PJ Shafer, WC Buchmiller. 1994. *Test Results of Vitrifying the TWRS DSSF Low-Level Waste Simulant. Small-Scale, High-Temperature Melter Test 3 (SSHTM-3).* PVTD-C95-0301A, Pacific Northwest Laboratory, Richland, Washington.

Incorporating these processing alternatives into a plant facility design will require significant engineering effort to refine the process design concepts, including testing and/or development work.

Sulfur losses of approximately 2% to melter offgas were observed in a small-scale joule-heated melter[a]. However, LAW melter offgas systems can accommodate volatilized sulfur as suggested in the current TWRS process flowsheet (Orme 1995), which converts offgas SO_2 to solid sulfur. No melter offgas system limit was identified because air emission limits can be met by suitable melter offgas treatment.[b]

Comparison of Process Limit and RFP Limit

The RFP limit for Envelope A is 61% below the process limit.

The RFP limit for Envelope B is 12% greater than the process limit.

The RFP limit for Envelope C is 20% below the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, 12 HTCE tank compositions exceed the RFP limit by more than 20% (Figure C.46). The single point solubility value for sulfate used in the HTCE model does not take into account common ion effects, which would lower the predicted solubility of sulfates, and has not been tuned to DST analytical data. Consequently, it is likely that the HTCE is over predicting sulfate solubility. The HTCE estimates are not used to determine the risk rating

The Privatization inventory estimate (Figure C.51) exceeds the Envelope A RFP limit by more than 20% for waste in tank AY102. The unassigned waste in AN101 (TWRS) also exceeds the limit by more than 20%. The waste in these tanks is considered to be insignificant.

In Envelope B, waste in AZ102 (Privatization) exceeds the process limit by more than 20%, and exceeds the RFP limit within 20%. Waste in AY101 (TWRS) is within 20% of the process limit but is more than 20% below the RFP limit. The waste in AY101 is the post consolidation composition of NCAW.

In Envelope C, five HTCE wastes are within 20% of or exceed the RFP limit by more than 20%. As stated in the description for Envelope A, the HTCE solubilities are uncertain, and therefore HTCE values are not considered in the risk assessment. One unassigned waste, AN101 is within 20%, but does not exceed the RFP limit. This waste is considered insignificant in Envelope C.

(a) Perez JM, PJ Shafer, WC Buchmiller. 1994. *Test Results of Vitrifying the TWRS DSSF Low-Level Waste Simulant. Small-Scale, High-Temperature Melter Test 3 (SSHTM-3).* PVTD-C95-0301A, Pacific Northwest Laboratory, Richland, Washington.

(b) Peurrung LM, TJ Deforest, JR Richards. 1995. *Process System Evaluation - Consolidated Letter Reports. Volume 1 - Alternatives for the Off-Gas Treatment System for the Low-Level Waste Vitrification Process.* PVTD-C95-03.02A, Vol. 1, Pacific Northwest Laboratory, Richland, Washington.

Risk Assessment

Low risk is associated with sulfate in Envelope A because the waste that exceeds the RFP limit is insignificant. In Envelope B, the risk is high, however it is reduced to medium when the post-consolidation composition of NCAW is considered. In Envelope C, the risk is low.

4.19 Total Inorganic Carbon

Process Limit

The selected process limit is based on batch distribution measurements (Dowex 1 X-8 resin) of technetium as pertechnetate (TcO_4^-) in simulated PUREX waste (Roberts et al. 1962). The effect of carbonate concentration on pertechnetate sorption was investigated for carbonate concentrations in the range 0 to 1 M (sodium concentration range 1 to 2 M). Carbonate enhanced technetium absorption. The selected process limit of 0.5 mole carbonate per mole of sodium is the maximum molar ratio of carbonate to sodium in the simulants used in this study.

The maximum TIC limit for the HWVP reference feed is 30 wt% CO_3^{-2} (A/C - 2.5 E-02 mol C/ mol Na, B - 6.3 E-03 mol C/ mol Na) of total feed as waste oxides[a] which is less than half of the selected process limit. The HWVP limit was probably based on the highest carbonate content of washed HLW sludge anticipated and is provided as a reference point only.

Inorganic carbon will be converted to carbon dioxide gas during glass melter operation, contributing to offgas generation. Although this will affect the size and cost of the associated gas handling equipment, no quantifiable process limit based on the effects of offgas was identified.

Comparison of Process Limit and RFP Limit

The RFP limit is 40% below the selected process limit for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, the Privatization inventory estimate for AY102 exceeds the RFP limit by 28%. This tank contains 81 MT Na and is therefore not considered significant waste for Envelope A (Figure C.49).

In Envelope B, the largest inventory estimate (Privatization AZ102) is 22% below the RFP limit and in Envelope C, the largest inventory estimate (Privatization AN107) is 53% below the RFP limit.

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package*. WHC-SD-HWVP-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Risk Assessment

The risk associated with TIC is low for all envelopes.

4.20 Total Organic Carbon

Process Limit (Envelope A/B)

Although TOC does not indicate which organic compounds are present, this easily measured quantity is widely used at Hanford for comparing the organic levels in tank waste. The feed envelopes do not address the presence or absence of a separable organic phase.

The process limit for Envelopes A and B is based on Hanford evaporator operations (Le 1995). Waste is classified as complexant-concentrate if TOC exceeds 10 g/L (A/B - 5.95 E-02 mol C/mol Na) and sodium aluminate dissolved in the evaporate waste has reached saturation without exceeding receiver tank composition limits (assume [Na+]=14 M). The 10 g/L value is empirically derived and, while consistent with tank farm operations, may not accurately reflect a limiting case for organics in downstream process steps. It is believed to reduce the potential for hydrogen or flammable gas accumulation during storage, prevent slurry-growth problems in receiver tanks if waste is concentrated beyond its nitrate/nitrite saturation level, and prevent gelation which may lead to transport problems (Le 1995).

Process Limit (Envelope C)

Interference by organics with strontium and americium sorption (March et al. 1995) may preclude removal of these radionuclides by ion exchange without prior destruction of organics. Organic species in Hanford tank waste that form complexes with strontium and americium include citrate, EDTA [ethylenediaminetetraacetic acid] and HEDTA [N-(2-hydroxyethyl) ethylenediaminetriacetic acid] (Orth et al. 1995). However, organics did not affect cesium and technetium sorption by ion exchange in tests with SY101 simulant (Marsh et al. 1995). The Envelope C process limit is based on the composition of a high organic content waste simulant (46 g/L, 10 M Na; 3.8 E-01 mol C/mole Na) used in cesium ion exchange. Organics at this level had no measurable effect on cesium removal in column experiments using resorcinol-formaldehyde resin. (Kurath et al. 1994).

The maximum TOC limit for the HWVP reference feed is 11 wt% (A/B - 4.6 E-01 mol C/mol Na, B - 1.2 mol C/mol Na) of total feed as waste oxides[(a)], approximately 10% less than the process limit based on cesium ion exchange. The HWVP specification was probably selected to exceed the organic content of sludges anticipated for HLW glass processing and is provided as a reference point only. A melter feed specification for organics is important for control of melt oxidation state, but no quantifiable process limit could be identified.

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package*. WHC-SD-HWVP-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Comparison of Process Limit and RFP Limit

The process limit and RFP limit for Envelopes A and B are based on the same definition of complexant-concentrate and therefore are equal.

The RFP limit for Envelope C is 31% greater than the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, 10 HTCE inventory estimates exceed the RFP limit by more than 20% and two estimates are within 20% of the RFP limit (Figure C.51). Solubility estimates for TOC in the HTCE model are uncertain and may be over estimated. HTCE estimates are not considered for the risk assessment.

The waste estimate for SY101 (TWRS) exceeds the Envelope A RFP limit by more than 20%. SY101 is unassigned waste. Waste estimates for AP104 (TWRS), AY102 (Privatization) and AN101 (TWRS) are within 20% of the RFP limit. AN101 is unassigned waste.

In Envelope B, the Privatization estimate for AZ102 is within 20% of the RFP limit but does not exceed the limit. The post-consolidation estimate for NCAW in AY101 is more than 20% below the RFP limit. Unassigned waste in AN101 (TWRS) also is within 20% of the RFP limit, and unassigned waste in SY101 (TWRS) exceeds the RFP limit by more than 20%.

In Envelope C, the Privatization estimate for AN107 is within 20% of the process limit but is 23% below the RFP limit. AN107 waste is not considered significant Envelope C waste.

Risk Assessment

Medium risk is assigned to waste in Envelope A because significant waste is within 20% of the RFP limit.

Medium risk is assigned to waste in Envelope B; however, no Envelope B wastes exceed the process or RFP limit. The risk is low if the estimate for post-consolidation NCAW is considered.

Low risk is assigned to Envelope C.

4.21 U

Process Limit

In a single-component study examining incorporation of uranium in borosilicate glasses, glass properties were acceptable throughout the 0 to 8 wt% UO_2 range (Lambert and Kim 1994). The upper limit of this range was selected for the process limit (A/C - 5.9 E-02 mol U/mol Na, B - 1.5 E-01 mol U/mol Na).

Comparison of Process Limit and RFP Limit

The RFP limit for uranium is more than an order of magnitude less than the selected process limit for all envelopes.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, ten HTCE inventory estimates have uranium values that are within 20% of the RFP limit (Figures C.52-53). These values are consistently 5 times greater than TWRS and Privatization estimates. In the HTCE model, the source term for uranium in tank waste is the 0.5% to 1.0% assumed uranium loss from PUREX operations[(a)]. The HTCE values are based on 1% uranium loss, which will produce a large uranium source term and high uranium content in the DST wastes. HTCE estimates are not considered in the risk assessment.

In Envelope B, the Privatization estimate for AZ102 exceeds the RFP by more than 20%. The HTCE estimates for AZ101 and AZ102 are within 20% of the RFP limit. For reason stated above, the HTCE estimates are not considered in the risk assessment. The TWRS estimate for NCAW in AY101 which reflects the composition post-consolidation, is more than 20% below the RFP limit.

In Envelope C, the HTCE estimate for SY101 is within 20% of the RFP value. This is insignificant waste and the HTCE estimates are not considered in the risk assessment.

Risk Assessment

Low risk is assigned to Envelopes A and C for uranium. Envelope B is assigned high risk because NCAW exceeds the RFP limit by more than 20%. However, this risk becomes low if the post-consolidation composition of NCAW is considered.

4.22 ^{137}Cs

Process Limit

As presented in Table E.2, the process limit (A/C - 8.9 E+09 mol ^{137}Cs/mol Na, B - 2.2 E+10 mol ^{137}Cs/mol Na) for removal of ^{137}Cs is dictated by a glass maximum content of 3 Ci/m^3 and 99.9% cesium removal by waste pretreatment (DF=1000) (refer to calculations in Appendix E). The decontamination factor was selected to be within a demonstrated technology range (McKee et al. 1995). The process limit did not take into account total cesium.

Comparison of Process Limit and RFP Limit

The RFP limit is 52% below the process limit for Envelopes A and C. The Envelope B RFP limit is nearly three times the process limit.

(a) Personal Communication with SF Agnew.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelopes A and C, the TWRS inventory estimate for AN101 (an unassigned waste) is within 20% of the RFP limit but does not exceed the RFP limit (Figures C.58-59). This waste is insignificant in either envelope.

For Envelope B, the HTCE estimates for both AZ tank wastes which represent NCAW exceed the selected process limit, but are below the RFP limit. Privatization and TWRS estimates for NCAW do not exceed the process limit. The principal cause for higher HTCE versus Privatization and TWRS estimates is lower HTCE sodium concentrations. The Privatization estimates are based on 1995 supernate samples from the AZ tanks and are considered more reliable than the HTCE prediction for sodium content. The post-consolidation estimate for NCAW in AY101 is more than 20% below the process limit.

Risk Assessment

Low risk is assigned to the cesium RFP limit for Envelopes A and C.

A very high risk is assigned to the cesium RFP limit for Envelope B because the RFP limit exceeds the process limit by more than 40%, and the HTCE composition estimates for AZ101 and AZ102 are more than 20% above the process limit. However, the risk is reduced to medium when the post-consolidation composition of NCAW is considered. The higher cesium concentrations may necessitate increased facility design factors for shielding and heat content. Additional columns may be required to achieve product specifications.

4.23 ^{90}Sr

Process Limit

As presented in Table E.2, the process limit for ^{90}Sr removal is dictated by a glass maximum content of 20 Ci/m^3. For Envelopes A and B waste, pretreatment for strontium removal is not required, whereas Envelope C requires 90% removal (DF=10) to meet product specifications. A DF of 10 is reported to be reasonably achievable (McKee 1995). A DF of 10 (A/C - 5.9 E+08 mol ^{90}Sr/mol Na, B - 1.5 E+09 mol ^{90}Sr/mol Na) was selected as the process limit for all envelopes.

Comparison of Process Limit and RFP Limit

For Envelope A, and B the RFP limits are 93% and 97% below the respective process limits. The RFP limit for Envelope C is 35% greater than the selected process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

In Envelope A, 12 HTCE estimates exceed the RFP limit by more than 20% (Figures C.65-66). Strontium solubility in the HTCE model is a single value applied to all tanks, despite the variable solubility of strontium in the presence of different complexing agents. Consequently, the HTCE model would be expected to over predict strontium solubility for non-organic tanks, and

HTCE estimates are not considered for the risk assessment. Estimates for waste in tanks AY102 (Privatization), AN101 (TWRS, an unassigned waste) and SY103 (TWRS, an unassigned waste) exceed the RFP limit by more than 20%. These waste are considered insignificant.

In Envelope B, the HTCE estimates for AZ101 and AZ102 exceed the RFP limit by more than 20%. For reasons stated under Envelope A, HTCE estimates for ^{90}Sr are not considered for the assessment. The Privatization inventory estimate for AZ102 is within 20% of the RFP limit, but it does not exceed the limit. The post-consolidation composition estimate for NCAW is more than 20% below the RFP limit. As in Envelope A, the unassigned waste in AN101 (TWRS) and SY103 (TWRS) exceed the RFP limit by more than 20%. The unassigned waste is considered insignificant for the assessment.

In Envelope C, the Privatization inventory estimate for AN107 and the TWRS estimate for AN101 (an unassigned waste) are within 20% of but do not exceed the process limit. These waste are not considered significant Envelope C waste. The HTCE estimate for AY101 is also within 20% of the process limit but it is not considered in the assessment (Figure C.70).

Risk Assessment

Low risk is assigned to the strontium RFP limit for Envelopes A and C. Over prediction by the HTCE model explains the apparent violations of RFP and process limits by HTCE estimates for these waste envelopes. Other wastes causing violations are insignificant.

Medium risk is associated with the strontium RFP limit for Envelope B since the Privatization inventory estimate for AZ102 is within 20% of the process limit. The risk is reduced to low when the post-consolidation NCAW estimate is considered.

4.24 ^{99}Tc

Process Limit

The process limit for technetium removal is dictated by a volume-averaged radionuclide concentration limit (<0.3 Ci/m^3) for the LAW product for the TWRS Privatization Project. In addition, the performance assessment (PA) specification requires treatment to reduce allowed radionuclide releases for certain long-lived radionuclides in proportion to the total allowed releases from solidified LAW waste produced from the entire tank waste system (DOE 1996). Assuming a LAW glass product, a removal of 80% of the entire technetium inventory (DF=5) is required. However, a DF of 10 (A/C - 8.9 E+06 mol ^{99}Tc/mol Na, B - 2.2 E+07 mol ^{99}Tc/mol Na) is reported as reasonably achievable (McKee 1995) and was selected as the process limit for all three envelopes. Recent findings suggest that the removal of ^{99}Tc in some waste types is less than expected, potentially due to reduction of the ^{99}Tc ion. These results require further evaluation.

Comparison of Process Limit and RFP Limit

The RFP limit is 20% below the process limit for Envelopes A and C. The RFP limit for Envelope B is 68% below the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

All tank waste compositions for technetium comply with process and RFP limits for all waste envelopes (Figures C.67-68). For Envelopes A and C, the largest compositional estimate (HTCE SY103; an unassigned tank) is 68% below the RFP limit. In Envelope B, the largest compositional estimate (Privatization AZ101) is 53% below the RFP limit..

Risk Assessment

Low risk is associated with the RFP limits for Envelopes A, B and C. Further evaluation is required to assess the risks associated with the ^{99}Tc speciation.

4.25 Transuranics (TRU)

Process Limit

Transuranic content is determined by measurement of the total alpha and ^{237}Np, ^{238}Pu, $^{239/240}$Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{242}Cm (^{242m}Am, ^{242}Am), $^{243/244}$Cm and ^{243}Am[(a)]. As presented in Table E.2, the process constraint for TRU removal is dictated by a glass maximum content of 100 nCi/g. For Envelopes A and B waste, pretreatment for TRU removal is not required, whereas for Envelope C waste, 80% TRU removal is required (DF=5) to meet the product specification. A DF of 5 is reported to be reasonably achievable by McKee (1995), however it is noted that solid/liquid separation requirements may be more challenging. A DF of 5 (A/C - 3.7 E+06 mol TRU/mol Na, B - 9.3 E+06 mol TRU/mol Na) was selected as the process limit for all envelopes.

Comparison of Process Limit and RFP Limit

Envelopes A, B and C RFP limits are 87%, 95%, and 19% respectively, below the process limit.

Comparison of Process Limit/RFP Limit with Tank Waste Compositions

Only limited data are available for TRU components (^{241}Am, ^{238}Pu, $^{239/240}$Pu, ^{237}Np) (refer to Table C.1 and Figures C.55-57, C.60-64, and C.69-70). The ^{241}Am estimates are approximately 5 times higher than other TRU components and therefore dictate the activity contribution from TRU. TRU inventory values were calculated by summing the contributions from all the available TRU components, ^{241}Am, ^{237}Np, ^{238}Pu, and $^{239/240}$Pu.

The Envelope A Privatization inventory estimate for AY102, and the TWRS inventory estimate for AN101 (an unassigned waste) exceeds RFP limit by more than 20%. Neither of these wastes is considered to be significant in Envelope A.

In Envelope B, the waste in AZ102 (Privatization) and the waste in AN101 (TWRS, an

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(a) There are different definitions of TRU radionuclides in various sources. The definition of TRU for the Privatization effort will be negotiated by the IPT.

unassigned waste) exceed the RFP limit by more than 20%. The HTCE estimate for AZ102 is within 20% of but does not exceed the RFP limit. The AZ102 (Privatization) value is reported as "less than"; an envelope violation that cannot be verified. The AZ102 Privatization and HTCE estimates reflect the composition of NCAW in AZ102. This waste will be consolidated with the NCAW in AZ101. The post-consolidation estimate for NCAW in tank AY101 is more than 20% below the RFP limit.

In Envelope C, as expected, inventories of waste in tanks AN102 and AN107 suggest high ^{241}Am values. Using the TRU Privatization estimates for these tanks, AN102 waste (1.1 E+06 Bq/mol Na) is less than half the Envelope C limit, but AN107 waste (3.6 E+06 Bq/mol Na) is more than 20% above the limit. The TWRS value for waste in AN107 is within 20% of but does not exceed the RFP limit. These violations are caused by insignificant quantities of waste. (Figure C.74).

Risk Assessment

Low risk is associated with Envelope A. In Envelope B, the risk is medium due to a violation by the HTCE AZ102 composition estimate. The risk is reduced to low if the post-consolidation composition of NCAW is considered. In Envelope C, low risk is assigned because minimum quantities of Envelope C waste may be met if AN107 waste, alone, is excluded. Solid/liquid separation risks require further assessment.

5.0 Conclusions

Preliminary, general conclusions from the qualitative risk assessment described in Section 4.0 are summarized in the text which follows. The conclusions focus on areas of potential increased risk.

The HTCE inventories are consistently high for OH^-, SO_4^{-2}, TOC, U and ^{90}Sr. The high ^{90}Sr, SO_4^{-2} and U inventories are attributed to solubility uncertainties. The HTCE estimates over predict the hydroxide quantity when compared to inventories based on analytical data such as the TWRS and Privatization inventories because the HTCE includes hydroxide bound in complexes with Al, Cr, Fe, Mn, etc. Flags for these inventories were not considered in this summary assessment.

Of the fourteen tanks for which waste inventories are flagged, three tank wastes are assigned as candidate LAW facility feeds (AP102, AP104, and AN107) and have potential RFP LAW envelope specification violations.

The potential violations for these tank wastes are:

AN107 (778MT Na)

- exceeds RFP Envelope C TRU limit by greater than 20% (Privatization)
- within 20% of the RFP Envelope C TRU limit (The RFP limit is exceeded) (TWRS).
- exceeds RFP Envelope C Ba limit (Privatization); the point is 10X greater than similar waste type (AN102) and appears to be unreliable.

AP102 (424MT Na)

- within 20% RFP Envelope C limit for PO_4^{-3} (The RFP limit is not exceeded) (Privatization)

AP104 (240MT Na)

- within 20% of RFP Envelope A TOC limit (The RFP limit is not exceeded)

The total quantity of waste (1202 MT Na) in the two Envelope C candidates feed sources, AP102 and AN107, which potentially violate the specification may result in less than sufficient quantities for both Envelope C and overall maximum order quantities, pending the availability of projected inventories for the DSTs. A relatively high risk in meeting Envelope A minimum order quantities is associated with the projected AP104 total organic carbon (TOC) concentration being within 20% (albeit below) the TOC limit. Particular attention will be required in the analysis of wastes which contain analytes whose concentration is near the envelope limit. It is noted that these tank wastes were not identified with potential violations in the LLW Feed Staging Plan (Certa et al. 1996b) because the LLW feed staging selection criteria was 10% of the RFP limit, rather than 20%, and the Privatization inventory was not included in the staging plan development.

Assignment of wastes to a LAW feed envelope is dependent on the projected inventories (ie., waste whose location and composition depend on future tank farm transfers). For example, the current strategy for providing Envelope B feed is dependent on completion of the high heat waste consolidation. Envelope C and the overall maximum projected order quantities are both dependent on projected waste inventories and waste which is borderline with respect to meeting the envelope specifications. Excluding "projected waste" and borderline cases, AN102 and AN107 may be the only sources for Envelope C. The OWVP, Retrieval Sequence, and TWRS Flowsheet all assume that the maximum order quantity (10,200 MT) will be processed during Phase I and the extension. Transfers should be avoided for tanks containing a large quantity of targeted waste. These tanks are AN102, AN103, AN104, AN105, AN107 and AW101. Future waste transfers should be conducted consistent with providing feed for processing per the RFP Envelope specifications. Particular attention will be required in the analysis of waste which contain analytes whose concentration is near the envelope limit.

Waste inventories for three tanks, SY101, SY103, and AN101, were flagged with a relatively large number of violations. As these tanks are projected to contain ~2100 MT Na, it would be beneficial to identify the potential violation(s) and consider strategies for incorporating this waste as LAW feed.

6.0 References

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Appendix A

Source Document Descriptions

Appendix A

Source Document Descriptions

This appendix describes the source documents used to determine the waste envelope definitions. Included are the documents describing inventory estimates used to refine envelope definitions for the final RFP.

A.1 Low-Activity Waste Envelopes for Phase I of the Hanford Tank Waste Remediation System Privatization Project

McKee et al. (1995) provide the initial basis for the waste envelope concept and describe the separation of LAW into three envelopes. The envelopes used in this report address phase 1 treatment objectives based on an assumed silicate glass product and the available technology to produce the product. Tank waste composition information is used to confirm that at least 80% of the waste is encompassed by the envelope specifications contained in this document. Identification of candidate waste tanks was based on an early version of the TWRS baseline flowsheet inventory (Shelton 1995a).

A.2 Inventory Estimate Source Documents

Although characterization data for the underground storage tanks at Hanford exist in many forms, documenting the contents of each tank is a difficult task. The data generated over the years were the result of specific programmatic objectives; they exist in a variety of formats and levels of detail. Tank farm operations, including evaporation to reduce tank space, transfers between tanks, addition of new waste, and other waste processing activities added to the complexities of determining current or projected tank composition data.

Many studies attempted to summarize all of the available resources and define the tank contents. These studies addressed historical process and transaction records, inventory estimates, tank farm operation and surveillance records, and original analytical reports. The TWRS Privatization Characterization subtask effort included review and evaluation of these resources. The TWRS Privatization Support Project Waste Characterization Resource Dictionary (Patello and Wiemers 1996) describes the various resources, their relationship to the original data source, interrelationships between the resources, and provides an assessment of the resources. Three major resources were used in stage II of the envelope development process.

A.2.1 TWRS Privatization Support Project Waste Characterization Inventory

Radionuclide and chemical analyte sample data and inventory estimates for 14 underground waste storage tanks were assembled and validated in support of the Tank Waste Remediation System Privatization Support Project (Johnson 1996). The tanks selected were considered to represent phase I candidate double-shelled tank wastes at the time (mid-1995). The tank waste composition data were assembled into various data sets: a master data set, a subset, and an unreviewed data set. The master data set contains information for seven DSTs; the subset contains only validated data from the master data set; and the unreviewed data set contains information for the remaining seven tanks. The methodology used in preparing the characterization data and how that information was validated by an independent team of scientists and engineers from PNNL, ICF-Kaiser, WHC, ANL, and LANL is described in a report produced by Johnson (1996). This review team is called the TWRS Privatization Support Project Waste Characterization Review Team. The analytical data used was current through August 1995.

The Privatization characterization subtask generated an inventory estimate from the analytical data in the form of a minimum, maximum, and best estimate for selected major components. Maximum values only were determined for a set of minor components. Minimum, maximum, and best estimate values were determined for an eighth tank independently of the original review work. This inventory estimate, referred to as the Privatization inventory, and the methods used to derive it are described by Patello et al. (1996).

A.2.2 Historical Tank Contents Estimate

The Historical Tank Contents Estimate (HTCE) consists of four documents--one for each quadrant of the Hanford Site (NE, NW, SW, and SE)--that provide historical evaluations of the radioactive mixed wastes stored in the underground storage tanks All the DSTs are in the SE quadrant. The historical evaluation of the radioactive mixed wastes stored in these tanks is reported by Brevick (1995) and is derived from process histories and waste transfer data. The HTCE contains values for selected analytes and radionuclides by tank and, as shown in the Inventory Resource Map by Patello and Wiemers (1996), was compiled from many source documents. HTCE inventories are estimated through December 31, 1993, and were recently revised to include additional components and corrections to source terms (Agnew 1996). The revised data is used in this report.

A.2.3 TWRS Privatization Support Project Double-Shelled In-tank Inventory

The TWRS Privatization Support Project Double-Shelled In-Tank Inventory (Shelton 1995b) is representative of the in-tank content of the double-shelled tanks. It was derived from the TWRS Baseline Flowsheet Inventory (Shelton 1995a), which is an inventory of all double-shelled and single-shelled tanks as of February 1994. The inventory, called in this report the TWRS inventory, was compiled from new data sources, the TCRC, TCRs, TRAC, HDW-EIS, HTCE, and the Wastren/Van Vleet inventory.

The inventory from this resource and recent sample data were projected to fiscal year 2002 according to the Operational Waste Volume Projection (Koreski and Strode 1995). The radionuclides were decayed to December 31, 2007. The projection is provided by Shelton (1996) in a document that details transfer activity in each DST. During FY1995 and 1996, the TWRS inventory was updated frequently to accommodate programmatic needs and new analytical data. The most recent update was used in this report and is the same inventory used for the Low-Level Waste Feed Staging Plan (Certa et al. 1996b). Supernate in AW102 and AW106 was not estimated in this projection because the expected waste transfer activities associated with of these tanks leads to high uncertainty in the inventory estimates.

A.2.4 Preliminary Low-Level Waste Feed Staging Plan

The Preliminary Low-Level Waste Feed Staging Plan (Certa et al. 1996a) provided a basis for the M&O commitment to deliver on schedule, waste feed within the defined composition envelopes. The plan also identified the source and quantity of DST wastes that satisfied each envelope based on the draft RFP specifications and a projected inventory. Recommendations for envelope limit adjustments are provided. This plan supported the second stage of envelope development as described in section 3.0.

A.2.5 Low-Level Waste Feed Staging Plan

The Low-Level Waste Feed Staging Plan (Certa et al. 1996b) is an update of the Preliminary Low-Level Waste Feed Staging Plan. The plan develops the sequence and transfer schedule for retrieval of double-shelled tank supernatant by the management and integration contractor and delivery of the staged supernatant to the private low-activity waste contractors for treatment. A transfer system conflict analysis provides part of the basis for determining transfer system upgrade requirements to support delivery of both low-level and high-level waste feed. Waste feed is assigned to the Privatization Request for Proposal (RFP) envelopes (DOE 1996a, 1996b) using inventory estimates from TWRS Privatization Double-Shelled In-Tank Inventory (Shelton 1996).

Appendix B

Ratio Calculations, File Structure and Quality Assurance

Appendix B

Ratio Calculations, File Structure and Quality Assurance

B.1 Presentation of Data

The three inventory estimates used to characterize the waste in the DSTs are the Privatization Support Project inventory, the HTCE inventory, and the TWRS inventory (Appendix A). The inventory estimates were either provided as Excel spreadsheet files or copied into Excel spreadsheet files that were then used as the original source file. Intermediate working Excel spreadsheet files were created to convert the values to proper units, arrange the values by analyte, and adjust the values as required by the desired output. A final set of three output Excel spreadsheet files (PMR9607.xls, PMO9607.xls and PMN9607.xls) was created to present the information in its final form. Plot files were created for the generation of final tables and plots of the inventory estimates with the established envelope limits. All of the files, except the final plot files, were linked to the source file so that any change or update in the source file requires only one change in the original file. When changes are made, all other files except the final plot files change automatically when the links are updated. The values in the final plot files must be manually replaced with the new values. Values that are not reported, not estimated, zero, or blank in the output file are changed to a blank cell in the plot file and are not plotted.

Figure B.1 shows the file structure and how the source files were used to generate the output files and plot files. Each file is shown in a box and the relationship to other files is indicated by arrows. Solid arrows show values linked between files, and dashed arrows show values that are copied but not linked. Each file contains a log that is maintained to provide a record of changes, additions, and other operations performed in the files.

The following sections describe in detail the calculations or operations performed in each file. Operations on a normalized data set (PMN9607.xls) are presented in Figure B.1 but are not discussed. Values normalized to 3 M to 7 M Na were prepared for the draft RFP but, because of limitations with presenting the numbers in this way, were not used for the final RFP.

B.1.1 Sodium Molar Ratio Data

The Privatization Support Project inventory is or presented in the file "MM112195.xls" as minimum, best estimate, and maximum concentrations in units of g/L for chemical analytes and Bq/L for radionuclides for each tank.

In the intermediate file, "R960702.xls," one worksheet is established for each analyte or radionuclide. The values are linked to the minimum and maximum concentrations of each analyte or radionuclide in the source file, "MM112195.xls." First, the analyte concentrations are converted from g/L to moles/L. Radionuclides do not require unit conversions. The chemical analytes and radionuclides are then ratioed to the sodium molar concentration. The maximum

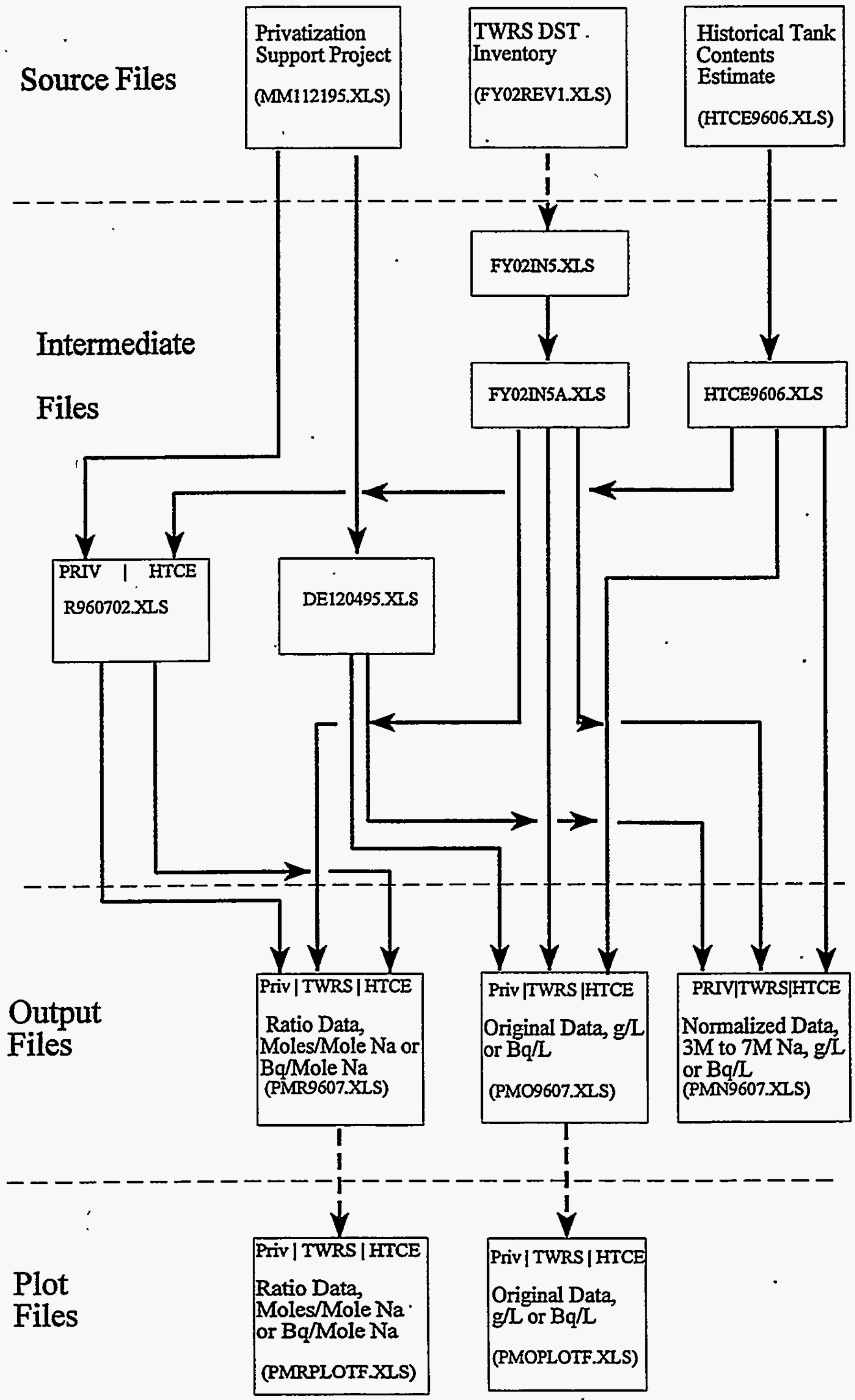

Figure B.1. Flow Diagram Showing File Structure with Links Between Files sodium molar concentration is used for the maximum ratio, and the minimum sodium molar concentration is used for the minimum ratio. The resulting units are moles (analyte)/mole sodium for the chemical analytes or Bq/mole sodium for the radionuclides.

One potentially confusing result of using the method above for determining analyte minimum and maximum concentration to sodium concentration ratio, is that a maximum concentration ratio might be smaller than the minimum concentration ratio, as occurred for some analytes ($Al(OH)_4$ in tank AW101, for example) and radionuclides. When the difference between the sodium minimum and maximum concentrations is larger than the difference between the analyte minimum and maximum concentrations, dividing by a larger number yields a maximum ratio smaller than the minimum ratio.

The HTCE inventory for the supernatant fraction is in the file, "HTCE9606.xls" on the worksheet "SMMESTIMATES." The inventory is arranged by tank and is listed in units of moles/L, ppm, and kg for the chemical analytes; moles, Ci, μCi, M, and kg for the radionuclides; and kgal for tank supernatant volumes. The values are copied on intermediate worksheets, "RLMWRKST" and "RLMWRKST (2)" in the same file. On this worksheet, the values are converted from kg to g/L using the supernatant volume. Radionuclide units are converted from kg, Ci/L, or μCi/L to Bq/L. On two second intermediate worksheets, "RLMSUMMARY" or "RLMSUMMARY (2)," the values are arranged by analyte and linked to the first intermediate worksheets.

The intermediate file "R960702.xls" also contains HTCE estimates linked to the intermediate worksheets "RLMSUMMARY" and "RLMSUMMARY (2)" in the file "HTCE1228.xls." In this intermediate file, the concentrations are maintained by analyte/radionuclide and the analyte units are converted from g/L to moles/L. The molar concentrations are then divided by the sodium molar concentration to arrive at the desired concentration ratio, moles analyte/mole sodium. The radionuclide values are divided by the sodium molar concentration to get the result Bq/mole sodium.

The TWRS inventory is in the source file, "FY02REV1.xls," in which the analytes are in units of both metric tons (MT) and moles/L (M) and the radionuclides are in units of Ci/L. The intermediate file, "FY02IN5.xls" links the values to the source file with the units moles/L for the chemical analytes and Ci/L for the radionuclides. This file also converts the units of the chemical analytes to g/L.

Another intermediate file used with the TWRS inventory is "FY02IN5A.xls," which contains several worksheets. The analyte values on the worksheet "Chem Sol by Tank" are linked to the first intermediate file, "FY02IN5.xls" with units of g/L. The values are then linked to the worksheet "Anal-R," where they are converted to moles/L and divided by the sodium molar concentration to determine the ratio of moles/L analyte to moles/L sodium. The radionuclide values are linked through a series of worksheets beginning with the worksheet "RADNUC-SOURCE," which links the values to the source file with units of Ci/L. From there, the values are link through worksheet "RADNUC BY TANK" to worksheet "RADNUC-0" to the worksheet "RADNUC-R." The worksheet "RADNUC-0" arranges the values by tank and converts the units to Bq/L. The values on worksheet "RADNUC-R" are converted to Bq/mole sodium by dividing by the sodium molar concentration.

The Privatization and the HTCE inventories in the output ratio file "PMR9607.xls" are linked to the intermediate file, "R960702.xls." The TWRS inventory estimates in the output file are linked to the worksheets in the intermediate file, "FY02IN5A.xls" that contain the chemical analyte and radionuclide ratio values. This output file presents the values as a molar ratio of the analyte to sodium and Bq per mole sodium for each radionuclide for each tank. A separate worksheet is used for each chemical analyte and radionuclide, each containing values from the three primary source files.

A plot for each analyte is in the plot file, "PMRPLOTF.xls." The plot file is not linked to the output file so that the values can be manipulated to produce the desired plot format. The output plots for each analyte and radionuclide are shown in Appendix C for the sodium molar ratio values.

B.1.2 Original Data

The Privatization Support Project inventory is in the file "MM112195.xls" as described in Section B.1.1. In the intermediate file, "DE120495.xls," the original Privatization estimate values are linked from the source file, where the concentrations are described as minimum, best estimate, and maximum concentrations. The chemical analytes are in g/L and the radionuclides are in Bq/L.

The TWRS inventory is in the source file, "FY02REV1.xls," as described in Section B.1.1. The intermediate file, "FY02IN5.xls" links the values to the source file with the units moles/L for the chemical analytes and Ci/L for the radionuclides. This file also converts the units of the chemical analytes to g/L.

The second intermediate file used with the TWRS inventory, "FY02IN5A.xls," links the values from "FY02IN5.xls." The values are arranged by tank on worksheets "Anal-O" and "RADNUC-O" for the chemical analytes and radionuclides, respectively. The radionuclide values are also converted to Bq/L.

The HTCE inventory is in the file "HTCE9606.xls," which contains the original source inventory on the worksheet "SMMESTIMATES," and the intermediate worksheets ("RLMWRKST," "RLMWRKST (2)," "RLMSUMMARY," and "RLMSUMMARY (2)") as described in Section B.1.1. The chemical analyte concentrations are converted to g/L and the radionuclide values are converted to Bq/L on the intermediate worksheets.

In the original output file, "PMO9607.xls," the Privatization inventory is linked from the intermediate file "DE120495.xls"; the TWRS inventory is linked from the intermediate file "FY02IN5A.xls"; and the HTCE inventory is linked from the intermediate worksheets "RLMSUMMARY" and "RLMSUMMARY (2)" in the file "HTCE9606.xls." The values are shown as g/L for the chemical analytes and Bq/L for the radionuclides. A separate worksheet is used for each chemical analyte and radionuclide, each containing values from the three primary source files. The values in the output file are arranged by analyte/radionuclide.

A plot for each analyte is in the file, "PMOPLOTF.xls." The plot file is not linked to the output file so that the values can be manipulated to produce the desired plot format. The output plots for each analyte and radionuclide are in Appendix D.

B.2 Data Quality Assurance Checks

All of the spreadsheet files listed in Section B.1 include a worksheet named "INTRODUCTION," which briefly describes the spreadsheet and contains a log showing the history of the file development. The log contains an entry for every change or addition, so that a complete record is available on every "INTRODUCTION" worksheets.

Values included in the Excel 5.0 spreadsheet files described in Section B.1 were randomly checked to verify that the transition links, formulas, and unit conversions used in the files are correct. All apparent "outliers" and other, randomly selected points were checked to verify that the formulas and links are correct. These checks were made by starting with the source values and manually calculating the end values that appears on the output files. The source value, of necessity, was assumed to be correct because it was verified by its providers. When the manual calculations matched the values on the output file, the processes on the intermediate files and worksheets were assumed to be correct. If the calculations did not match the output values, the intermediate files were searched and necessary corrections made until the manual calculations matched the output values.

The values in the output files are linked through the intermediate files to the source files so that any change made manually to the source file will automatically be incorporated into the output files. Changes in HTCE source values on worksheet "SMMESTIMATES" in file "HTCE9606.xls" must be manually copied into the worksheet "RLMWRKST," which is not linked to the source worksheet. The two plot files also are not linked to the output files, and so any change in any source value will require a manual change in the plot files.

Appendix C

Sodium Molar Ratio Data and Output Plots

Appendix C

Sodium Molar Ratio Data and Output Plots

This appendix provides information for comparing the Privatization, TWRS flowsheet, and HTCE inventory estimates with envelope limits. The data has been ratioed to sodium as described in appendix B. Table C.1 shows a summary that conveys the amount of data available for each species represented in the table. The numbers represent the number of tanks that have analytical, TWRS, and HTCE values. The tables and graphs following the summary table provide more detailed information for each analyte. The data tables contain the values that are used in the graphs. Envelope limits are shown on the graph to provide a comparison. For the assessment provided in section four, wastes with less than 50 MT Na were not considered. All Privatization inventory wastes have greater than 50 MT Na and therefore all are assessed. When using HTCE estimates, waste in tanks AN106, AP104, AP107, AW103, and SY102 contain less than 50 MT Na. When using the TWRS estimates, waste in tanks AP103, AP105, AP108, AW103, AW104, AW105, AY102, AZ101, AZ102 and SY102 contain less than 50 MT Na. For all inventories, evaporator feed and product tanks (AW102 and AW106) were not considered. The estimates for the tanks not assessed are shown on the graphs and in the tables. The second and third graphs for an analyte shows a finer y-scale.

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Table C.1. Characterization Data Summary

Analyte	Number of Tanks with Data					Envelope Limits Established
	Privatization					
	Est. Min	Est. Max	TWRS	HTCE	Total	
Maximum	**8**	**8**	**28**	**28**	**28**	NA
Ag	0	2	8	0	9	No
$Al(OH)_4^-$	8	8	26	26	28	Yes
As	0	5	6	0	9	No
Ba	0	7	17	0	20	Yes
Be	0	4	8	0	9	No
Bi	0	0	4	26	26	No
Ca	0	5	22	28	28	Yes
Cd	0	7	11	0	14	Yes
Ce	0	2	3	0	4	No
Cl	8	8	26	27	28	Yes
CN	0	2	0	0	2	No
Co	0	1	0	0	1	No
$Cr(OH)_4^-$	7	7	26	27	28	Yes
F	6	8	21	26	28	Yes
Fe	1	8	24	28	28	Yes
Hg	0	2	5	26	26	Yes
K	7	7	25	26	28	Yes
La	0	2	6	26	26	Yes
Mn	0	0	14	26	28	No
Na	8	8	26	28	28	Yes
Nd	0	3	0	0	3	No
NH_3/NH_4	1	2	0	27	27	No
Ni	0	5	18	27	28	Yes
NO_2^-	8	8	25	27	28	Yes
NO_3^-	8	8	26	28	28	Yes
OH	8	8	26	28	28	Yes
Pb	0	7	14	26	28	Yes
PO_4^{-3}	8	8	26	27	28	Yes
Sb	0	3	0	0	3	No
Se	0	4	5	0	7	No
SO_4^{-2}	8	8	25	27	28	Yes
Sr tot	1	1	0	0	1	No
Te	0	2	2	0	3	No

Analyte	Number of Tanks with Data					Envelope Limits Established
	Privatization					
	Est. Min	Est. Max	TWRS	HTCE	Total	
TIC	8	8	23	28	28	Yes
Tl	0	1	1	0	2	No
TOC	8	8	26	0	26	Yes
U	0	6	20	26	28	Yes
V	0	2	1	0	3	No
TRU	8	8	23	26	28	Yes
^{241}Am	8	8	25	0	25	See TRU
^{137}Cs	8	8	26	27	28	Yes
^{237}Np	3	5	8	0	12	See TRU
^{238}Pu	2	3	0	26	26	See TRU
$^{239/240}Pu$	7	7	25	0	25	See TRU
^{90}Sr	8	8	25	26	28	Yes
^{99}Tc	6	6	25	0	25	Yes

Table C.2. Silver (Ag) Ratioed to Sodium in Moles Ag/Moles Na

	Silver			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.08E-05	
AN102				
AN103				
AN104				
AN105				
AN106			6.82E-08	
AN107				
AP101			2.02E-06	
AP102		<1.01E-05		
AP103				
AP104			1.07E-16	
AP105			2.04E-10	
AP106			1.19E-12	
AP107			5.03E-09	
AP108				
AW101				
AW102				
AW103				
AW104			2.52E-11	
AW105				
AW106				
AY101				
AY102			5.45E-07	
AZ101				
AZ102		2.53E-05		
SY101				
SY102				
SY103				

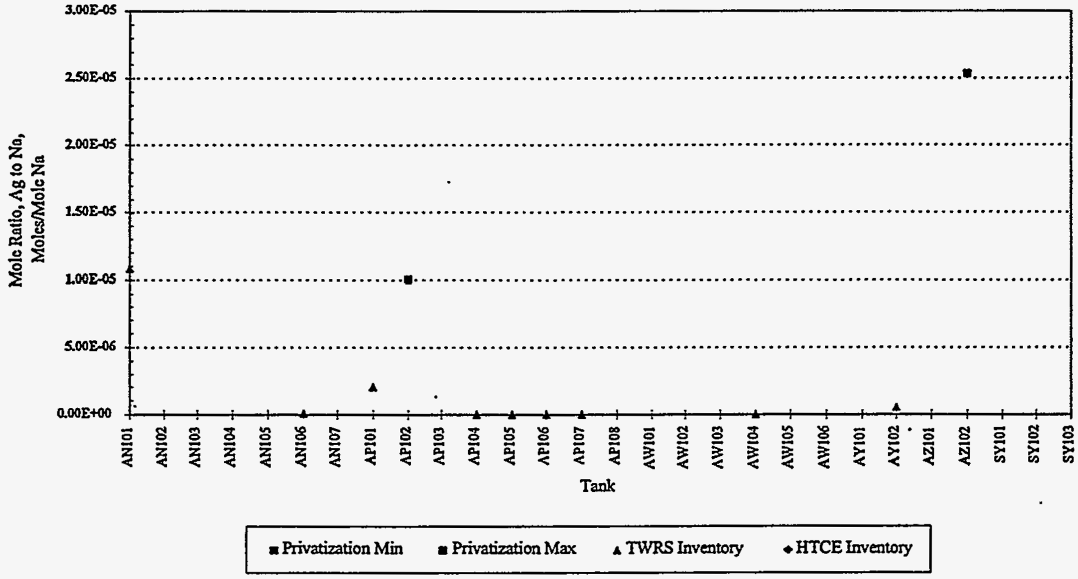

Figure C.1. Silver in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.3. $Al(OH)_4^-$ Ratioed to Sodium in Moles $Al(OH)_4^-$ /Moles Na

	$Al(OH)_4^-$			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			3.29E-02	1.45E-01
AN102	6.04E-02	4.75E-02	4.75E-02	1.38E-01
AN103			1.46E-01	1.31E-01
AN104			1.16E-01	1.34E-01
AN105			1.45E-01	1.36E-01
AN106			4.58E-02	1.31E-01
AN107	7.35E-04	2.09E-02	4.59E-03	1.47E-01
AP101			5.24E-02	1.08E-01
AP102	9.65E-02	9.73E-02	9.69E-02	1.30E-01
AP103			3.95E-02	1.32E-01
AP104			1.16E-01	
AP105	5.67E-02	6.18E-02	4.58E-02	1.14E-01
AP106			1.15E-01	1.21E-01
AP107			4.54E-02	
AP108			3.19E-02	1.43E-01
AW101	1.10E-01	9.71E-02	1.03E-01	1.21E-01
AW102				1.13E-01
AW103			1.81E-03	3.65E-03
AW104			4.97E-02	1.28E-03
AW105			2.10E-03	1.06E-01
AW106				1.16E-01
AY101			5.77E-02	1.02E-01
AY102	4.61E-03	4.83E-03	5.31E-04	1.49E-01
AZ101	8.39E-02	8.30E-02	8.23E-02	1.20E-01
AZ102	2.48E-02	2.48E-02	2.05E-03	1.18E-01
SY101			1.33E-01	1.32E-01
SY102			1.03E-01	5.76E-02
SY103			1.67E-01	1.35E-01

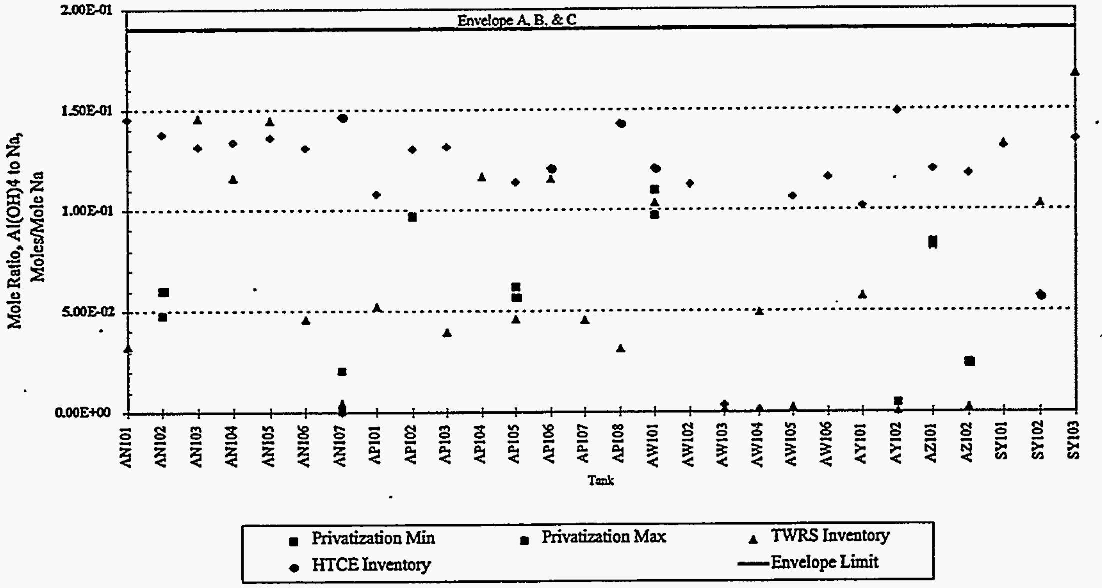

Figure C.2. $Al(OH)_4^-$ in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.4. Arsenic (As) Ratioed to Sodium in Moles As/Moles Na

Arsenic				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			7.65E-06	
AN102				
AN103				
AN104				
AN105				
AN106			5.14E-08	
AN107				
AP101			2.74E-06	
AP102		2.95E-07	2.67E-07	
AP103			2.80E-06	
AP104			1.53E-17	
AP105		1.64E-06	1.92E-09	
AP106			1.71E-13	
AP107			4.72E-08	
AP108				
AW101		<9.96E-09		
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		2.25E-05	1.94E-05	
AZ102		2.44E-05	1.77E-05	
SY101				
SY102				
SY103				

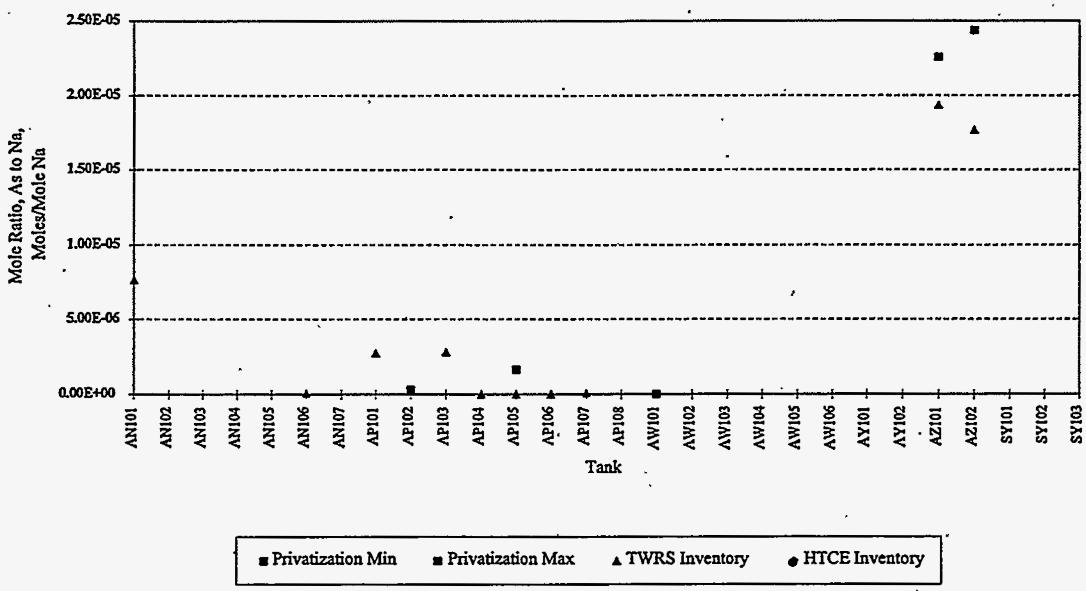

Figure C.3. Arsenic in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

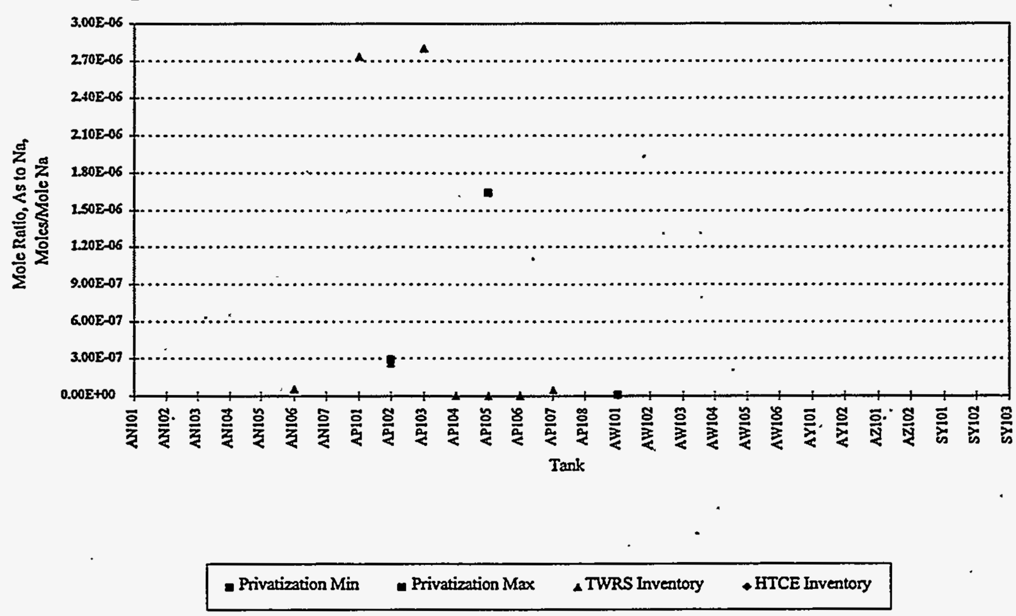

Figure C.4. Arsenic in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.5. Barium (Ba) Ratioed to Sodium in Moles Ba/Moles Na

Barium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			8.05E-06	
AN102		1.13E-05		
AN103				
AN104				
AN105				
AN106			2.53E-08	
AN107		4.96E-04		
AP101			2.76E-06	
AP102		6.62E-07	4.67E-07	
AP103				
AP104			5.64E-16	
AP105		1.26E-06	3.35E-08	
AP106			2.13E-08	
AP107			8.24E-07	
AP108			4.60E-06	
AW101		4.66E-07		
AW102				
AW103			4.79E-06	
AW104			1.03E-07	
AW105			7.33E-08	
AW106				
AY101			8.06E-08	
AY102			3.93E-07	
AZ101		4.39E-06	3.79E-07	
AZ102		2.44E-06	7.47E-07	
SY101				
SY102				
SY103			6.90E-06	

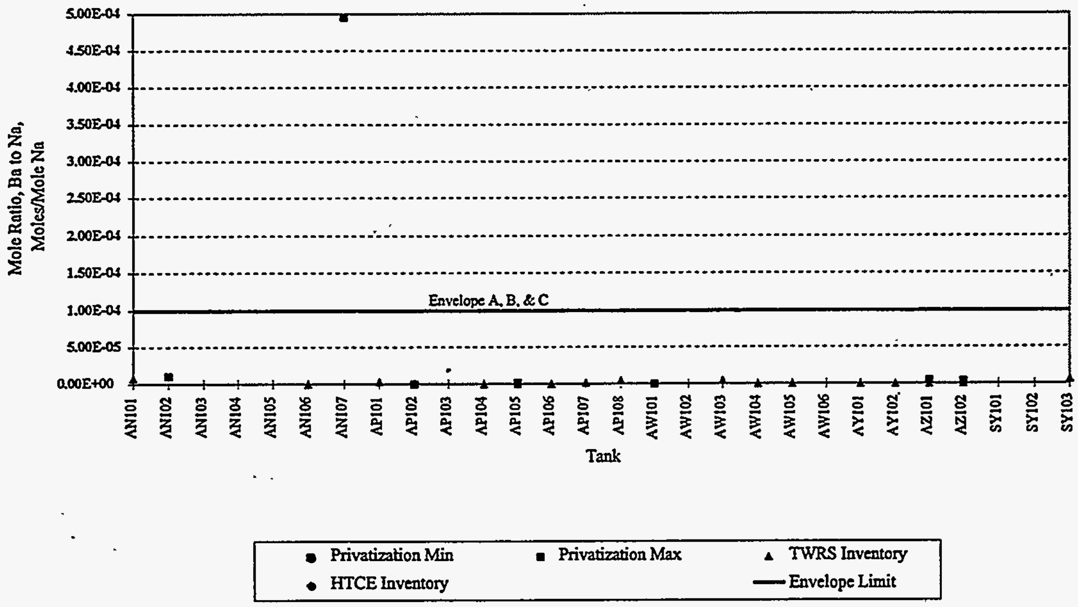

Figure C.5. Barium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

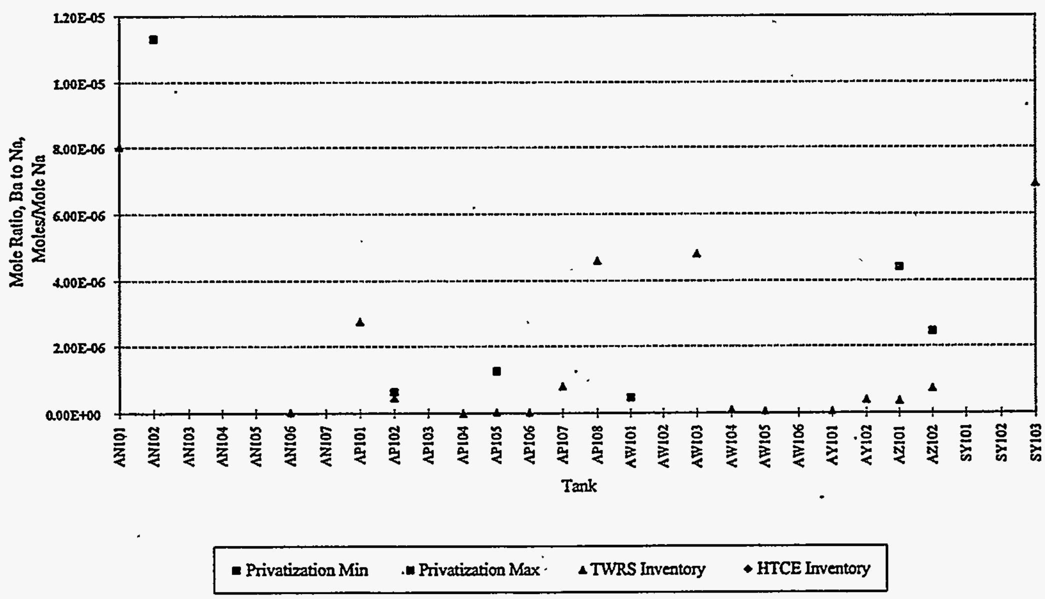

Figure C.6. Barium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.6. Beryllium (Be) Ratioed to Sodium in Moles Be/Moles Na

Beryllium				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			2.29E-07	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102		4.04E-06	3.65E-06	
AP103				
AP104			7.73E-16	
AP105		2.22E-05		
AP106			1.13E-07	
AP107				
AP108			2.90E-07	
AW101				
AW102				
AW103				
AW104				
AW105			3.88E-07	
AW106				
AY101				
AY102				
AZ101		2.94E-06	6.56E-08	
AZ102		5.37E-06	7.52E-07	
SY101				
SY102				
SY103				

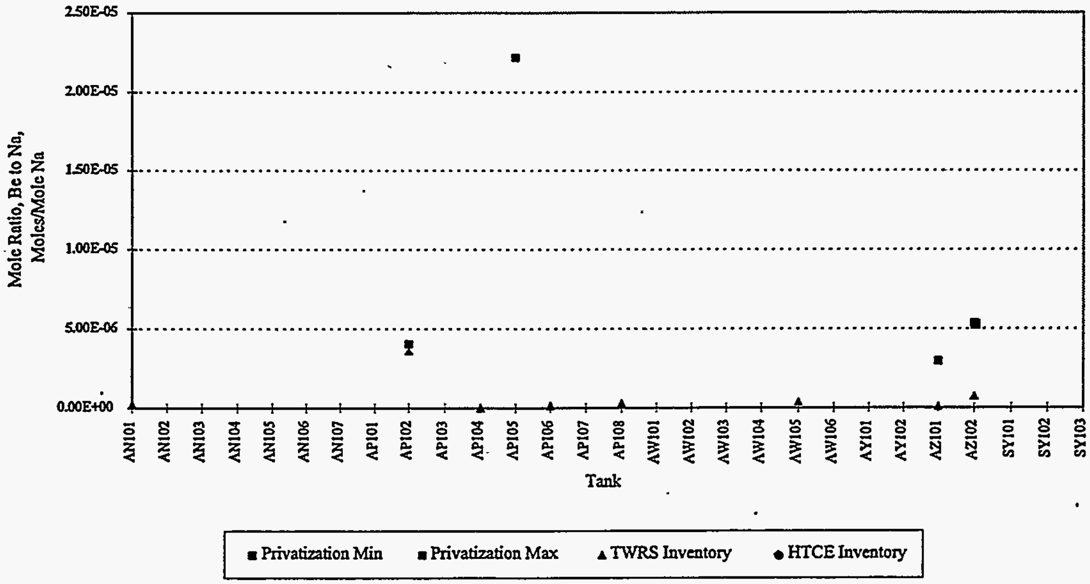

Figure C.7. Beryllium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.7. Bismuth (Bi) Ratioed to Sodium in Moles Bi/Moles Na

Bismuth				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			6.97E-05	1.30E-04
AN102				9.70E-05
AN103				9.27E-05
AN104				9.79E-05
AN105				1.06E-04
AN106			5.85E-08	1.00E-04
AN107				1.07E-04
AP101				5.12E-05
AP102				9.94E-05
AP103				5.72E-06
AP104			1.65E-15	
AP105				5.36E-05
AP106			1.83E-11	4.02E-05
AP107				
AP108				1.02E-06
AW101				7.86E-05
AW102				6.16E-05
AW103				2.38E-06
AW104				8.80E-07
AW105				5.35E-05
AW106				5.32E-05
AY101				5.37E-05
AY102			3.52E-06	5.48E-07
AZ101				1.93E-05
AZ102				1.70E-06
SY101				1.16E-04
SY102				5.79E-07
SY103				1.14E-04

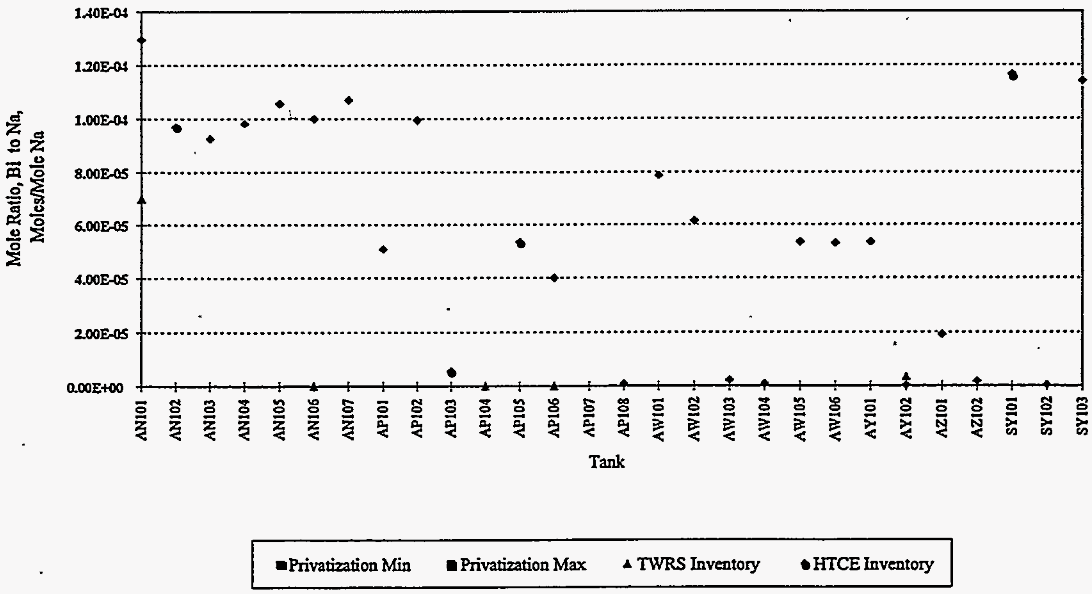

Figure C.8. Bismuth in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.8. Calcium (Ca) Ratioed to Sodium in Moles Ca/Moles Na

Calcium				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			1.00E-03	2.83E-03
AN102		1.72E-03	9.49E-04	2.56E-03
AN103			1.48E-04	3.73E-03
AN104				3.27E-03
AN105				3.09E-03
AN106			1.90E-07	3.41E-03
AN107		1.71E-03	1.42E-03	2.26E-03
AP101			4.07E-04	1.57E-02
AP102				3.47E-03
AP103				4.10E-03
AP104			2.37E-11	1.42E-02
AP105			4.32E-06	5.84E-03
AP106			2.68E-05	5.31E-03
AP107			1.07E-04	1.50E-01
AP108			6.55E-05	4.08E-03
AW101		1.92E-04	8.26E-05	4.44E-03
AW102				5.82E-03
AW103			1.81E-04	1.77E-02
AW104			3.39E-06	1.39E-02
AW105			8.73E-05	6.12E-03
AW106				5.69E-03
AY101			9.98E-06	2.42E-03
AY102			4.93E-05	3.39E-03
AZ101		6.13E-05	2.18E-05	3.16E-03
AZ102		6.44E-05	8.91E-05	3.29E-03
SY101			1.78E-03	2.97E-03
SY102			1.54E-12	8.42E-03
SY103			6.81E-04	2.85E-03

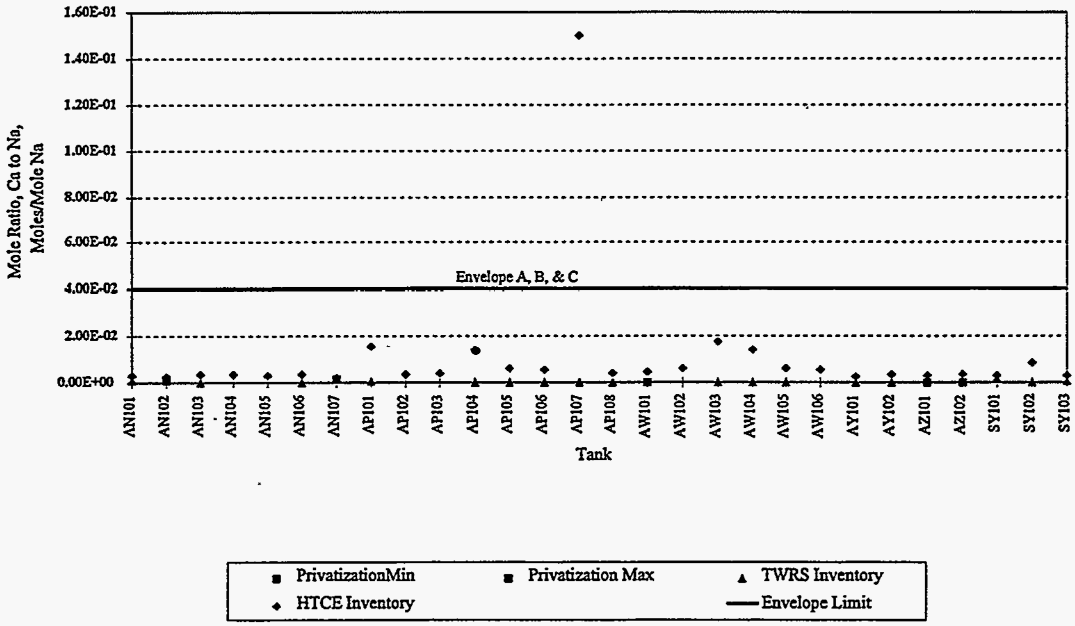

Figure C.9. Calcium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

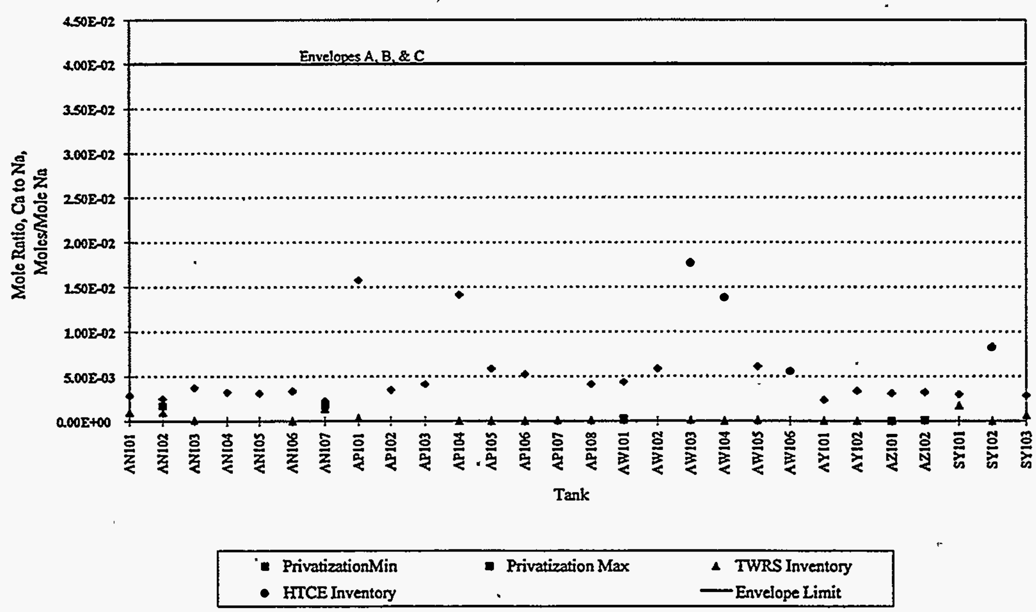

Figure C.10. Calcium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.9. Cadmium (Cd) Ratioed to Sodium in Moles Cadmium/Moles Na

DST	Cadmium			
	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			5.58E-05	
AN102		4.26E-05		
AN103			9.75E-06	
AN104				
AN105				
AN106			7.59E-08	
AN107		6.17E-05		
AP101			2.76E-06	
AP102		3.45E-06	2.95E-06	
AP103			4.28E-06	
AP104			2.04E-16	
AP105		2.17E-06	2.50E-09	
AP106			2.27E-12	
AP107			6.12E-08	
AP108			2.04E-04	
AW101		4.69E-06		
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102			2.80E-06	
AZ101		9.38E-06	2.86E-07	
AZ102		7.31E-06	1.03E-06	
SY101				
SY102				
SY103				

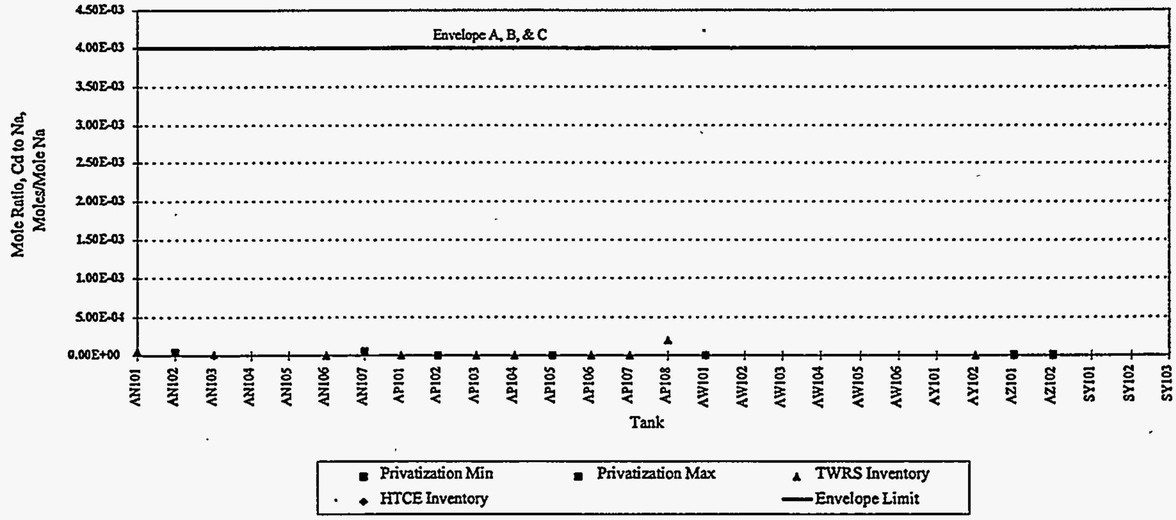

Figure C.11. Cadmium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

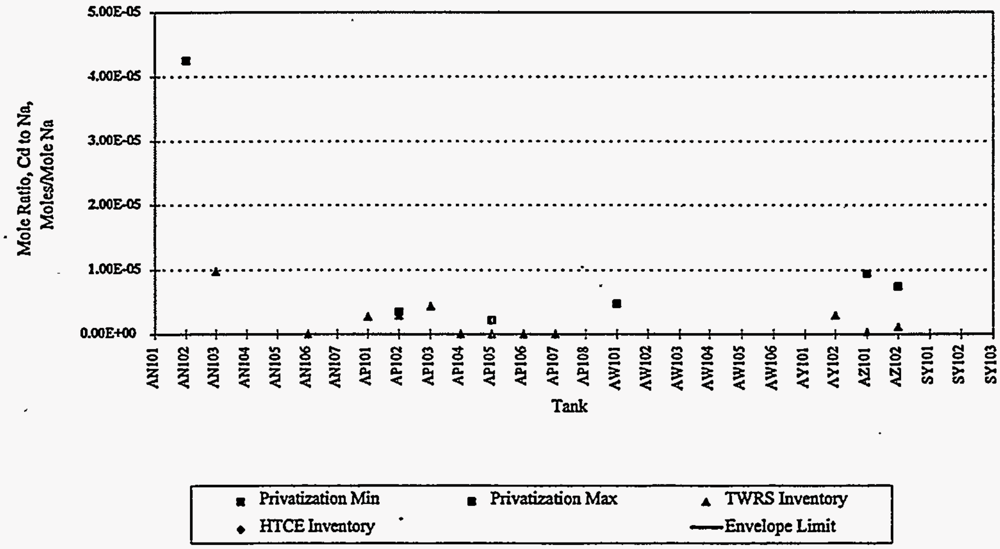

Figure C.12. Cadmium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.10. Cerium (Ce) Ratioed to Sodium in Moles Ce/Moles Na

Cerium				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			3.92E-06	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107		4.10E-05		
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101			9.45E-06	
AZ102		3.61E-05	9.27E-06	
SY101				
SY102				
SY103				

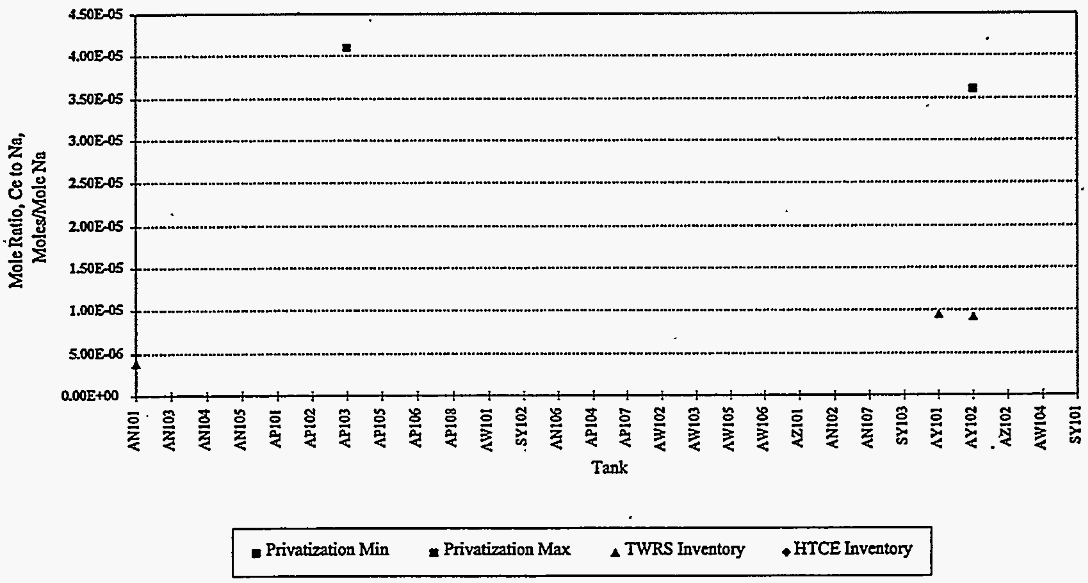

Figure C.13. Cerium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.11. Chlorine (Cl) Ratioed to Sodium in Moles Cl/Moles Na

Chlorine				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			3.77E-03	1.74E-02
AN102	5.56E-03	1.02E-02	9.49E-03	1.78E-02
AN103			1.85E-02	1.74E-02
AN104			1.77E-02	1.76E-02
AN105			2.00E-02	1.82E-02
AN106			2.80E-05	1.71E-02
AN107	2.88E-03	5.95E-03	9.03E-03	1.81E-02
AP101			8.12E-03	1.68E-02
AP102	1.56E-02	2.79E-02	1.85E-02	1.70E-02
AP103			6.05E-03	1.97E-02
AP104			3.37E-02	5.00E-03
AP105	5.06E-03	1.37E-02	2.05E-05	1.67E-02
AP106			3.25E-02	1.73E-02
AP107			5.03E-04	1.53E-02
AP108			6.47E-03	1.79E-02
AW101	1.73E-02	1.72E-02	1.46E-02	1.72E-02
AW102				1.66E-02
AW103			4.47E-03	9.52E-03
AW104			2.66E-02	6.21E-03
AW105			1.22E-02	1.63E-02
AW106				1.67E-02
AY101			8.30E-04	1.79E-02
AY102	1.65E-02	3.20E-02	4.42E-05	1.83E-02
AZ101	1.20E-03	1.25E-03	6.62E-04	1.83E-02
AZ102	8.37E-04	8.25E-04		1.85E-02
SY101			2.64E-02	1.77E-02
SY102			3.29E-02	2.83E-02
SY103			2.84E-02	1.77E-02

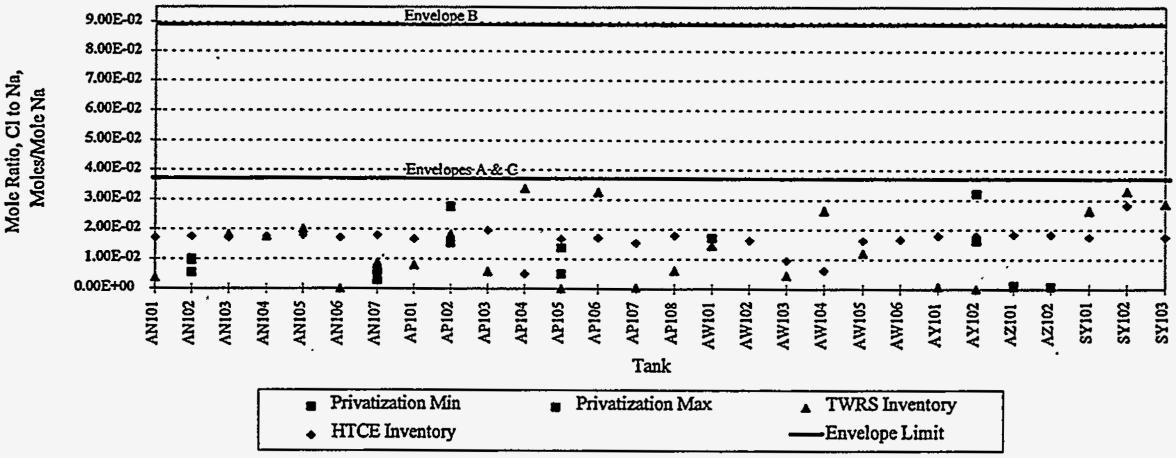

Figure C.14. Chlorine in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

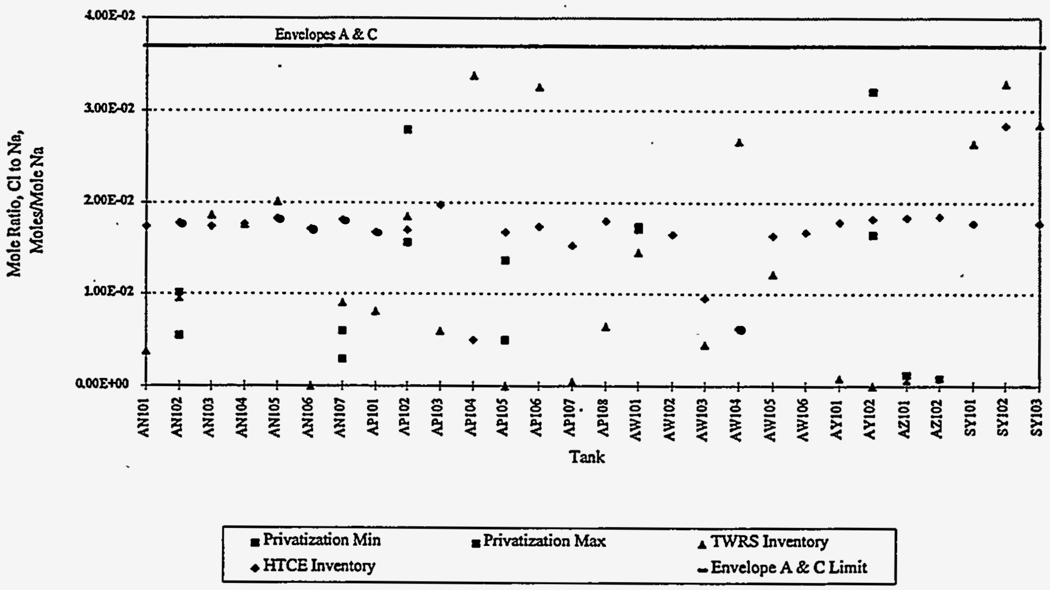

Figure C.15. Chlorine in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.12. Cyanide (CN) Ratioed to Sodium in Moles CN/Moles Na

Cyanide				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102		2.05E-04		
AP103				
AP104				
AP105		8.65E-05		
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101				
AZ102				
SY101				
SY102				
SY103				

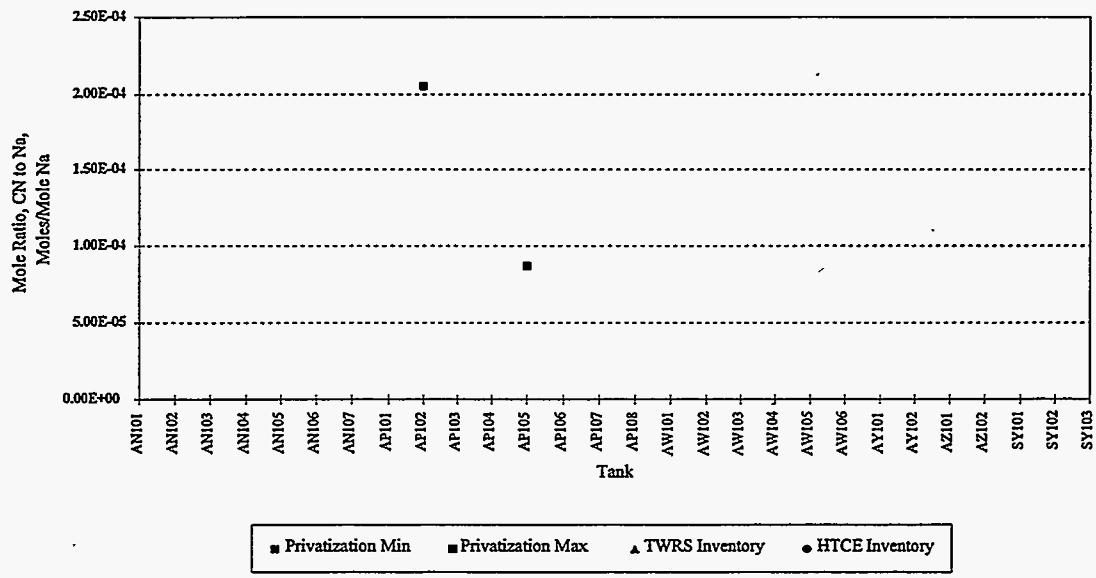

Figure C.16. Cyanide in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.13. Cobalt (Co) Ratioed to Sodium in Moles Co/Moles Na

Cobalt				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101				
AZ102		6.20E-05		
SY101				
SY102				
SY103				

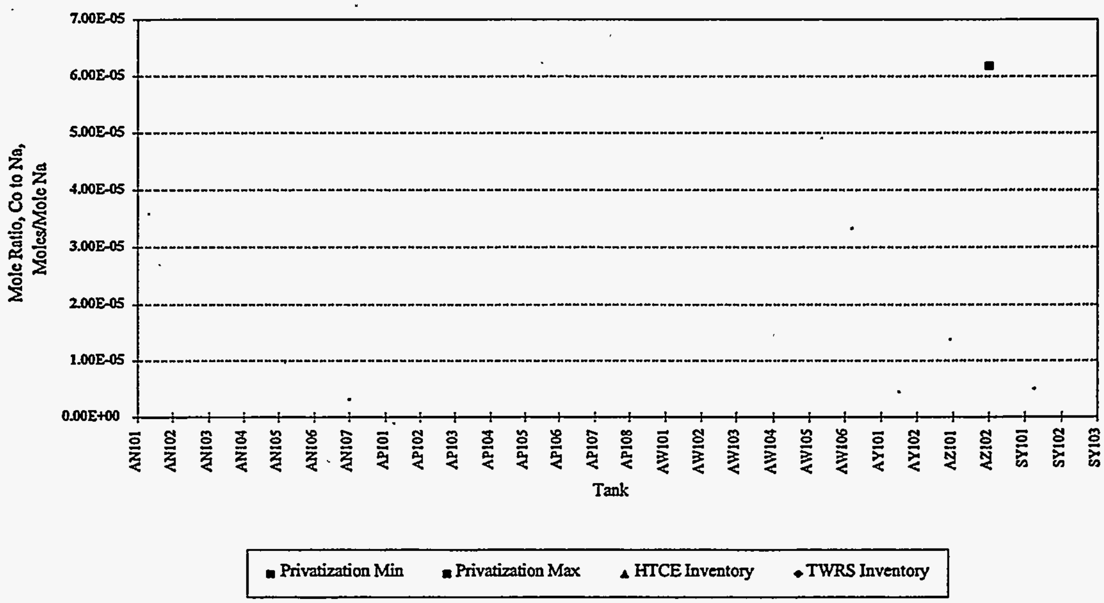

Figure C.17. Cobalt in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.14. $Cr(OH)_4^-$ Ratioed to Sodium in Moles $Cr(OH)_4^-$/Moles Na

$Cr(OH)_4^-$				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			2.38E-03	5.58E-03
AN102	7.88E-04	8.56E-04	4.75E-04	4.40E-03
AN103			1.12E-03	4.10E-03
AN104			1.08E-03	4.15E-03
AN105			1.08E-03	4.00E-03
AN106			1.56E-06	4.98E-03
AN107	5.22E-04	5.09E-04	3.38E-04	3.76E-03
AP101			4.29E-04	3.53E-03
AP102	2.67E-03	2.99E-03	2.68E-03	5.01E-03
AP103			3.66E-04	1.73E-03
AP104			6.05E-11	1.26E-02
AP105	4.39E-04	5.02E-04	1.04E-06	3.92E-03
AP106			2.53E-05	3.16E-03
AP107			2.58E-05	
AP108			4.09E-04	9.46E-04
AW101	3.20E-04	5.35E-04	3.10E-04	4.27E-03
AW102				4.13E-03
AW103			1.64E-03	7.88E-04
AW104			6.63E-07	1.24E-02
AW105			7.45E-05	3.97E-03
AW106				3.94E-03
AY101			4.54E-03	4.61E-03
AY102			2.27E-05	7.41E-04
AZ101	4.02E-04	3.69E-03	3.84E-03	8.22E-04
AZ102	8.37E-03	8.25E-03	4.85E-03	1.76E-04
SY101			4.40E-04	4.87E-03
SY102			3.94E-12	7.84E-03
SY103			1.30E-02	4.82E-03

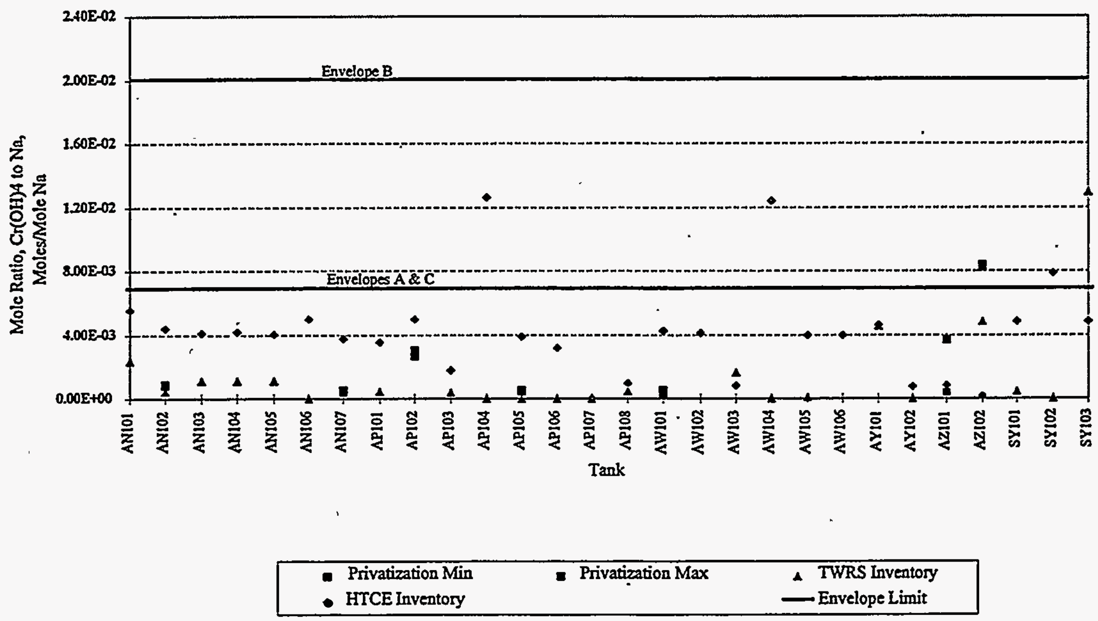

Figure C.18. $Cr(OH)_4^-$ in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

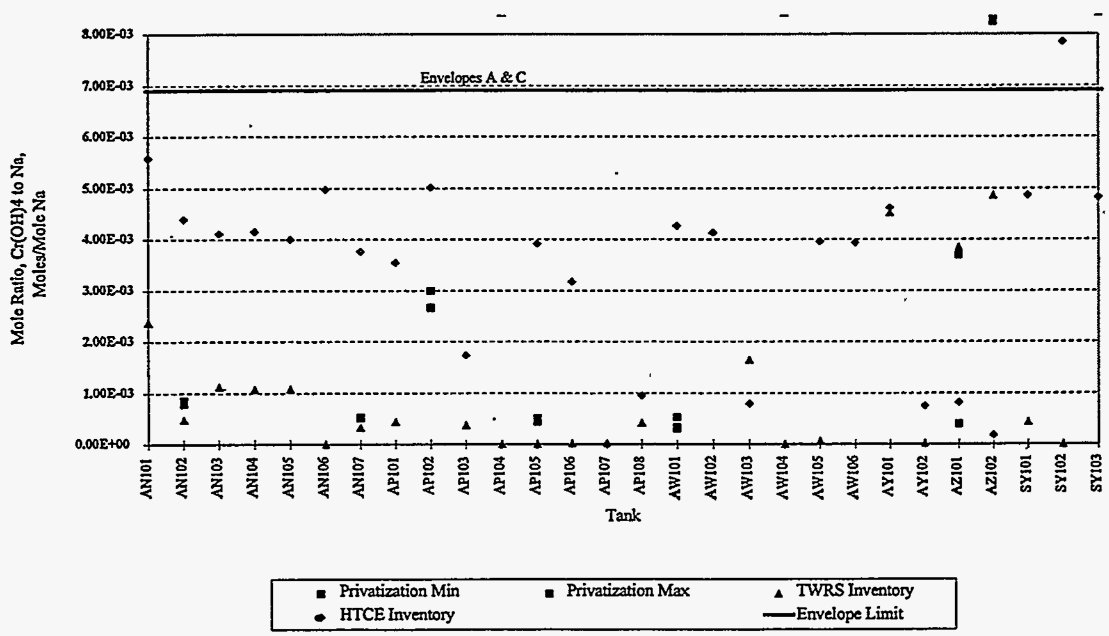

Figure C.19. $Cr(OH)_4^-$ in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.15. Fluorine (F) Ratioed to Sodium in Moles F/Moles Na

Fluorine				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.21E-02	8.69E-03
AN102	1.31E-02	1.12E-02	9.49E-03	5.83E-03
AN103			2.65E-03	1.53E-02
AN104				1.09E-02
AN105				6.74E-03
AN106			9.65E-03	6.00E-03
AN107		<2.20E-02		6.70E-03
AP101			3.45E-02	2.42E-03
AP102	<1.63E-04	<2.39E-03		5.97E-03
AP103			2.94E-02	2.89E-03
AP104			4.30E-02	
AP105	<8.37E-05	5.56E-02	9.18E-03	2.78E-02
AP106			5.86E-02	2.06E-02
AP107			9.57E-03	
AP108			7.47E-02	5.64E-04
AW101		<3.07E-04		2.19E-02
AW102				2.71E-02
AW103			1.08E+00	4.49E-01
AW104			1.81E-03	1.55E-04
AW105			5.26E-02	4.96E-02
AW106				2.53E-02
AY101			2.09E-02	3.12E-03
AY102	5.35E-03	7.01E-03	1.24E-04	3.02E-04
AZ101	1.99E-02	2.01E-02	2.26E-02	9.93E-03
AZ102	1.83E-02	2.43E-02	1.20E-02	9.96E-03
SY101			7.09E-04	6.57E-03
SY102			3.65E-02	3.96E-05
SY103			5.65E-03	6.49E-03

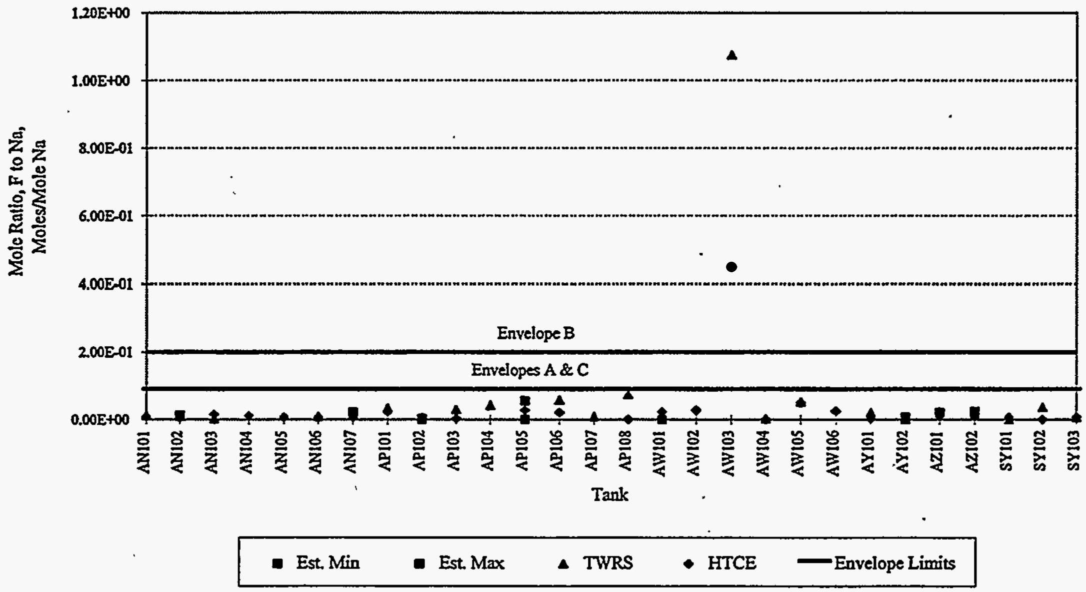

Figure C.20. Fluorine in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less that 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

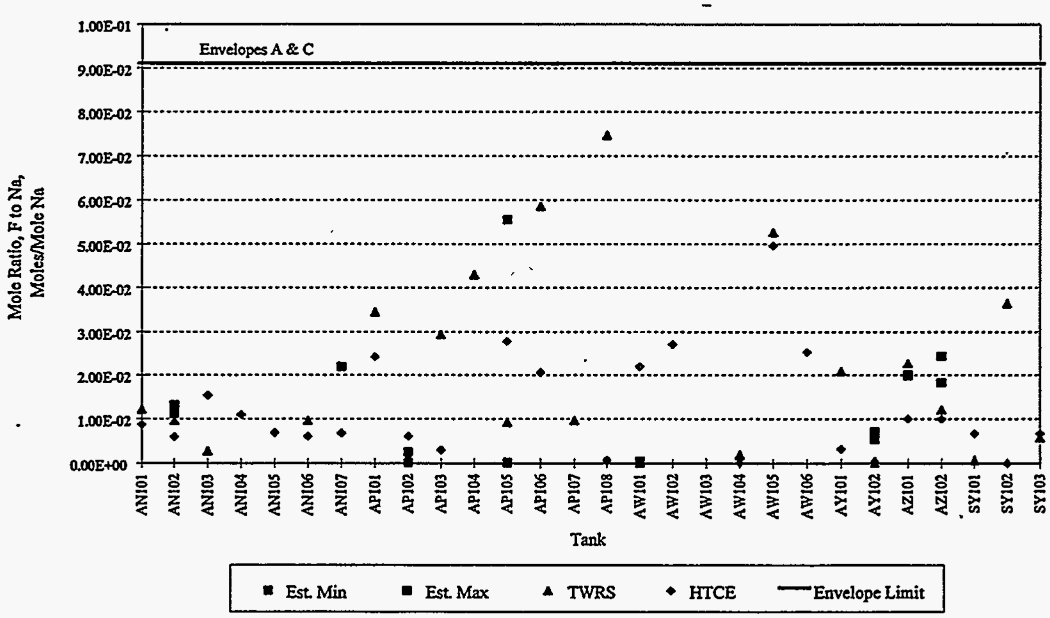

Figure C.21. Fluorine in Double-Shelled Tank Waste Supernatant Ratioed to Sodium.For the assessment of envelope limits, waste containing less that 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.16. Iron (Fe) Ratioed to Sodium in Moles Fe/Moles Na

Iron				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			7.69E-04	6.23E-04
AN102		4.54E-04		5.63E-04
AN103			8.63E-05	8.26E-04
AN104			1.67E-05	7.24E-04
AN105			1.67E-05	6.83E-04
AN106			1.97E-06	7.53E-04
AN107		5.22E-03	2.77E-03	4.99E-04
AP101			7.61E-05	3.49E-03
AP102		4.08E-05	1.54E-05	7.66E-04
AP103			9.54E-05	9.10E-04
AP104			1.90E-05	3.15E-03
AP105		2.06E-05	1.58E-07	1.30E-03
AP106			8.48E-06	1.18E-03
AP107			3.89E-06	3.34E-02
AP108			4.96E-04	9.06E-04
AW101		1.58E-04		9.83E-04
AW102				1.29E-03
AW103				3.93E-03
AW104			2.77E-05	3.09E-03
AW105			9.40E-03	1.36E-03
AW106				1.26E-03
AY101			3.44E-07	5.28E-04
AY102		<9.17E-02	3.86E-05	7.53E-04
AZ101		<4.27E-05	4.74E-06	7.00E-04
AZ102		8.28E-05	1.75E-05	7.30E-04
SY101			4.98E-05	6.53E-04
SY102			7.46E-05	1.87E-03
SY103			3.19E-03	6.28E-04

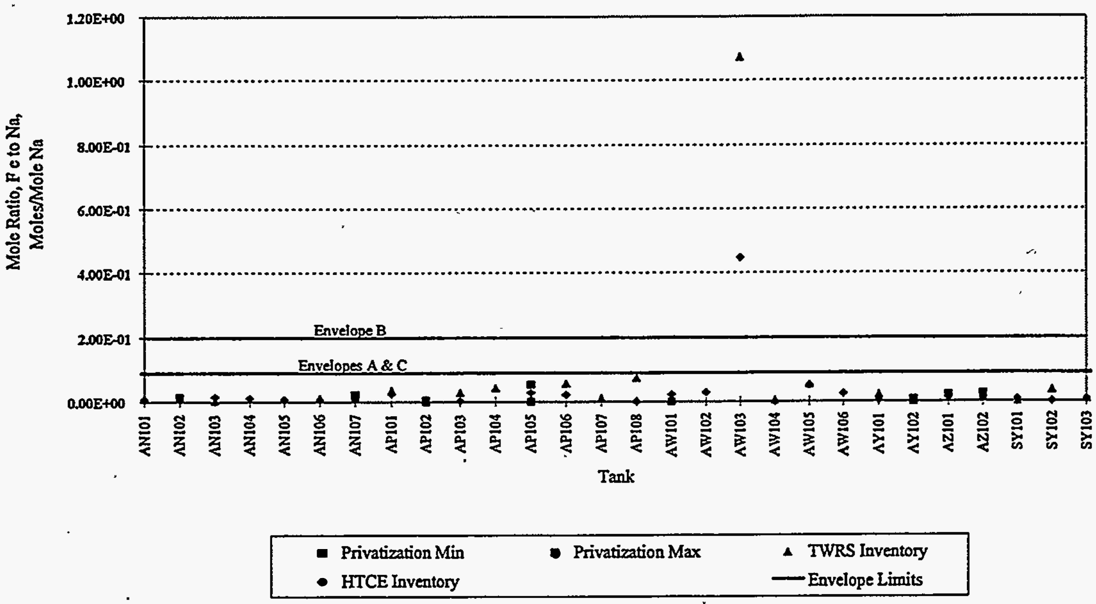

Figure C.22. Iron in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

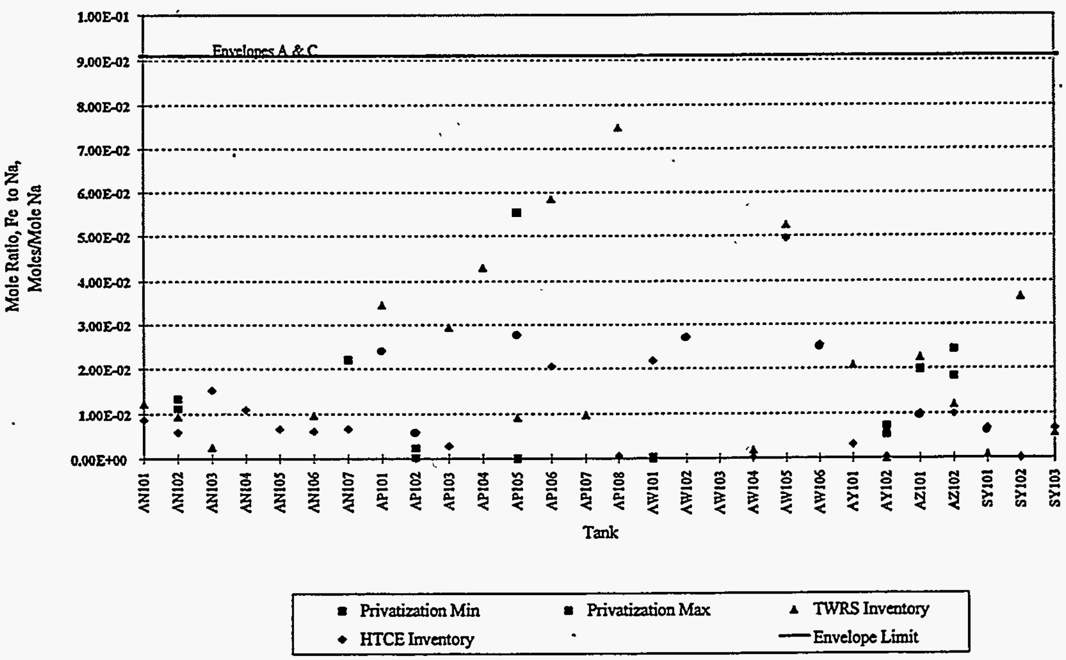

Figure C.23. Iron in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.17. Mercury (Hg) Ratioed to Sodium in Moles Hg/Moles Na

Mercury				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.28E-06	8.25E-07
AN102				7.62E-07
AN103			5.46E-06	1.10E-06
AN104				9.37E-07
AN105				7.72E-07
AN106			9.73E-11	7.46E-07
AN107				8.93E-07
AP101			2.20E-09	1.27E-06
AP102		<1.08E-08		7.43E-07
AP103			1.08E-07	1.32E-07
AP104				
AP105				1.44E-06
AP106				1.07E-06
AP107				
AP108				1.83E-08
AW101		1.24E-08		1.34E-06
AW102				1.41E-06
AW103				1.87E-05
AW104				1.11E-08
AW105				2.35E-06
AW106				1.33E-06
AY101				4.51E-07
AY102			6.49E-08	9.81E-09
AZ101				1.49E-07
AZ102				1.40E-08
SY101				7.78E-07
SY102				4.32E-09
SY103				7.85E-07

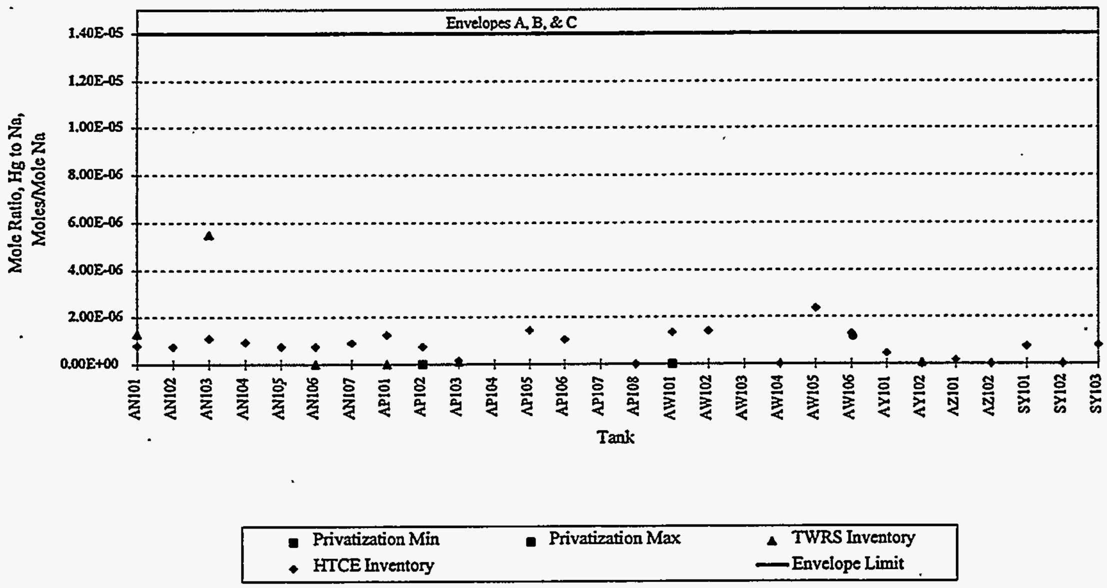

Figure C.24. Mercury in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

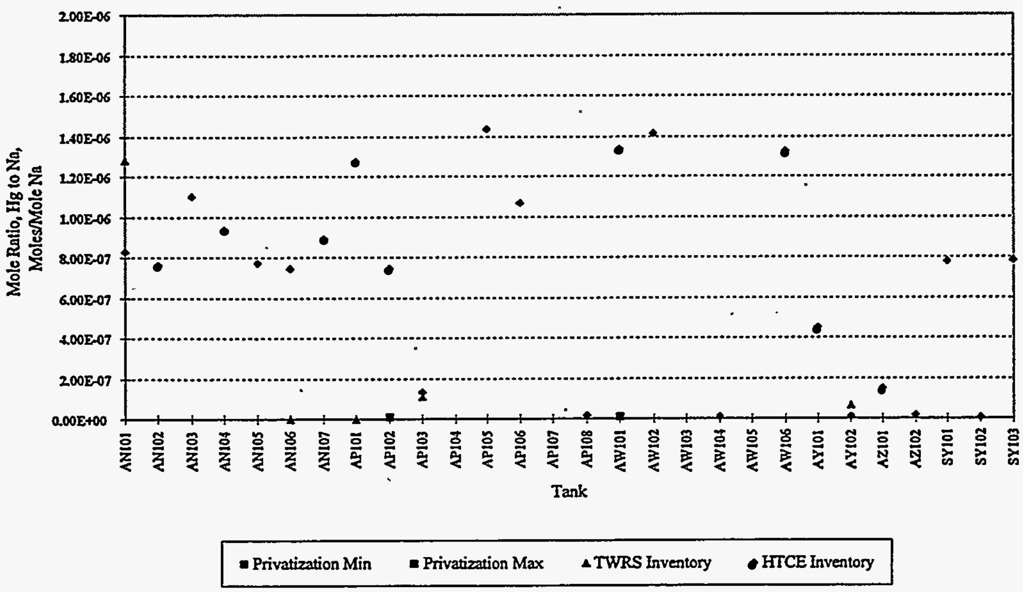

Figure C.25. Mercury in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.18. Potassium (K) Ratioed to Sodium in Moles K/Moles Na

Potassium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			3.96E-03	6.07E-03
AN102	5.38E-03	9.50E-03	8.63E-03	5.00E-03
AN103			2.66E-02	1.42E-02
AN104			1.53E-02	9.76E-03
AN105			1.31E-02	5.44E-03
AN106			2.33E-06	4.74E-03
AN107	2.28E-03	4.56E-03	5.60E-03	5.09E-03
AP101			8.80E-02	2.47E-02
AP102	7.14E-03	7.77E-03	7.44E-03	4.72E-03
AP103			1.68E-01	6.16E-03
AP104			2.02E-08	1.09E-03
AP105	1.14E-01	1.13E-01	1.32E-04	2.81E-02
AP106			9.31E-03	2.18E-02
AP107			3.37E-03	3.34E-03
AP108			1.02E-01	4.45E-03
AW101	8.54E-02	1.07E-01	1.07E-01	2.13E-02
AW102				2.71E-02
AW103			6.13E-01	4.20E-01
AW104			1.40E-05	1.07E-02
AW105			2.78E-02	4.84E-02
AW106				2.58E-02
AY101			1.70E-02	4.89E-03
AY102				4.09E-03
AZ101	1.88E-02	2.83E-02	2.35E-02	4.20E-03
AZ102	1.60E-02	1.58E-02	2.13E-03	4.09E-03
SY101			9.42E-03	4.81E-03
SY102			1.32E-09	4.65E-03
SY103			1.05E-02	4.81E-03

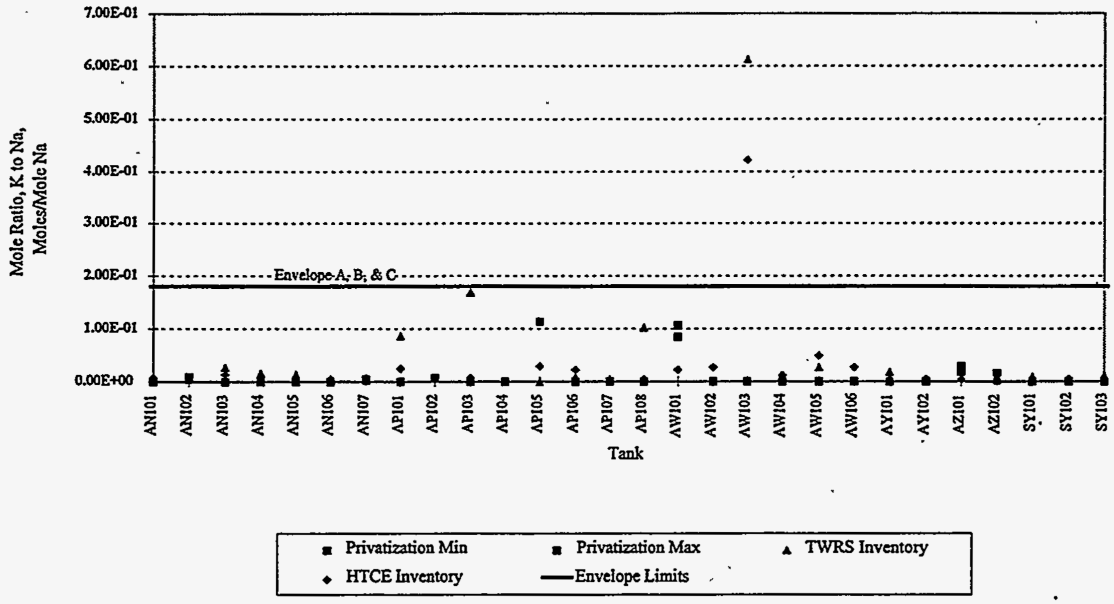

Figure C.26. Potassium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.19. Lanthanum (La) Ratioed to Sodium in Moles La/Moles Na

Lanthanum				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			4.74E-05	6.80E-07
AN102				1.63E-06
AN103				1.07E-06
AN104				1.32E-06
AN105				1.15E-06
AN106				2.21E-06
AN107				1.07E-06
AP101			1.67E-05	1.47E-06
AP102				2.20E-06
AP103				1.26E-07
AP104				
AP105			3.45E-07	1.44E-06
AP106				1.03E-06
AP107			8.46E-06	
AP108				2.19E-08
AW101				1.12E-06
AW102				1.50E-06
AW103				2.02E-08
AW104				1.28E-08
AW105				9.95E-07
AW106				1.38E-06
AY101			8.49E-07	1.06E-06
AY102			2.37E-06	1.17E-08
AZ101		6.74E-06	7.18E-07	3.93E-07
AZ102		5.36E-06	1.50E-06	1.98E-08
SY101				4.06E-06
SY102				5.98E-09
SY103				3.35E-06

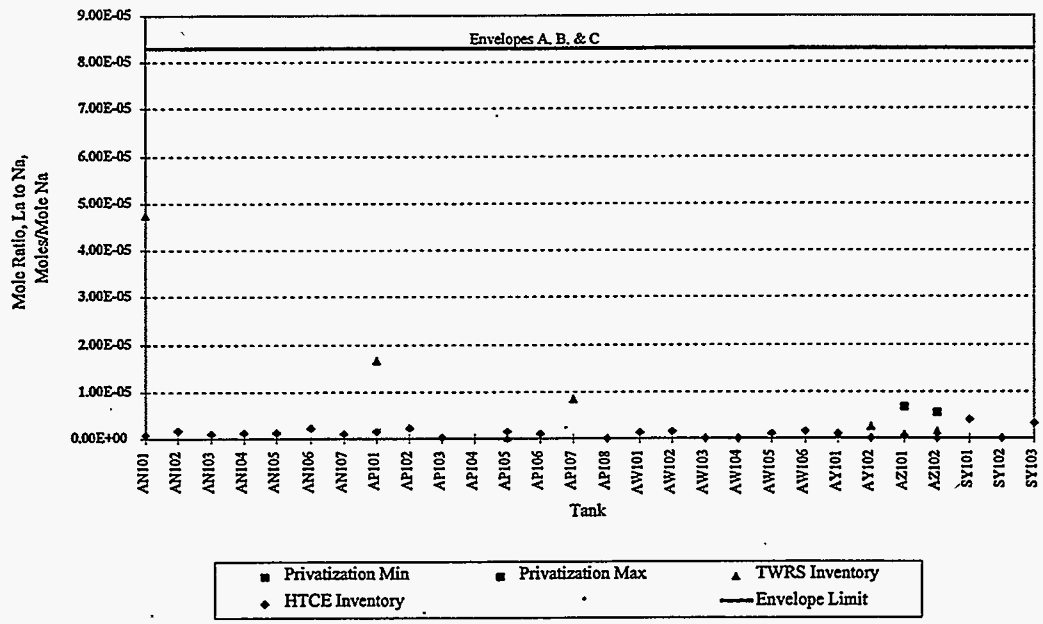

Figure C.27. Lanthanum in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

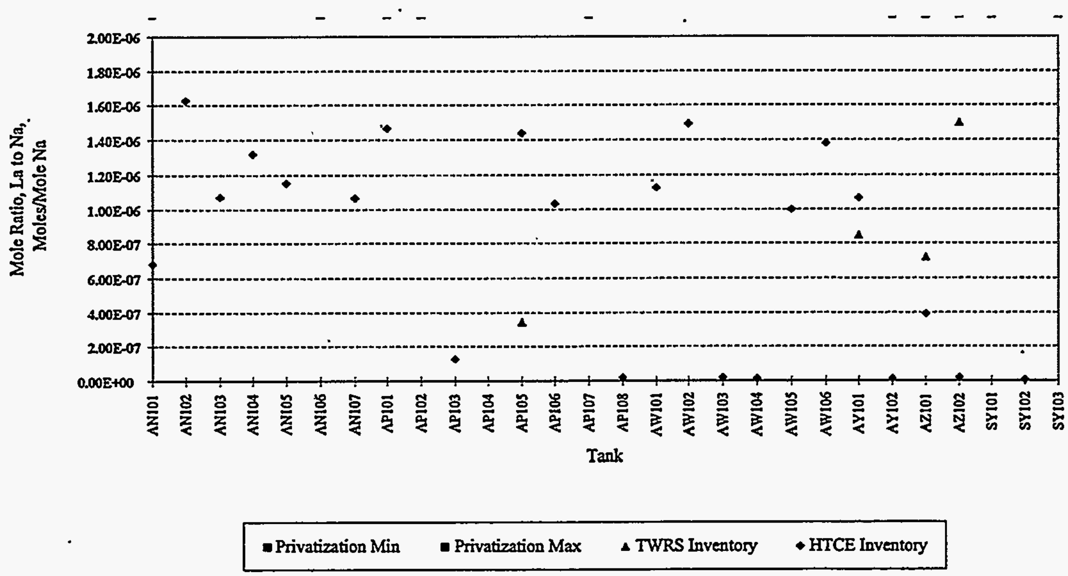

Figure C.28. Lanthanum in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.20. Manganese (Mn) Ratioed to Sodium in Moles Mn/Moles Na

Manganese				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			1.55E-04	3.81E-04
AN102				4.71E-04
AN103			3.59E-05	7.35E-04
AN104				6.88E-04
AN105				5.15E-04
AN106			2.64E-07	3.41E-04
AN107			9.40E-04	4.32E-04
AP101			5.16E-06	1.13E-03
AP102				3.39E-04
AP103			3.40E-06	1.28E-04
AP104			2.69E-04	
AP105				1.33E-03
AP106			1.20E-05	1.01E-03
AP107			7.33E-11	
AP108				3.36E-04
AW101			4.75E-05	1.09E-03
AW102				1.40E-03
AW103				5.33E-04
AW104			5.34E-09	9.28E-03
AW105				1.39E-03
AW106				1.30E-03
AY101				5.92E-04
AY102			7.81E-06	9.15E-06
AZ101			4.41E-07	9.72E-05
AZ102			1.61E-06	6.86E-05
SY101				3.43E-04
SY102			1.23E-03	5.31E-06
SY103				3.48E-04

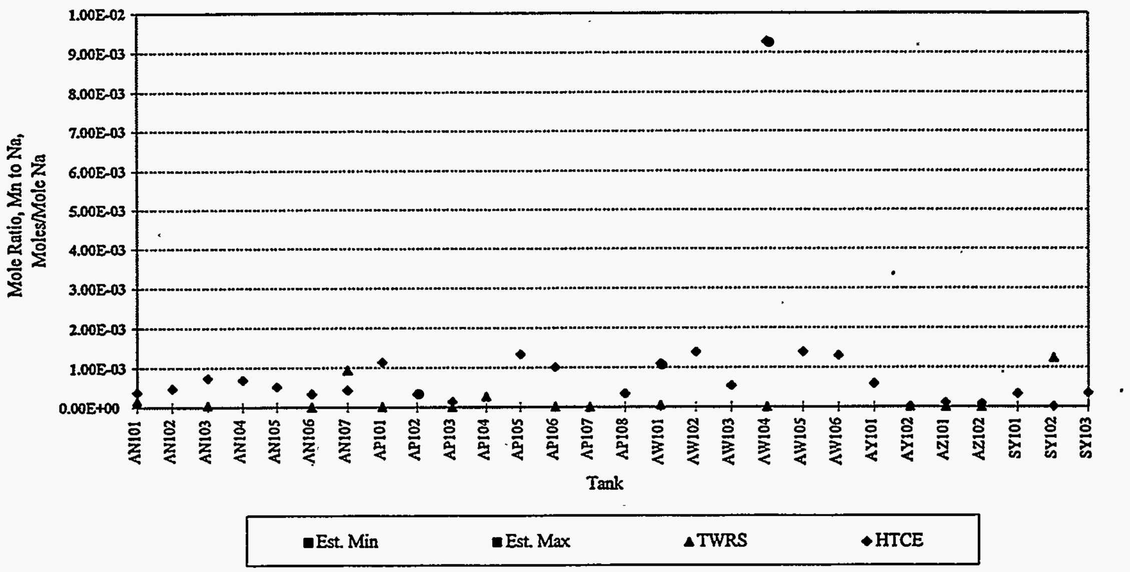

Figure C.29. Manganese in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

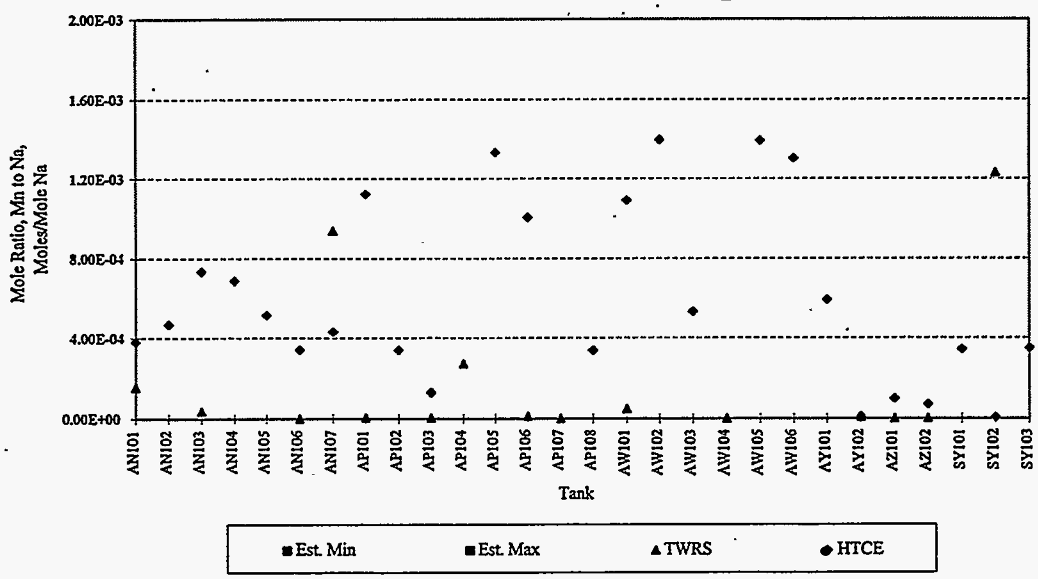

Figure C.30. Manganese in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded.

Table C.21. Sodium (Na) Ratioed to Sodium in Moles Na/Moles Na

	Sodium			
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			1.00E+00	1.00E+00
AN102	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AN103			1.00E+00	1.00E+00
AN104			1.00E+00	1.00E+00
AN105			1.00E+00	1.00E+00
AN106			1.00E+00	1.00E+00
AN107	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AP101			1.00E+00	1.00E+00
AP102	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AP103			1.00E+00	1.00E+00
AP104			1.00E+00	1.00E+00
AP105	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AP106			1.00E+00	1.00E+00
AP107			1.00E+00	1.00E+00
AP108			1.00E+00	1.00E+00
AW101	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AW102				1.00E+00
AW103			1.00E+00	1.00E+00
AW104			1.00E+00	1.00E+00
AW105			1.00E+00	1.00E+00
AW106				1.00E+00
AY101			1.00E+00	1.00E+00
AY102	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AZ101	1.00E+00	1.00E+00	1.00E+00	1.00E+00
AZ102	1.00E+00	1.00E+00	1.00E+00	1.00E+00
SY101			1.00E+00	1.00E+00
SY102			1.00E+00	1.00E+00
SY103			1.00E+00	1.00E+00

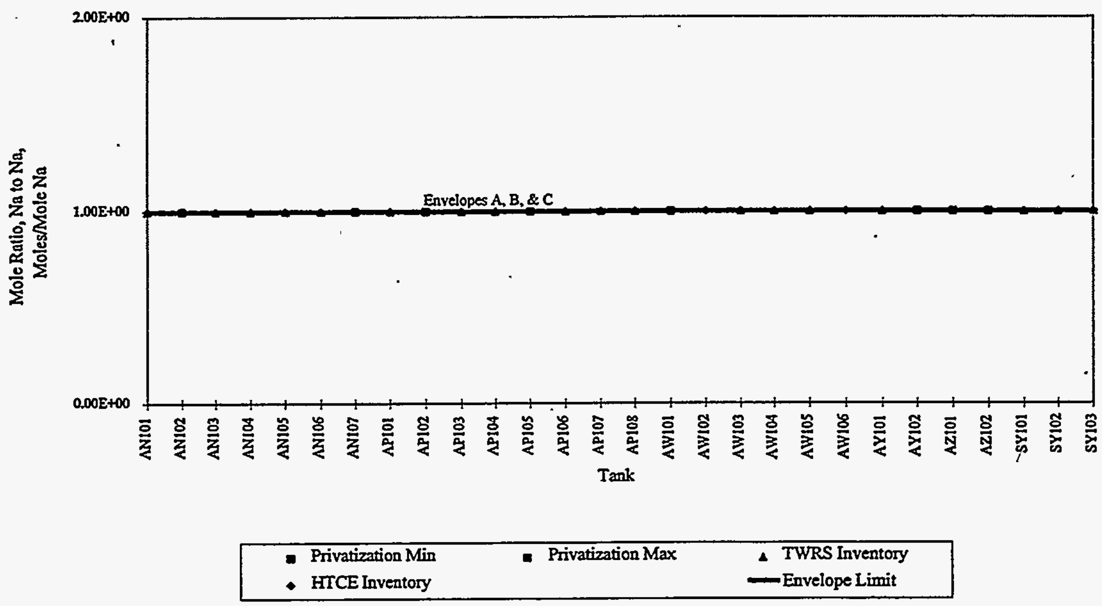

Figure C.31. Sodium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.22. Neodymium (Nd) Ratioed to Sodium in Moles Nd/Moles Na

Neodymium				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107		7.76E-05		
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		2.34E-06		
AZ102		1.61E-05		
SY101				
SY102				
SY103				

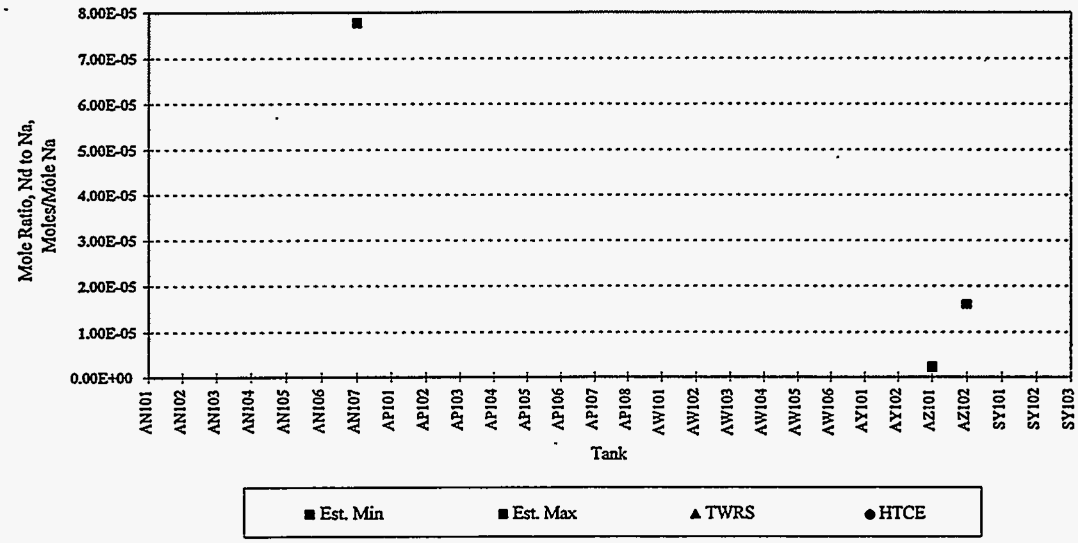

Figure C.32. Neodymium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.23. NH_3/NH_4^+ Ratioed to Sodium in Moles NH_3/NH_4^+/Moles Na

	NH_3/NH_4^+			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101				9.62E-03
AN102				3.85E-03
AN103				3.54E-02
AN104				1.95E-02
AN105				4.77E-03
AN106				4.13E-03
AN107				2.79E-03
AP101				1.33E-01
AP102	<5.20E-04	4.97E-03		4.14E-03
AP103				8.54E-03
AP104				
AP105				8.60E-02
AP106				6.43E-02
AP107				8.33E-01
AP108				4.30E-03
AW101		2.11E-03		5.88E-02
AW102				8.23E-02
AW103				1.46E+00
AW104				3.85E-04
AW105				1.54E-01
AW106				7.82E-02
AY101				4.17E-03
AY102				6.32E-04
AZ101				5.67E-03
AZ102				5.67E-03
SY101				4.84E-03
SY102				3.58E-05
SY103				4.63E-03

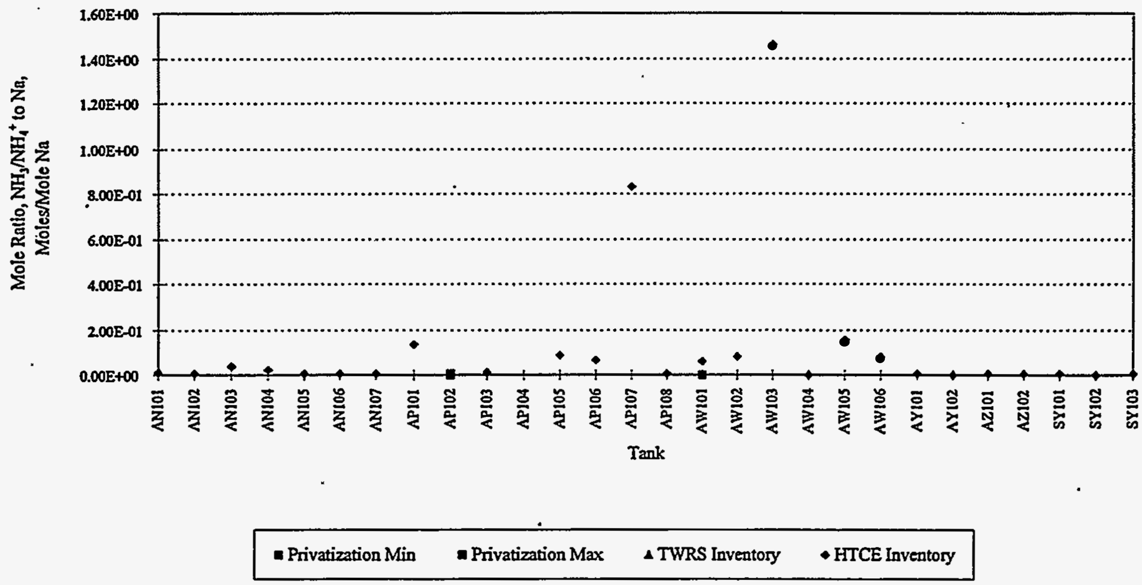

Figure C.33. NH_3/NH_4^+ in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

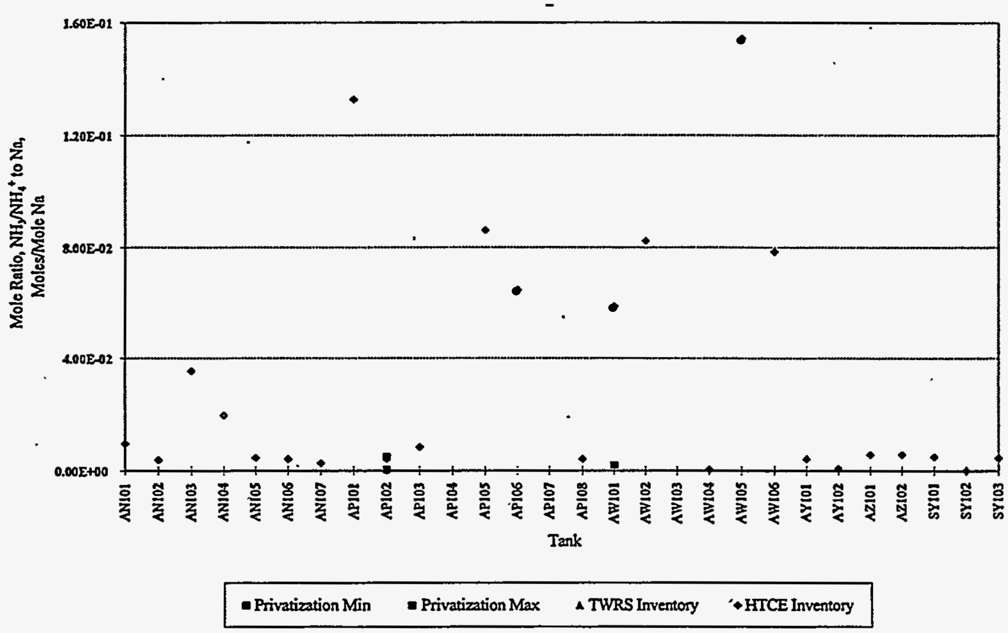

Figure C.34. NH_3/NH_4^+ in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.24. Nickel (Ni) Ratioed to Sodium in Moles Ni/Moles Na

Nickel				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.50E-06	5.33E-04
AN102		5.94E-04	5.18E-04	4.72E-04
AN103			2.80E-05	6.44E-04
AN104				5.83E-04
AN105				5.85E-04
AN106				6.46E-04
AN107		9.91E-04	7.92E-04	4.10E-04
AP101			6.01E-05	7.31E-04
AP102		1.27E-04	1.02E-04	6.57E-04
AP103				7.33E-04
AP104			3.91E-16	2.83E-03
AP105		2.50E-05	8.61E-07	8.16E-04
AP106			4.35E-12	7.75E-04
AP107			2.11E-05	
AP108			2.70E-05	6.81E-04
AW101				7.32E-04
AW102				8.31E-04
AW103			5.93E-05	1.71E-04
AW104			1.05E-08	2.78E-03
AW105				8.02E-04
AW106				8.06E-04
AY101			2.05E-06	3.78E-04
AY102				6.67E-04
AZ101			1.18E-06	1.01E-04
AZ102		1.56E-05	3.82E-06	7.07E-05
SY101			5.62E-05	5.56E-04
SY102				1.68E-03
SY103			1.52E-04	5.34E-04

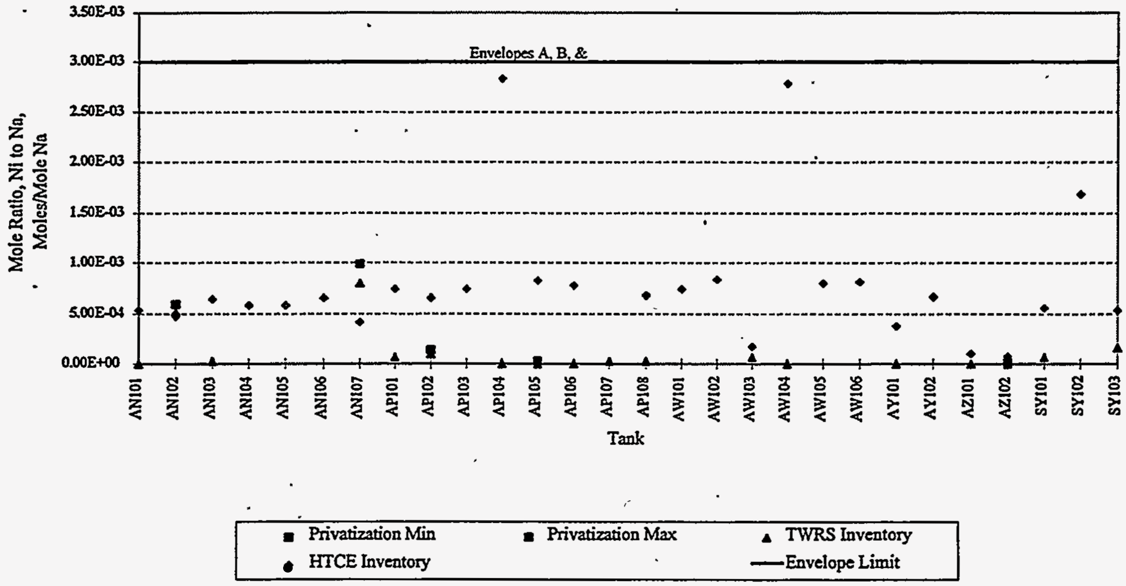

Figure C.35. Nickel in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

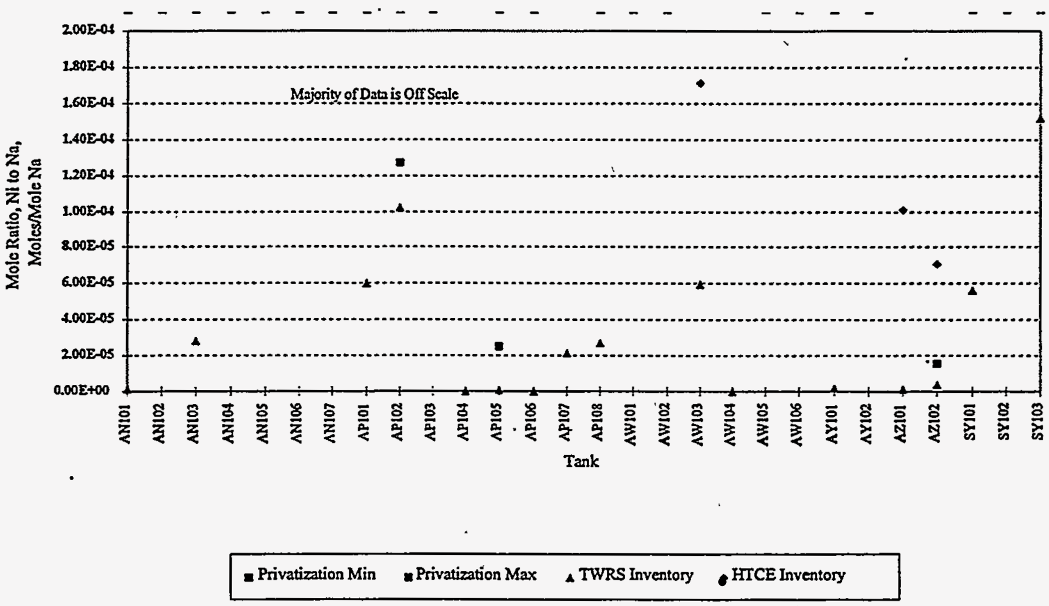

Figure C.36. Nickel in Double-Shelled Tank Waste Supernatant Ratioed to Sodium.. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.25. Nitrite (NO_2^-) Ratioed to Sodium in Moles NO_2^-/Moles Na

Nitrite				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.07E-01	2.24E-01
AN102	4.00E-02	1.56E-01	1.57E-01	2.02E-01
AN103			2.05E-01	1.55E-01
AN104			1.60E-01	1.72E-01
AN105			2.18E-01	1.67E-01
AN106			1.58E-01	1.89E-01
AN107	3.15E-02	1.37E-01	1.11E-01	2.02E-01
AP101			1.38E-01	9.85E-02
AP102	1.58E-01	2.60E-01	1.86E-01	1.88E-01
AP103			1.22E-01	4.04E-02
AP104			1.87E-01	2.21E-02
AP105	1.23E-01	1.61E-01	1.58E-01	1.04E-01
AP106			1.86E-01	8.50E-02
AP107			1.55E-01	
AP108			9.93E-02	3.28E-02
AW101	1.98E-01	1.77E-01	2.22E-01	1.38E-01
AW102				1.09E-01
AW103			3.11E-02	2.01E-02
AW104			5.62E-02	2.74E-02
AW105			1.48E-01	1.03E-01
AW106				1.08E-01
AY101			2.85E-01	1.92E-01
AY102	1.36E-01	2.10E-01	8.76E-02	3.16E-02
AZ101	2.94E-01	3.03E-01	2.28E-01	1.68E-01
AZ102	2.10E-01	2.75E-01	1.79E-01	1.52E-01
SY101			9.61E-02	1.95E-01
SY102			1.68E-01	2.12E-02
SY103			2.62E-01	2.00E-01

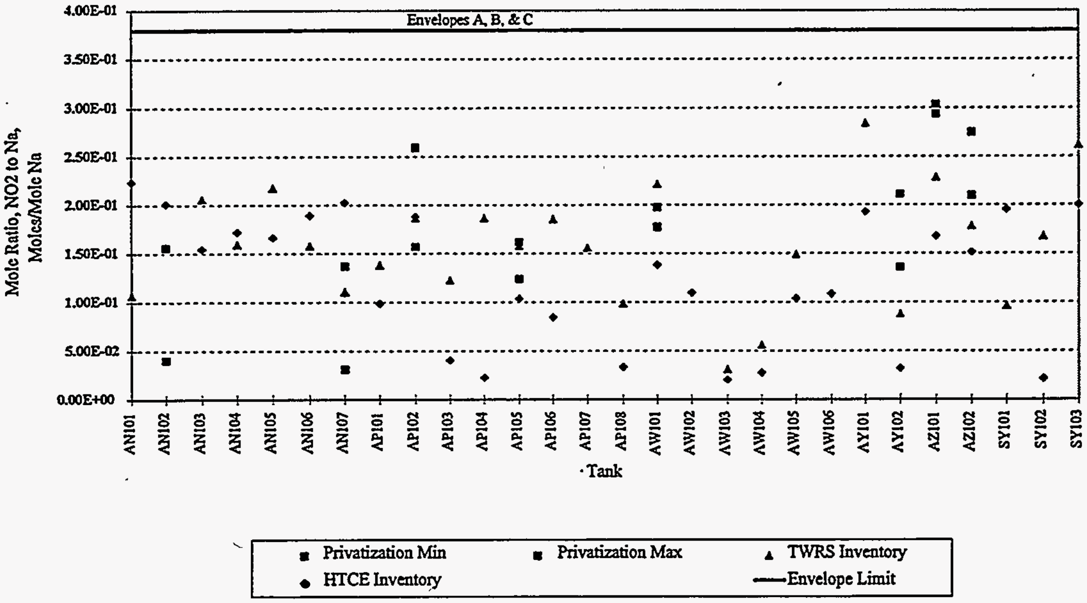

Figure C.37. Nitrite in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.26. Nitrate (NO_3^-) Ratioed to Sodium in Moles NO_3^-/Moles Na

Nitrate				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			9.29E-02	4.37E-01
AN102	8.69E-02	3.07E-01	3.08E-01	3.90E-01
AN103			1.77E-01	4.41E-01
AN104			2.58E-01	4.15E-01
AN105			2.60E-01	4.30E-01
AN106			2.84E-01	4.04E-01
AN107	1.66E-01	4.04E-01	3.95E-01	3.68E-01
AP101			3.52E-01	5.17E-01
AP102	2.03E-01	3.40E-01	2.85E-01	4.03E-01
AP103			2.82E-01	5.06E-01
AP104			2.81E-01	2.47E-01
AP105	3.17E-01	4.28E-01	2.84E-01	4.73E-01
AP106			2.90E-01	4.81E-01
AP107			2.88E-01	1.11E+00
AP108			2.73E-01	4.76E-01
AW101	3.64E-01	2.84E-01	3.45E-01	4.53E-01
AW102				4.70E-01
AW103			6.65E-02	7.67E-01
AW104			3.18E-01	3.91E-01
AW105			3.36E+00	4.85E-01
AW106				4.71E-01
AY101			2.29E-01	3.38E-01
AY102	5.62E-02	9.22E-02	9.43E-04	4.81E-01
AZ101	2.56E-01	2.60E-01	1.91E-01	1.31E-01
AZ102	1.34E-01	1.79E-01	7.78E-02	1.05E-01
SY101			8.29E-02	4.42E-01
SY102			2.53E-01	7.44E-01
SY103			2.56E-02	4.34E-01

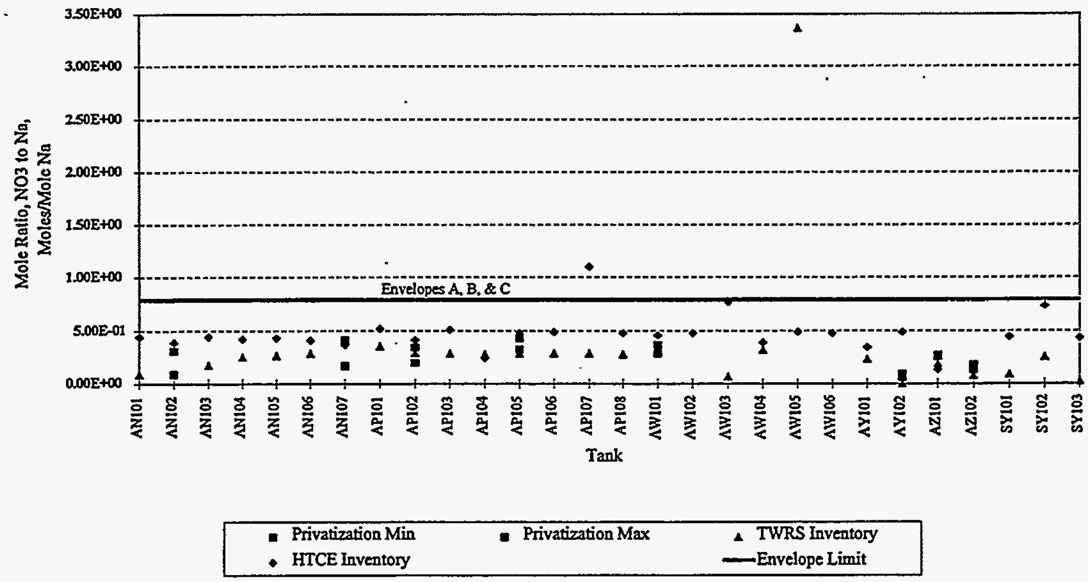

Figure C.38. Nitrate in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.27. Hydroxide (OH^-) Ratioed to Sodium in Moles OH^-/Moles Na

Hydroxide				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			5.95E-01	6.23E-01
AN102	6.21E-02	1.29E-01	5.44E-02	6.07E-01
AN103			3.93E-01	5.79E-01
AN104			3.41E-01	5.89E-01
AN105			3.03E-01	5.96E-01
AN106			3.66E-02	5.76E-01
AN107	6.39E-03	5.67E-02	1.09E-01	6.39E-01
AP101			3.81E-01	5.07E-01
AP102	1.09E-01	1.21E-01	1.21E-01	5.73E-01
AP103			4.31E-01	6.11E-01
AP104			3.47E-01	8.13E-02
AP105	4.92E-01	3.84E-01	3.66E-02	5.15E-01
AP106			3.27E-01	5.45E-01
AP107			5.40E-02	2.67E-01
AP108			3.62E-01	6.41E-01
AW101	4.81E-01	4.17E-01	5.08E-01	5.40E-01
AW102				5.11E-01
AW103			2.21E-01	2.19E-01
AW104			5.04E-01	3.09E-02
AW105			4.67E-01	4.92E-01
AW106				5.24E-01
AY101			1.26E-01	4.82E-01
AY102	<1.40E-01	1.75E-01	4.43E+00	6.62E-01
AZ101	1.62E-01	1.58E-01	1.77E-01	9.08E-01
AZ102	4.68E-02	5.01E-02	3.63E-01	9.44E-01
SY101			8.27E-01	5.74E-01
SY102			4.14E-01	3.34E-01
SY103			1.41E-01	5.87E-01

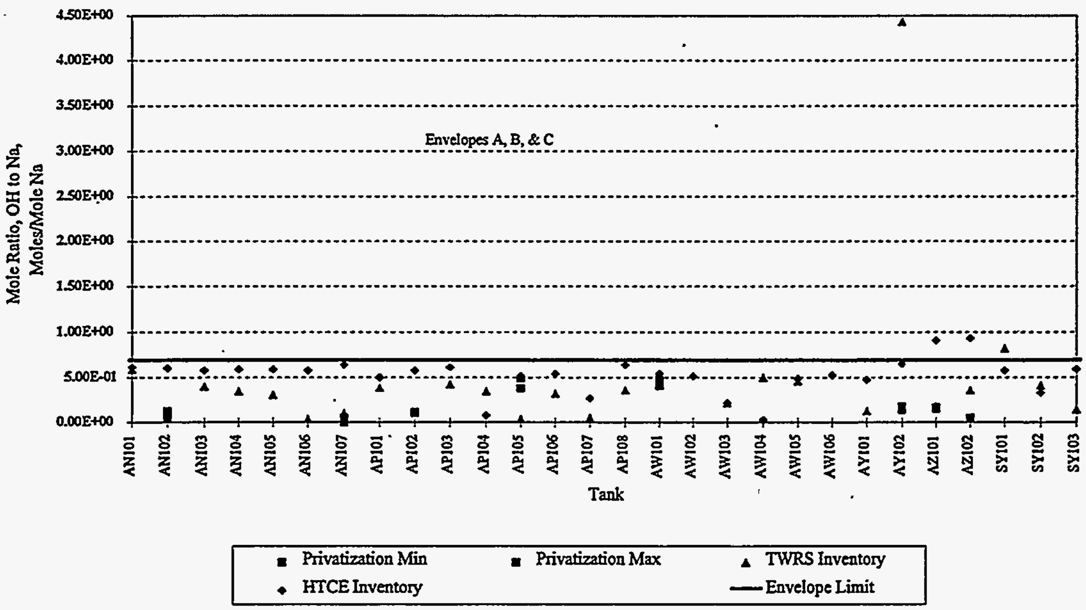

Figure C.39. Hydroxide in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.28. Lead (Pb) Ratioed to Sodium in Moles Pb/Moles Na

Lead				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			4.20E-05	8.33E-05
AN102		1.10E-04		1.02E-04
AN103			2.38E-05	9.13E-05
AN104				9.66E-05
AN105				9.60E-05
AN106			1.87E-07	9.25E-05
AN107		2.20E-04	1.65E-04	1.29E-04
AP101			2.84E-06	5.73E-05
AP102		5.58E-06	3.58E-06	9.21E-05
AP103				6.39E-06
AP104			2.22E-15	
AP105		4.38E-06	4.12E-09	6.11E-05
AP106			2.47E-11	4.58E-05
AP107			1.04E-07	
AP108				3.42E-06
AW101		<1.09E-04	1.46E-04	8.66E-05
AW102				6.14E-05
AW103				6.56E-06
AW104			1.52E-08	6.81E-05
AW105				6.29E-05
AW106				5.92E-05
AY101				5.98E-05
AY102			2.06E-06	5.96E-07
AZ101		9.45E-05	2.52E-06	1.97E-05
AZ102		1.22E-05	2.22E-06	2.37E-06
SY101				8.47E-05
SY102				5.36E-07
SY103				8.94E-05

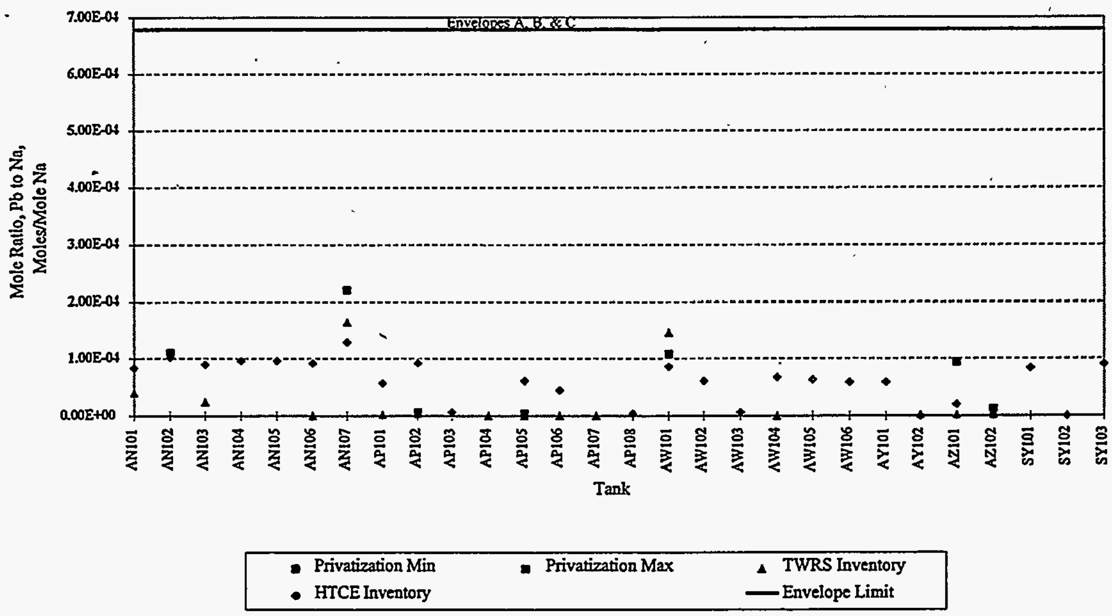

Figure C.40. Lead in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

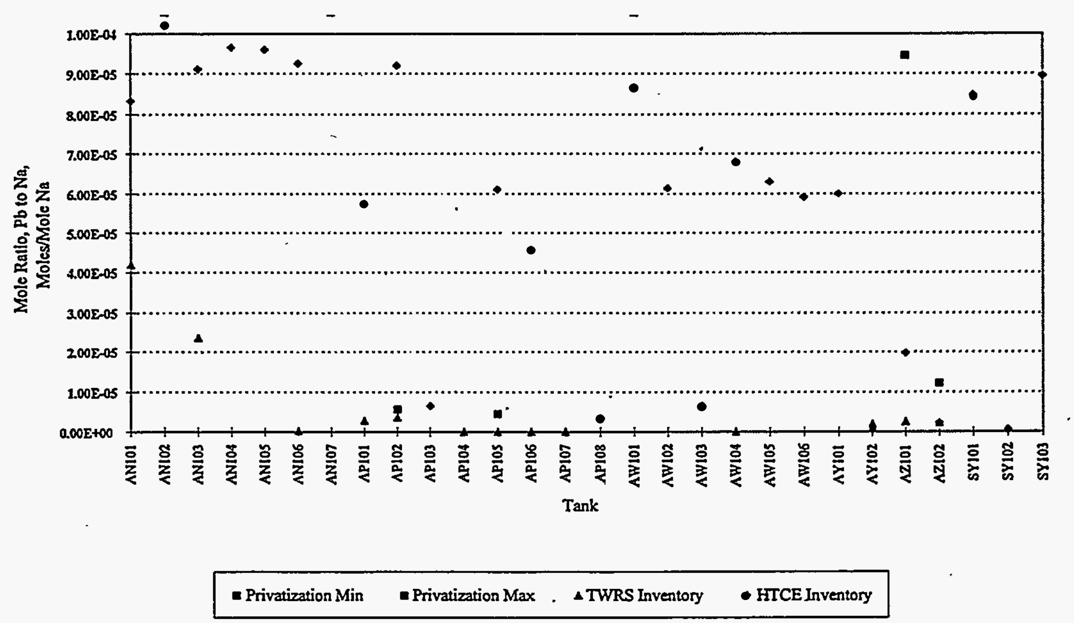

Figure C.41. Lead in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.29. Phosphate (PO_4^{-3}) Ratioed to Sodium in Moles PO_4^{-3}/Moles Na

Phosphate				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			4.43E-02	8.86E-03
AN102	4.43E-03	4.66E-03	4.49E-03	8.25E-03
AN103			6.69E-04	1.30E-02
AN104			2.45E-03	1.18E-02
AN105			1.67E-03	1.03E-02
AN106			4.85E-03	2.15E-02
AN107	2.52E-03	6.63E-03	5.76E-04	8.57E-03
AP101			1.44E-03	1.59E-02
AP102	2.00E-02	3.13E-02	2.76E-02	2.25E-02
AP103			6.34E-03	3.83E-03
AP104			6.57E-03	2.36E-01
AP105	3.58E-04	8.48E-04	4.83E-03	1.85E-02
AP106			4.76E-03	1.46E-02
AP107			4.69E-03	
AP108			8.74E-03	6.58E-03
AW101	1.84E-03	8.17E-03	2.22E-03	1.64E-02
AW102				1.95E-02
AW103			7.17E-04	6.29E-03
AW104			1.32E-02	1.08E-01
AW105			2.55E-02	1.91E-02
AW106				1.82E-02
AY101			2.30E-03	5.00E-03
AY102	5.57E-03	6.94E-03	2.20E-03	2.93E-03
AZ101	3.16E-03	3.41E-03	2.08E-03	1.81E-03
AZ102	6.74E-04	6.64E-04	1.11E-04	1.08E-03
SY101			8.18E-03	8.06E-03
SY102			1.28E-02	1.18E-04
SY103			1.36E-02	7.94E-03

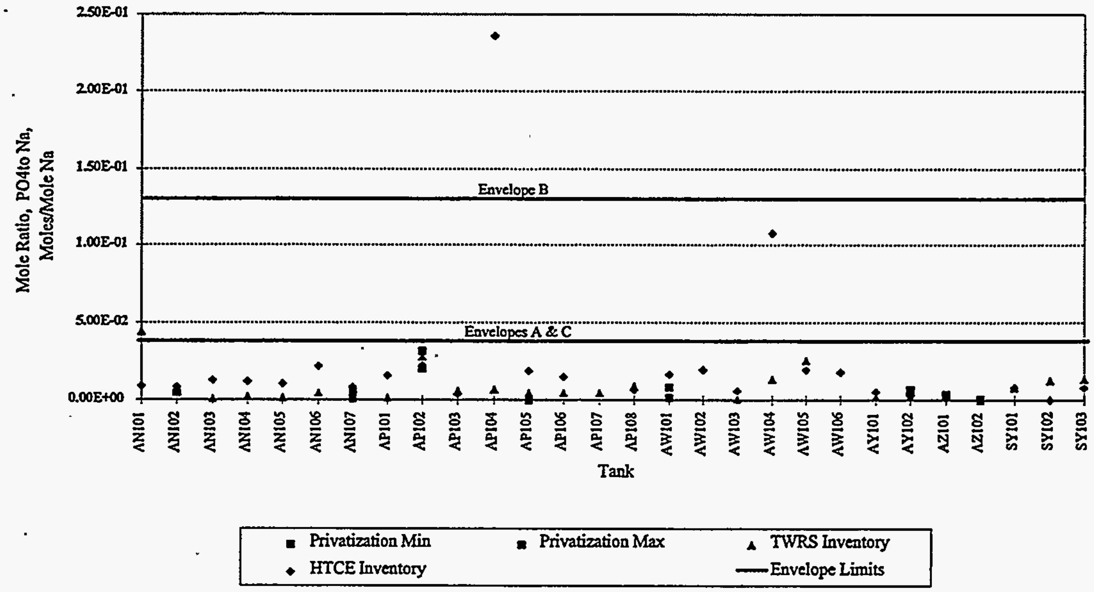

Figure C.42. Phosphate in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

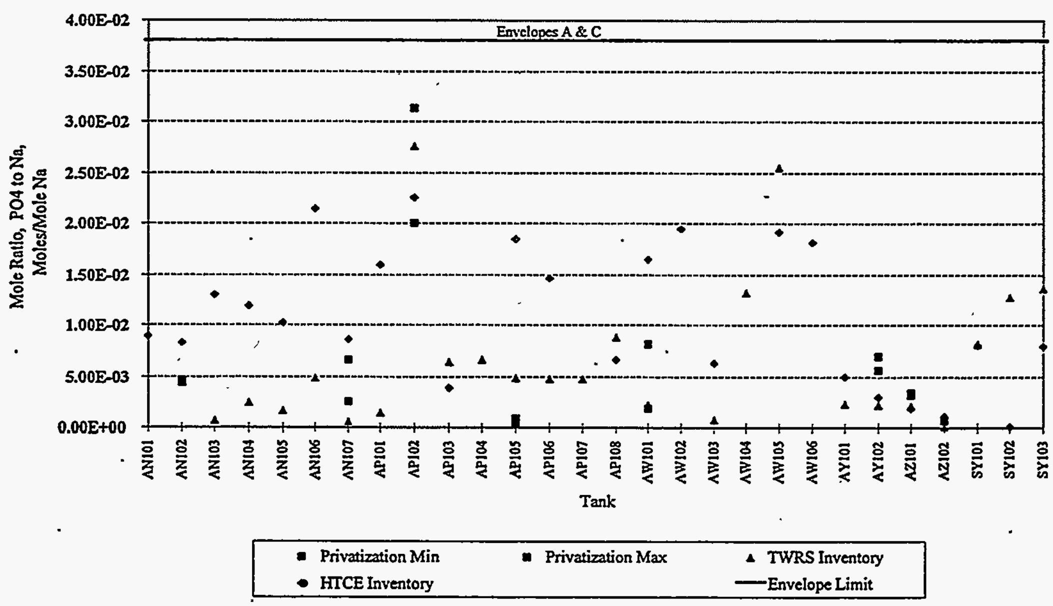

Figure C.43. Phosphate in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.30. Antimony (Sb) Ratioed to Sodium in Moles Sb/Moles Na

	Antimony			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.18E-06	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102		1.69E-05		
AP103				
AP104				
AP105		6.61E-06		
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101			9.33E-06	
AZ102		<3.62E-05		
SY101				
SY102				
SY103				

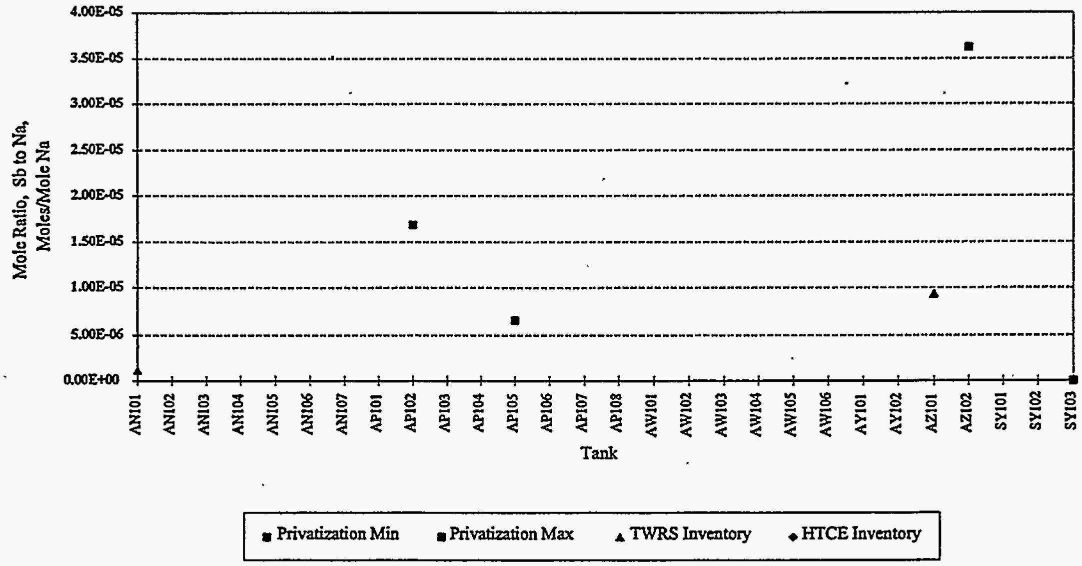

Figure C.44. Antimony in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.31. Selenium (Se) Ratioed to Sodium in Moles Se/Moles Na

Selenium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			7.47E-06	
AN102				
AN103				
AN104				
AN105				
AN106			2.96E-10	
AN107				
AP101			1.89E-07	
AP102		1.87E-06	1.05E-09	
AP103				
AP104				
AP105		2.94E-07	2.83E-10	
AP106				
AP107			6.94E-09	
AP108				
AW101			4.19E-08	
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		8.50E-04	2.70E-05	
AZ102		5.86E-05	1.38E-05	
SY101				
SY102				
SY103				

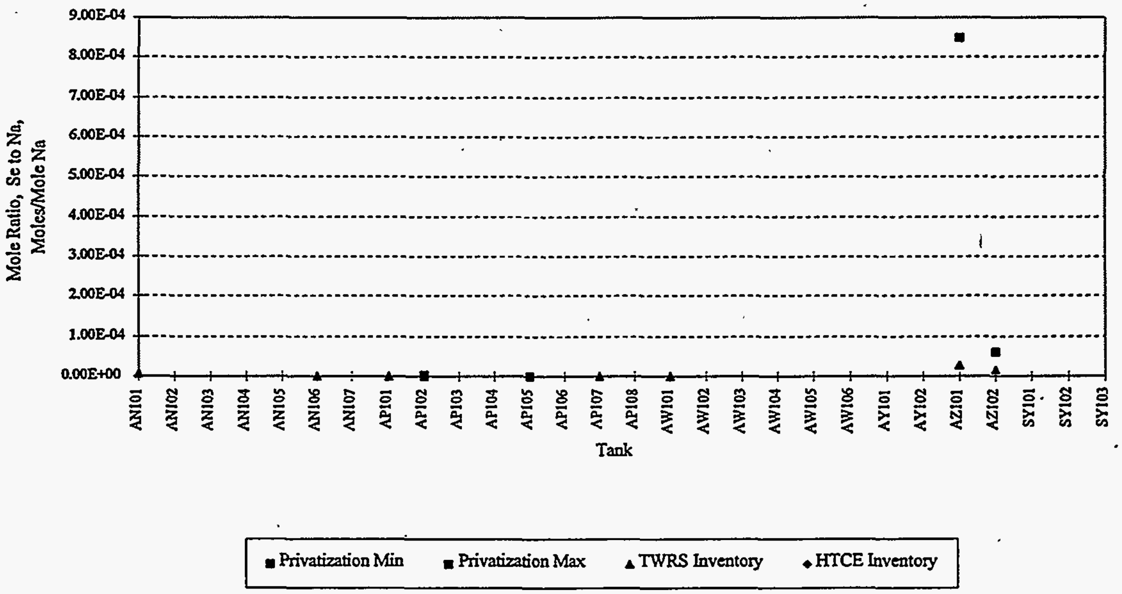

Figure C.45. Selenium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.32. Sulfate (SO_4^{-2}) Ratioed to Sodium in Moles SO_4^{-2}/Moles Na

Sulfate				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.80E-02	2.02E-02
AN102	2.57E-03	1.36E-02	1.29E-02	2.39E-02
AN103			1.14E-03	1.92E-02
AN104			5.69E-03	2.13E-02
AN105			5.69E-03	2.10E-02
AN106			7.37E-03	2.15E-02
AN107	6.38E-03	1.29E-02	1.47E-02	2.51E-02
AP101			7.05E-03	1.46E-02
AP102	8.65E-03	1.17E-02	1.06E-02	2.14E-02
AP103			1.58E-02	1.33E-02
AP104			6.69E-03	6.31E-03
AP105	1.85E-03	6.05E-03	7.37E-03	1.54E-02
AP106			6.51E-03	1.47E-02
AP107			8.09E-03	
AP108			6.14E-03	1.34E-02
AW101	1.07E-03	1.76E-03	1.07E-03	1.79E-02
AW102				1.56E-02
AW103			6.88E-04	8.46E-04
AW104			1.34E-03	6.45E-03
AW105			2.57E-02	1.49E-02
AW106				1.54E-02
AY101			5.09E-02	2.76E-02
AY102	1.49E-02	1.64E-02	2.14E-04	1.34E-02
AZ101	3.86E-02	3.94E-02	2.17E-02	4.39E-02
AZ102	6.24E-02	8.38E-02	3.55E-02	4.56E-02
SY101			5.13E-03	2.15E-02
SY102			7.39E-03	4.51E-03
SY103			5.65E-03	2.17E-02

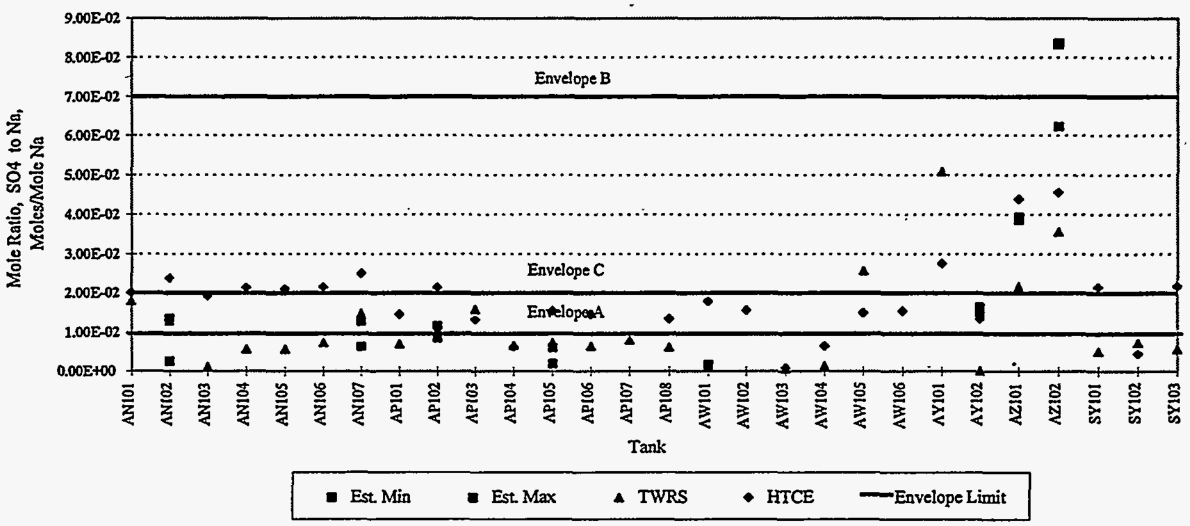

Figure C.46. Sulfate in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.33. Total Strontium Ratioed to Sodium in Moles Sr tot/Moles Na

Total Strontium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101				
AZ102	9.91E-07	9.76E-07		
SY101				
SY102				
SY103				

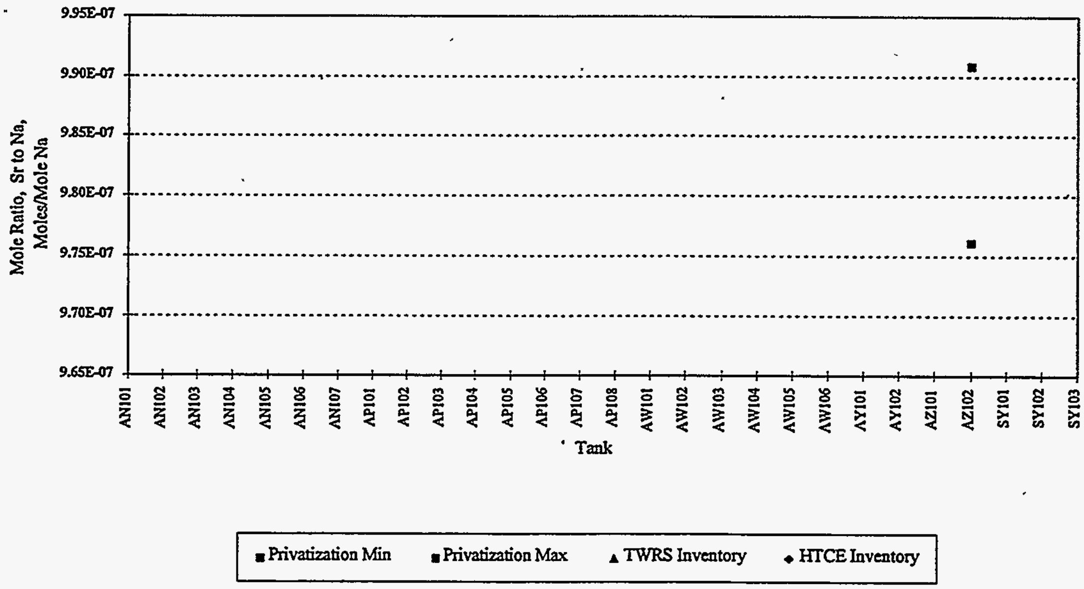

Figure C.47. Total Strontium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.34. Tellurium (Te) Ratioed to Sodium in Moles Te/Moles Na

Tellurium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			2.90E-06	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		4.98E-06	1.79E-05	
AZ102		8.79E-06	2.17E-06	
SY101				
SY102				
SY103				

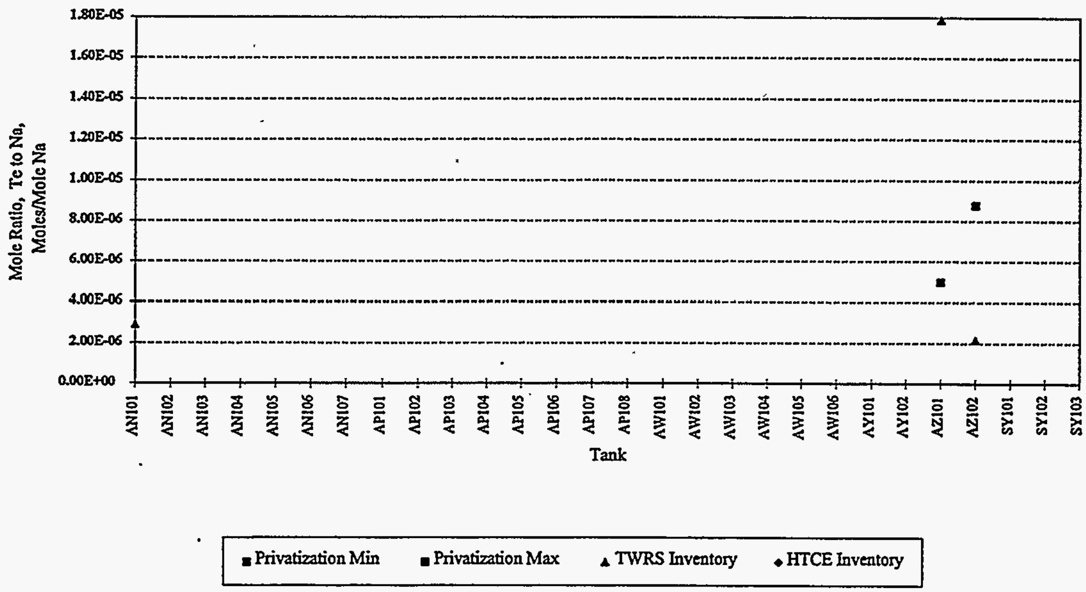

Figure C.48. Tellurium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.35. Total Inorganic Carbon (TIC) Ratioed to Sodium in Moles TIC/Moles Na

Total Inorganic Carbon				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			5.80E-02	3.33E-02
AN102	1.10E-01	1.24E-01	9.67E-02	4.63E-02
AN103			1.02E-02	5.36E-02
AN104			3.94E-02	5.18E-02
AN105			3.03E-02	5.01E-02
AN106			6.07E-02	4.01E-02
AN107	1.24E-01	1.42E-01	1.29E-01	4.74E-02
AP101			5.53E-02	6.30E-02
AP102	8.52E-02	1.08E-01	1.01E-01	3.99E-02
AP103			1.86E-01	6.90E-02
AP104			5.10E-02	3.10E-03
AP105	4.56E-02	6.13E-02	6.09E-02	6.86E-02
AP106			5.09E-02	7.02E-02
AP107			6.31E-02	8.16E-03
AP108			1.70E-01	7.87E-02
AW101	2.29E-02	2.87E-02	2.05E-02	5.95E-02
AW102				6.80E-02
AW103			9.01E-02	2.78E-02
AW104			4.09E-02	1.72E-01
AW105			3.77E-03	6.67E-02
AW106				6.77E-02
AY101			1.45E-01	5.40E-02
AY102	3.80E-01	3.88E-01	8.20E-04	7.64E-02
AZ101	1.16E-01	1.18E-01	7.14E-02	1.22E-02
AZ102	1.94E-01	2.35E-01	9.50E-02	1.09E-02
SY101				3.98E-02
SY102			5.00E-02	4.50E-02
SY103			5.05E-02	3.96E-02

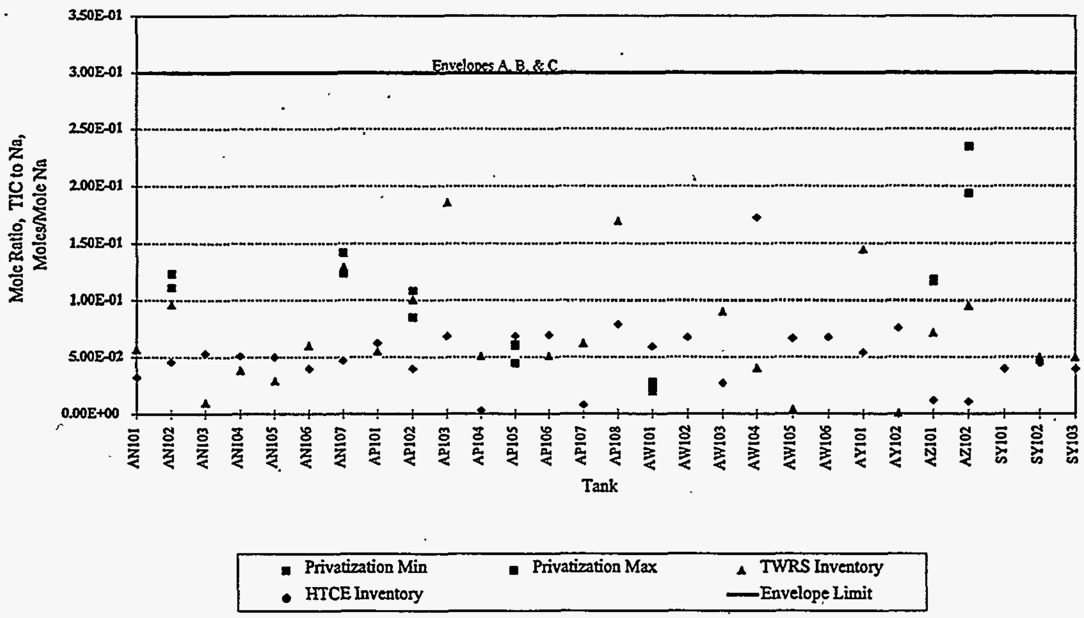

Figure C.49. Total Inorganic Carbon in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.36. Thallium (Tl) Ratioed to Sodium in Moles Tl/Moles Na

Thallium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.44E-05	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101			1.12E-04	
AZ102		7.96E-05	9.34E-07	
SY101				
SY102				
SY103				

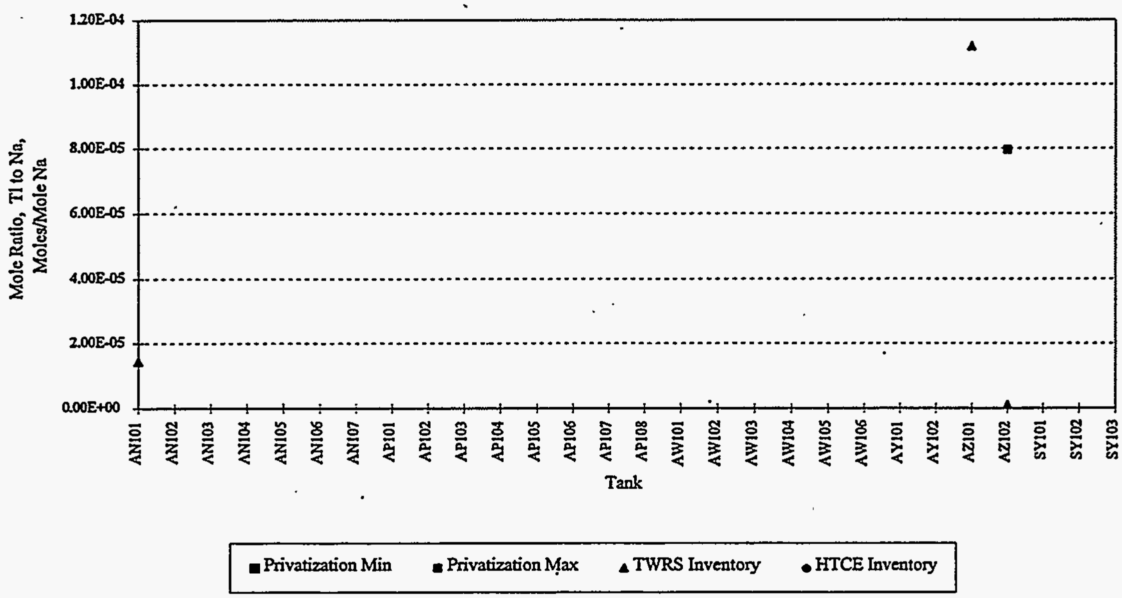

Figure C.50. Thallium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.37. Total Organic Carbon (TOC) Ratioed to Sodium in Moles TOC/Moles Na

Total Organic Carbon				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			6.48E-02	6.48E-02
AN102	2.99E-01	2.30E-01	1.89E-01	1.44E-01
AN103			4.20E-02	1.11E-01
AN104			3.20E-02	1.34E-01
AN105			2.70E-02	1.17E-01
AN106			2.77E-01	1.18E-01
AN107	1.69E-01	3.86E-01	3.69E-01	1.66E-01
AP101			6.12E-02	1.02E-01
AP102	5.86E-02	1.01E-01	6.17E-02	1.17E-01
AP103			4.04E-02	1.11E-01
AP104			5.16E-02	
AP105	2.43E-02	3.22E-02	2.77E-01	1.08E-01
AP106			4.28E-02	1.13E-01
AP107			2.67E-01	
AP108			1.65E-01	1.33E-01
AW101	2.88E-02	3.41E-02	2.05E-02	1.09E-01
AW102				1.06E-01
AW103			9.15E-02	6.24E-03
AW104			1.71E-01	6.45E-02
AW105			2.11E-01	1.02E-01
AW106				1.06E-01
AY101			3.27E-02	3.36E-01
AY102	6.08E-02	6.88E-02	2.60E-03	1.38E-01
AZ101	1.92E-02	2.15E-02	1.16E-02	2.95E-02
AZ102	5.07E-02	5.64E-02	2.78E-02	1.31E-02
SY101			1.53E-01	1.07E-01
SY102			8.91E-02	7.45E-04
SY103			1.90E-02	1.10E-01

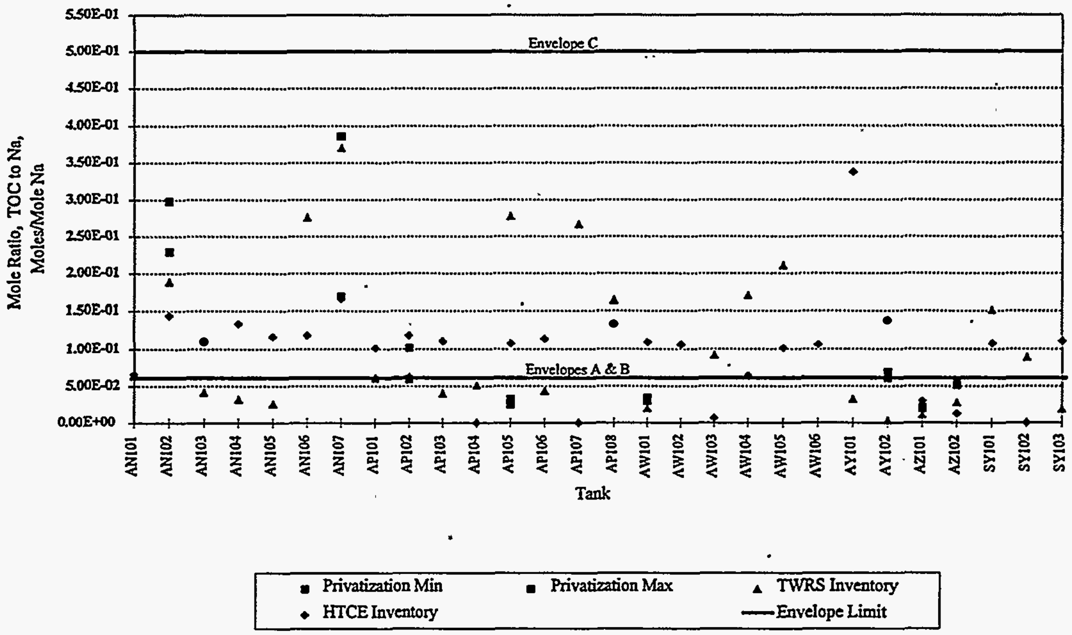

Figure C.51. Total Organic Carbon in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.38. Uranium (U) Ratioed to Sodium in Moles U/Moles Na

Uranium				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			4.37E-04	1.04E-03
AN102		8.80E-06		9.28E-04
AN103			1.49E-07	1.05E-03
AN104				9.70E-04
AN105				8.99E-04
AN106			5.53E-08	9.17E-04
AN107		7.16E-05	9.75E-05	8.12E-04
AP101			2.42E-05	1.11E-03
AP102		6.46E-06	3.34E-06	9.12E-04
AP103			6.72E-05	9.88E-04
AP104			3.57E-06	
AP105		2.43E-05	9.26E-08	1.21E-03
AP106			2.50E-06	1.16E-03
AP107			2.28E-06	
AP108			6.41E-05	1.13E-03
AW101			9.41E-05	1.10E-03
AW102				1.20E-03
AW103			4.87E-05	6.00E-03
AW104			4.63E-04	7.25E-04
AW105			8.84E-04	1.43E-03
AW106				1.19E-03
AY101			8.78E-04	9.91E-04
AY102			4.19E-07	1.14E-03
AZ101		7.09E-06	1.89E-05	1.35E-03
AZ102		2.88E-03	1.45E-03	1.41E-03
SY101				1.06E-03
SY102			1.40E-05	5.60E-06
SY103			2.16E-04	1.03E-03

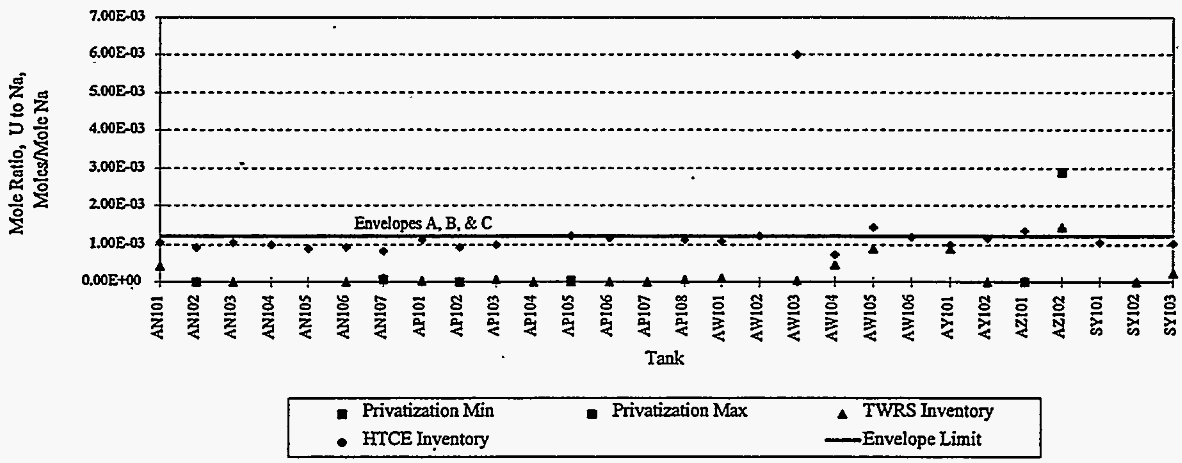

Figure C.52. Uranium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

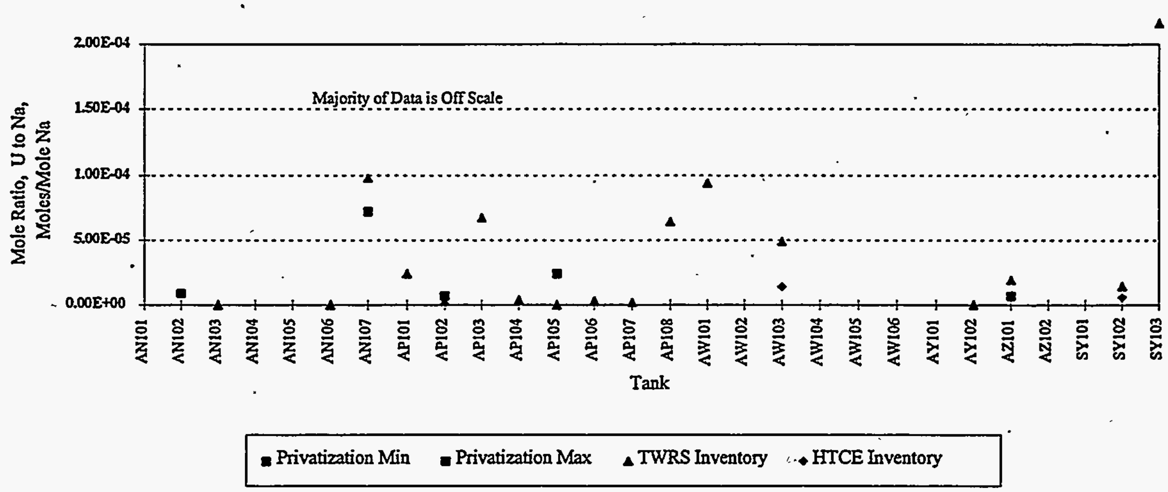

Figure C.53. Uranium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.39. Vanadium (V) Ratioed to Sodium in Moles V/Moles Na

Vanadium				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			6.70E-07	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		4.10E-06	1.55E-06	
AZ102		1.71E-05	1.61E-06	
SY101				
SY102				
SY103				

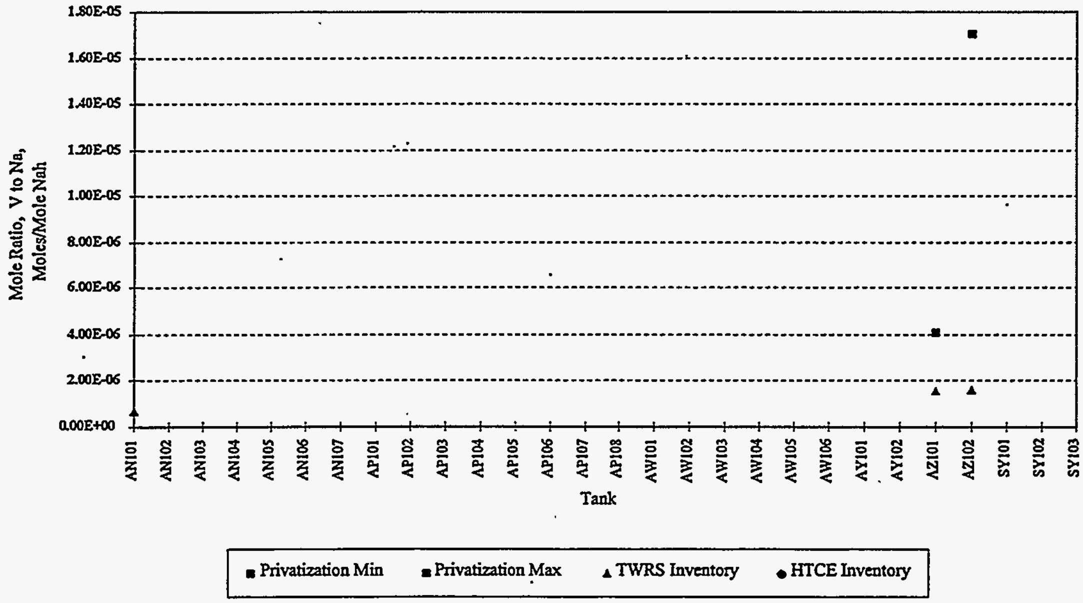

Figure C.54. Vanadium in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.40. ^{241}Am Ratioed to Sodium in Moles ^{241}Am/Moles Na

^{241}Am				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			2.14E+06	
AN102	4.31E+05	8.29E+05	2.00E+05	
AN103			5.89E+03	
AN104			4.72E+03	
AN105			4.72E+03	
AN106			1.90E+00	
AN107	4.91E+05	3.16E+06	2.42E+06	
AP101			4.31E+04	
AP102	1.83E+03	7.87E+03	3.54E+03	
AP103				
AP104			1.75E-01	
AP105	1.54E+03	2.66E+03	8.51E+02	
AP106			3.57E-01	
AP107			2.09E+04	
AP108			1.38E-05	
AW101	4.99E+03	4.03E+03	4.49E+03	
AW102				
AW103				
AW104			2.72E+01	
AW105				
AW106				
AY101			1.67E+05	
AY102	<2.41E+04	6.64E+05	2.79E+02	
AZ101	1.44E+02	1.15E+05	1.68E+07	
AZ102	2.36E+04	2.33E+04	1.17E+04	
SY101			5.82E+04	
SY102			7.29E-01	
SY103			9.92E+04	

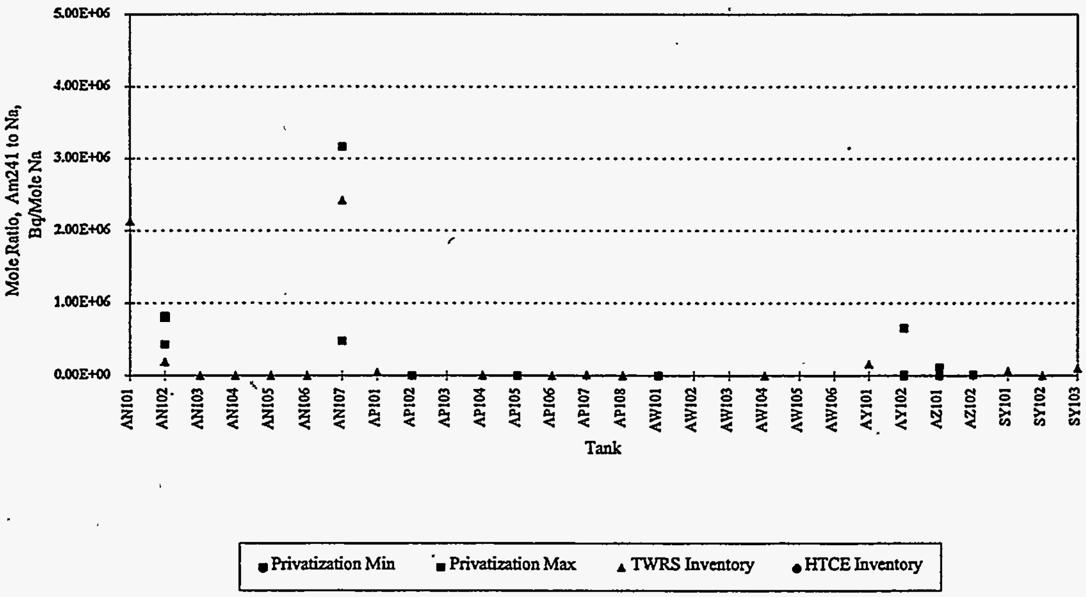

Figure C.55. ^{241}Am in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

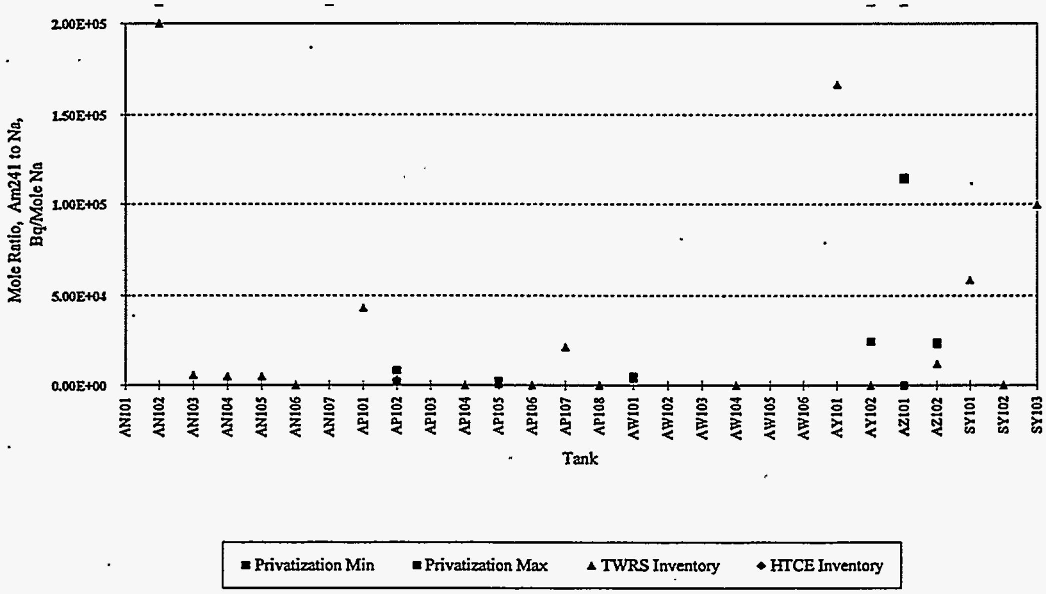

Figure C.56. ^{241}Am in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

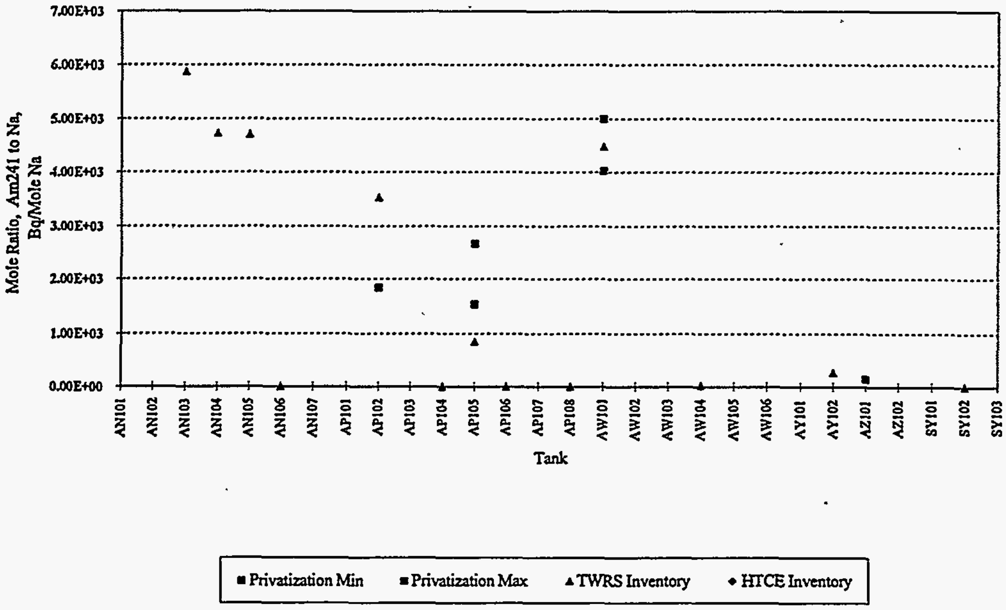

Figure C.57. ^{241}Am in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

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Table C.41. ^{137}Cs Ratioed to Sodium in Moles ^{137}Cs/Moles Na

	^{137}Cs			
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			4.14E+09	8.44E+08
AN102	1.19E+09	1.20E+09	6.14E+08	8.16E+08
AN103			1.27E+09	7.07E+08
AN104			1.70E+09	7.74E+08
AN105			1.13E+09	7.34E+08
AN106			4.20E+05	8.09E+08
AN107	8.78E+08	1.32E+09	7.34E+08	8.40E+08
AP101			6.88E+08	5.36E+08
AP102	1.70E+09	1.87E+09	1.37E+09	8.05E+08
AP103			7.32E+08	1.48E+09
AP104			5.18E+01	
AP105	1.11E+09	1.16E+09	3.62E+06	5.93E+08
AP106			2.42E+05	5.11E+08
AP107			8.96E+07	
AP108			2.48E+08	8.85E+08
AW101	1.62E+09	1.28E+09	1.22E+09	6.97E+08
AW102				6.27E+08
AW103			6.61E+08	2.67E+08
AW104			6.45E+05	1.72E+09
AW105			3.11E+08	6.13E+08
AW106				6.04E+08
AY101			8.91E+09	5.98E+08
AY102	1.12E+09	1.20E+09	3.36E+07	4.42E+08
AZ101	1.44E+10	1.39E+10	1.02E+10	2.86E+10
AZ102	1.66E+10	1.68E+10	7.94E+09	3.19E+10
SY101			7.07E+08	7.93E+08
SY102			4.79E+00	4.46E+06
SY103			9.97E+08	8.15E+08

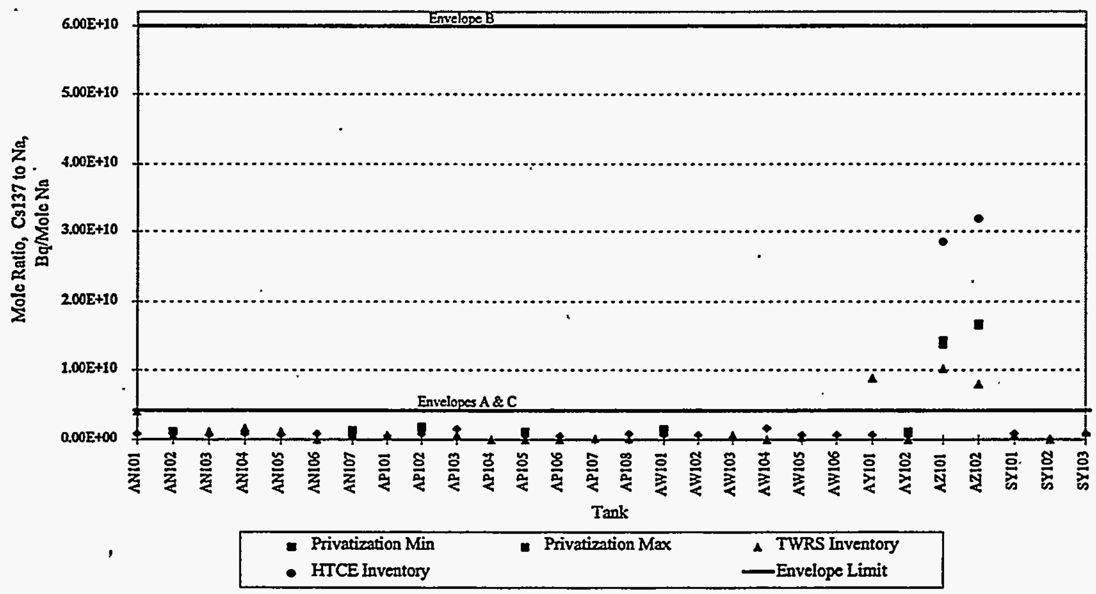

Figure C.58. ^{137}Cs in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

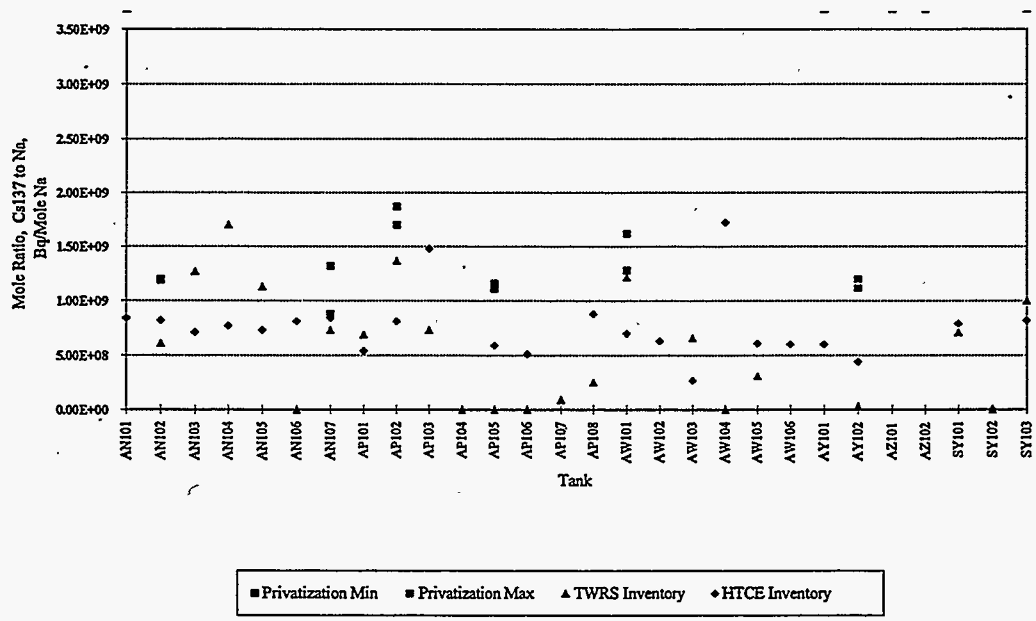

Figure C.59. ^{137}Cs in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.42. ^{237}Np Ratioed to Sodium in Moles ^{237}Np/Moles Na

	^{237}Np			
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			1.94E+04	
AN102				
AN103			5.12E+01	
AN104				
AN105				
AN106				
AN107	<2.25E+03	3.30E+03		
AP101				
AP102	<1.89E+03	8.02E+03		
AP103				
AP104			2.05E-03	
AP105		<1.91E+03		
AP106			8.40E+00	
AP107				
AP108			6.06E-02	
AW101		<8.43E+00		
AW102				
AW103				
AW104				
AW105				
AW106				
AY101			6.43E+02	
AY102				
AZ101		<6.19E+02	1.86E+04	
AZ102	3.06E+04	3.01E+04	5.79E+04	
SY101				
SY102			1.34E-04	
SY103				

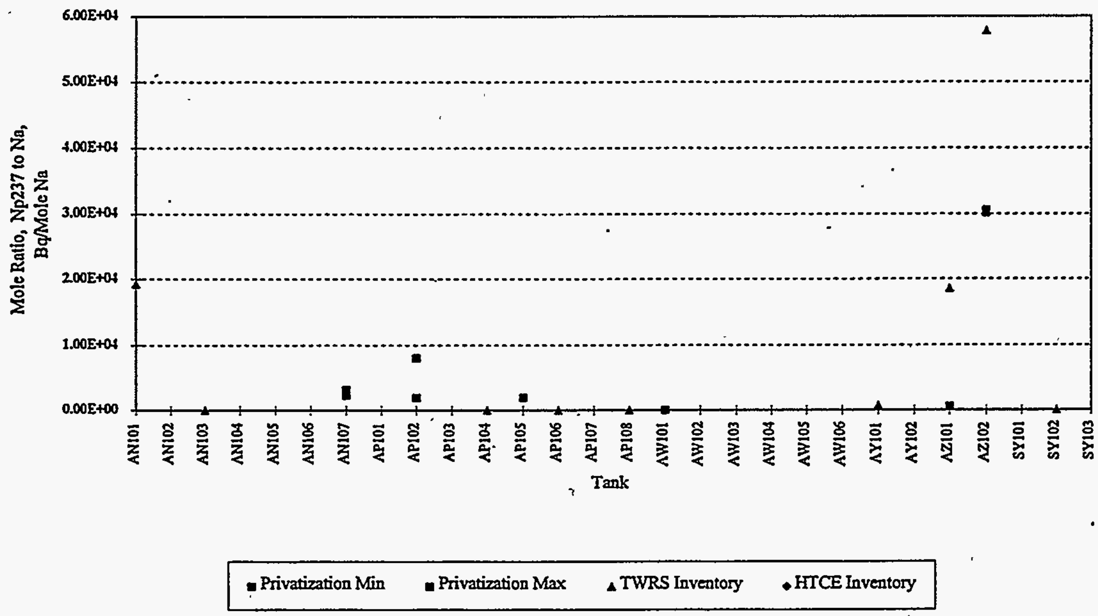

Figure C.60. ^{237}Np in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

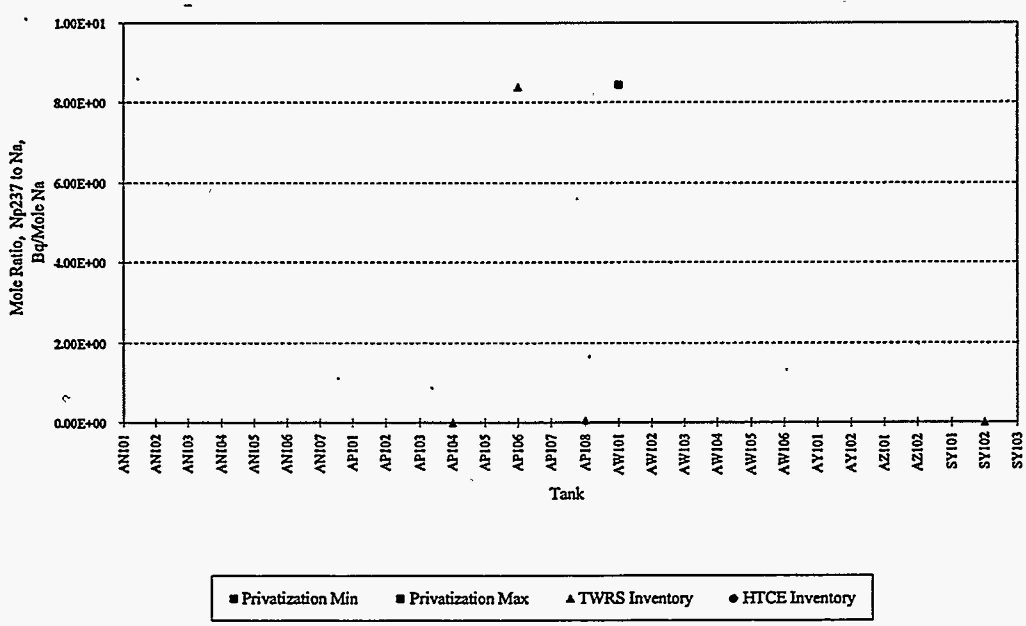

Figure C.61. ^{237}Np in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Pu-238				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101				2.36E+05
AN102				2.44E+05
AN103				2.98E+05
AN104				2.67E+05
AN105				2.50E+05
AN106				2.35E+05
AN107				2.21E+05
AP101				3.40E+05
AP102	<7.30E+02	<1.67E+00		2.34E+05
AP103				2.97E+05
AP104				
AP105		<2.08E+03		3.73E+05
AP106				3.58E+05
AP107				
AP108				3.20E+05
AW101				3.30E+05
AW102				3.68E+05
AW103				2.10E+06
AW104				2.68E+05
AW105				4.58E+05
AW106				3.62E+05
AY101				2.66E+05
AY102				3.20E+05
AZ101		<6.78E+02		3.72E+05
AZ102	<6.43E+04	<6.34E+04		3.92E+05
SY101				2.66E+05
SY102				2.51E+05
SY103				2.58E+05

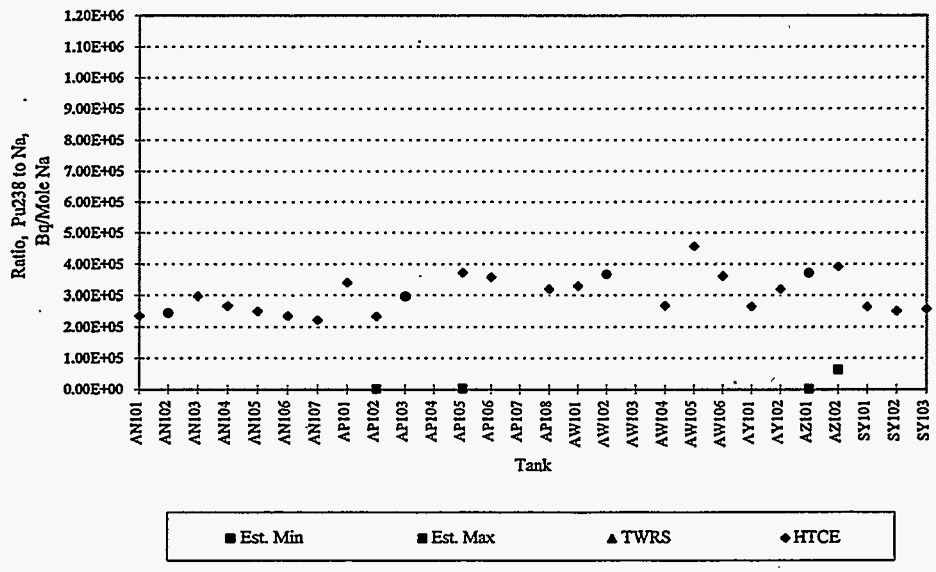

Figure C.62. ^{238}Pu in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.43. $^{239/240}Pu$ Ratioed to Sodium in Moles $^{239/240}Pu$/Moles Na

$^{239/240}Pu$				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			3.35E+05	
AN102	6.71E+04	2.21E+05	1.90E+05	
AN103			4.87E+03	
AN104			2.59E+04	
AN105			2.59E+04	
AN106			9.52E-02	
AN107	1.49E+05	4.47E+05	1.05E+05	
AP101			1.37E+04	
AP102	<5.72E+02	<6.01E+02		
AP103				
AP104			1.18E-02	
AP105	6.99E+02	7.98E+02	2.72E+02	
AP106			1.23E+01	
AP107			6.67E+03	
AP108				
AW101	2.39E+03	4.01E+03	3.45E+03	
AW102				
AW103				
AW104			3.74E+00	
AW105				
AW106				
AY101			1.10E+05	
AY102	<4.29E+03	1.72E+04	1.40E+04	
AZ101	4.69E+00	4.51E+00	2.68E+03	
AZ102	<6.13E+05	<6.04E+05	1.96E+05	
SY101			6.39E+03	
SY102			3.58E-02	
SY103			1.38E+04	

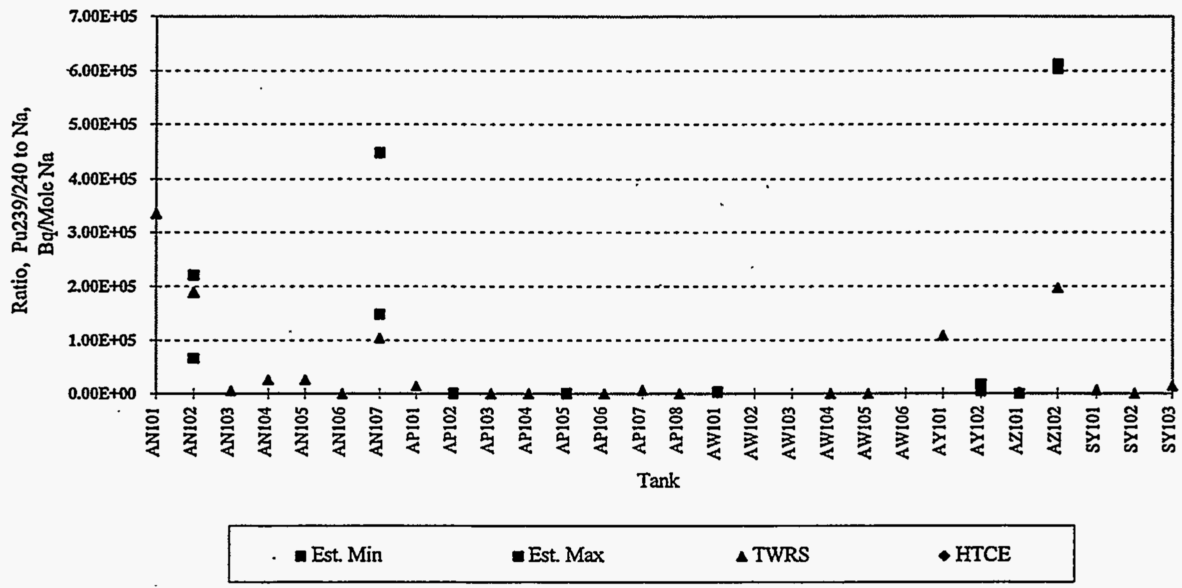

Figure C.63. $^{239/240}$Pu in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

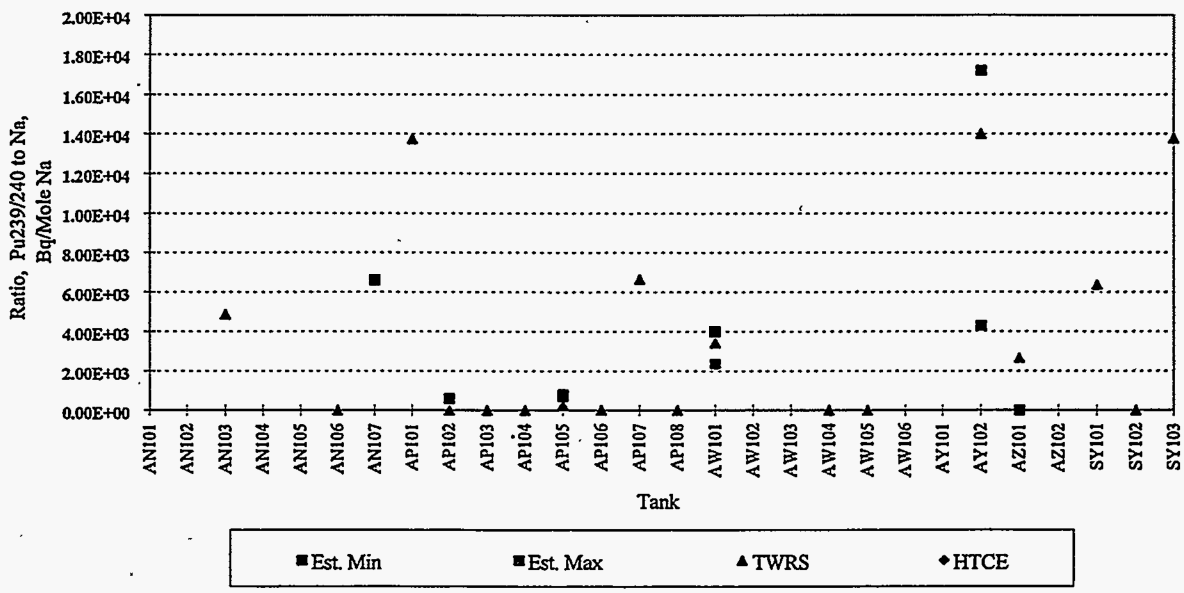

Figure C.64. $^{239/240}$Pu in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.44. ^{90}Sr Ratioed to Sodium in Moles ^{90}Sr/Moles Na

^{90}Sr				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			5.18E+08	3.64E+08
AN102	2.04E+08	3.07E+08	1.85E+08	3.76E+08
AN103			2.16E+07	3.77E+08
AN104			2.17E+07	3.77E+08
AN105			7.14E+06	3.36E+08
AN106			4.46E+03	3.37E+08
AN107	4.07E+08	4.75E+08	2.56E+08	3.11E+08
AP101			1.92E+08	4.15E+08
AP102	4.81E+06	1.35E+07	8.51E+06	3.35E+08
AP103			2.87E+05	3.19E+08
AP104			6.27E-02	
AP105	1.01E+06	1.10E+06	3.91E+06	4.61E+08
AP106			1.01E+02	4.29E+08
AP107			9.69E+07	
AP108			7.88E+03	3.99E+08
AW101	4.94E+06	2.11E+07	2.67E+06	4.15E+08
AW102				4.74E+08
AW103			6.94E+03	2.25E+08
AW104			5.73E+02	1.49E+09
AW105				4.54E+08
AW106				4.61E+08
AY101			1.73E+07	5.73E+08
AY102	7.35E+07	7.95E+07	9.70E+05	3.61E+08
AZ101	1.07E+07	1.08E+07	4.11E+09	4.41E+08
AZ102	2.35E+07	3.80E+07	9.50E+06	4.51E+08
SY101			2.24E+07	3.91E+08
SY102			2.24E-01	2.41E+06
SY103			7.70E+07	3.80E+08

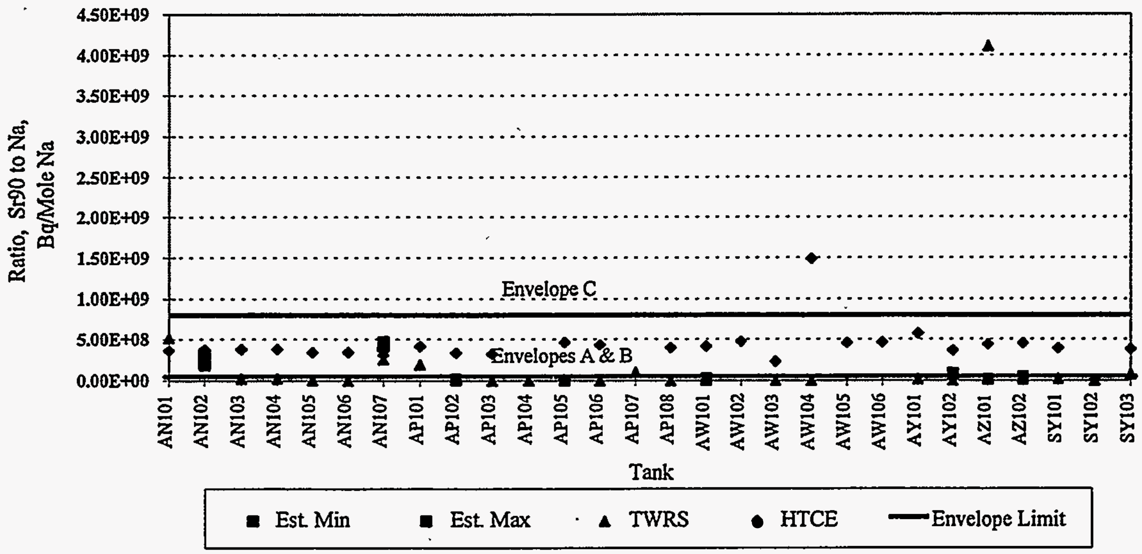

Figure C.65. ^{90}Sr in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

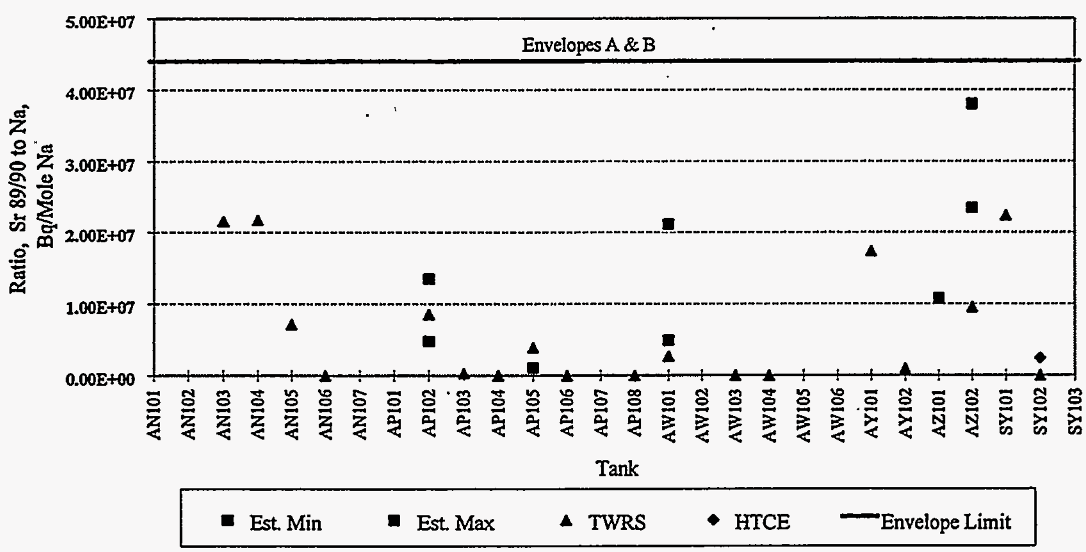

Figure C.66. ^{90}Sr in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.45. ^{99}Tc Ratioed to Sodium in Moles ^{99}Tc/Moles Na

^{99}Tc				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.29E+06	
AN102	1.44E+05	9.29E+04	1.00E+06	
AN103			4.35E+05	
AN104			4.08E+05	
AN105			4.08E+05	
AN106			2.18E+02	
AN107			1.20E+06	
AP101			7.21E+05	
AP102	1.10E+05	8.19E+05	7.23E+05	
AP103			1.75E+05	
AP104			1.15E-03	
AP105	3.26E+05	3.79E+05	9.10E+03	
AP106			1.28E+01	
AP107			2.23E+05	
AP108			2.98E+04	
AW101	6.85E+05	1.22E+06	5.64E+05	
AW102				
AW103			1.00E+06	
AW104			4.40E+02	
AW105			3.98E+04	
AW106				
AY101			3.01E+06	
AY102			2.47E+04	
AZ101	2.95E+06	3.36E+06	2.46E+06	
AZ102	1.83E+06	1.81E+06	1.65E+06	
SY101			1.86E+06	
SY102				
SY103			2.27E+06	

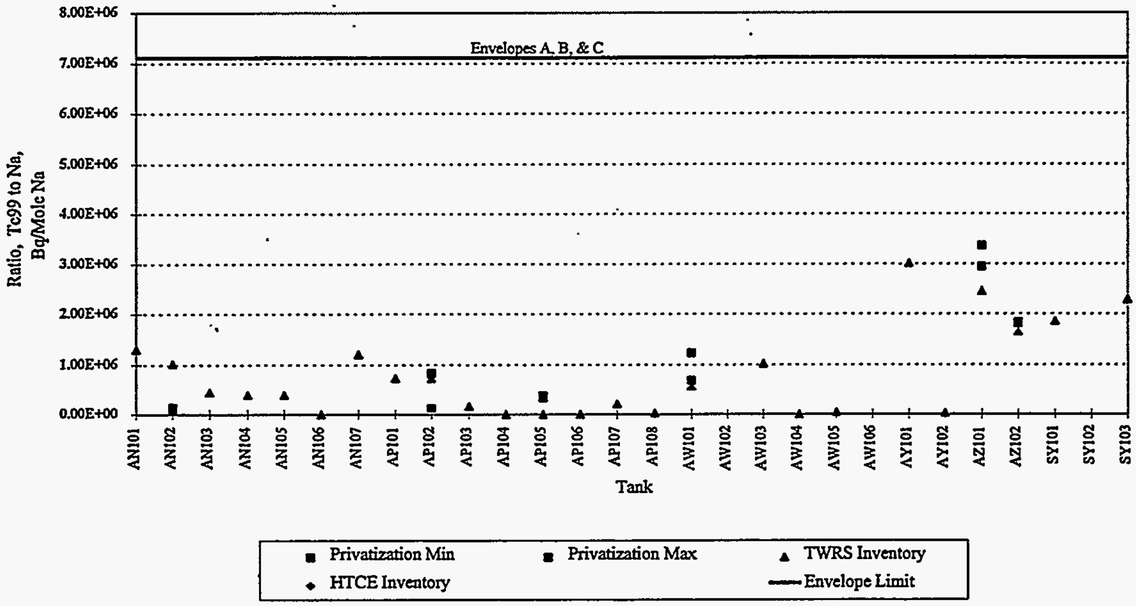

Figure C.67. ^{99}Tc in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

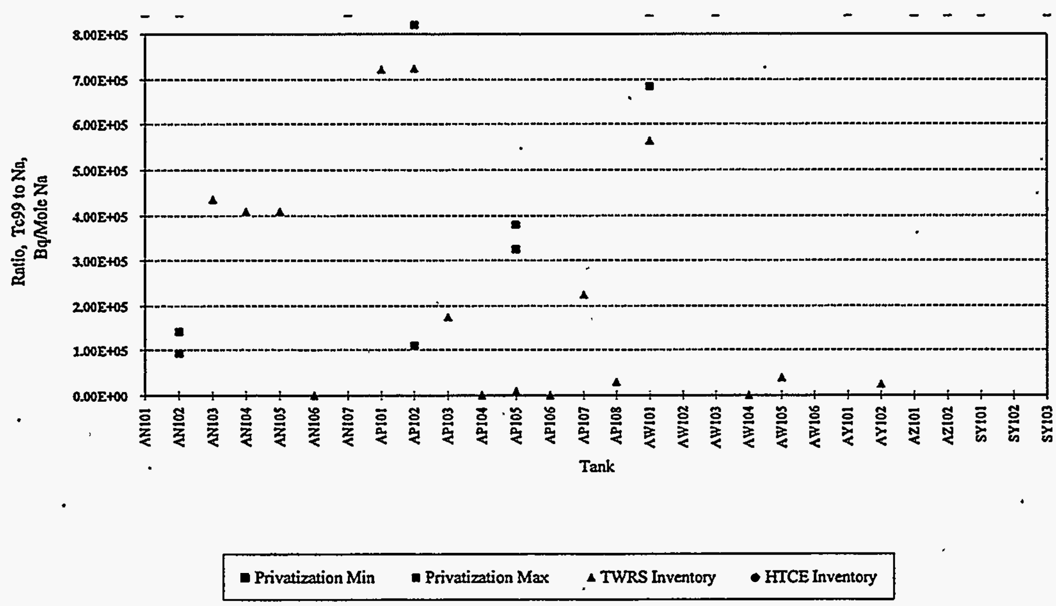

Figure C.68. ^{99}Tc in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Table C.46. Transuranics (TRU) Ratioed to Sodium in Moles TRU/Moles Na

Transuranics				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			2.49E+06	2.36E+05
AN102	4.98E+05	1.05E+06	3.90E+05	2.44E+05
AN103			1.08E+04	2.98E+05
AN104			3.07E+04	2.67E+05
AN105			3.07E+04	2.50E+05
AN106			1.99E+00	2.35E+05
AN107	6.42E+05	3.61E+06	2.52E+06	2.21E+05
AP101			5.68E+04	3.40E+05
AP102	<5.02E+03	1.82E+04	3.54E+03	2.34E+05
AP103				2.97E+05
AP104			1.89E-01	
AP105	2.24E+03	<7.44E+03	1.12E+03	3.73E+05
AP106			2.11E+01	3.58E+05
AP107			2.75E+04	
AP108			6.07E-02	3.20E+05
AW101	7.37E+03	8.05E+03	7.94E+03	3.30E+05
AW102				3.68E+05
AW103				2.10E+06
AW104			3.10E+01	2.68E+05
AW105			0.00E+00	4.58E+05
AW106				3.62E+05
AY101			2.77E+05	2.66E+05
AY102	<2.84E+04	6.81E+05	1.43E+04	3.20E+05
AZ101	1.49E+02	1.16E+05	1.68E+07	3.72E+05
AZ102	<7.31E+05	<7.20E+05	2.66E+05	3.92E+05
SY101			6.46E+04	2.66E+05
SY102			7.65E-01	2.51E+05
SY103			1.13E+05	2.58E+05

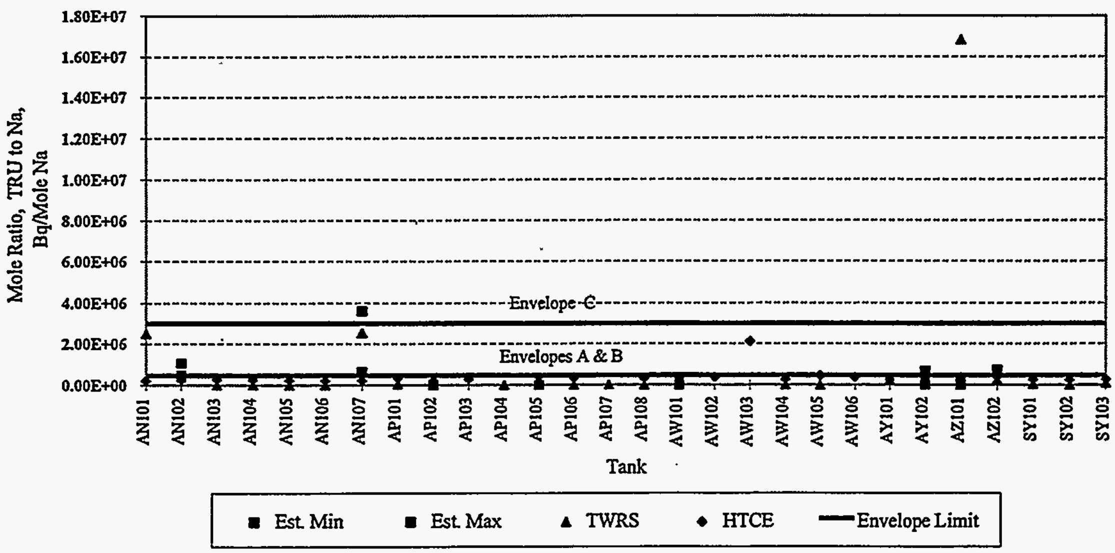

Figure C.69. TRU in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

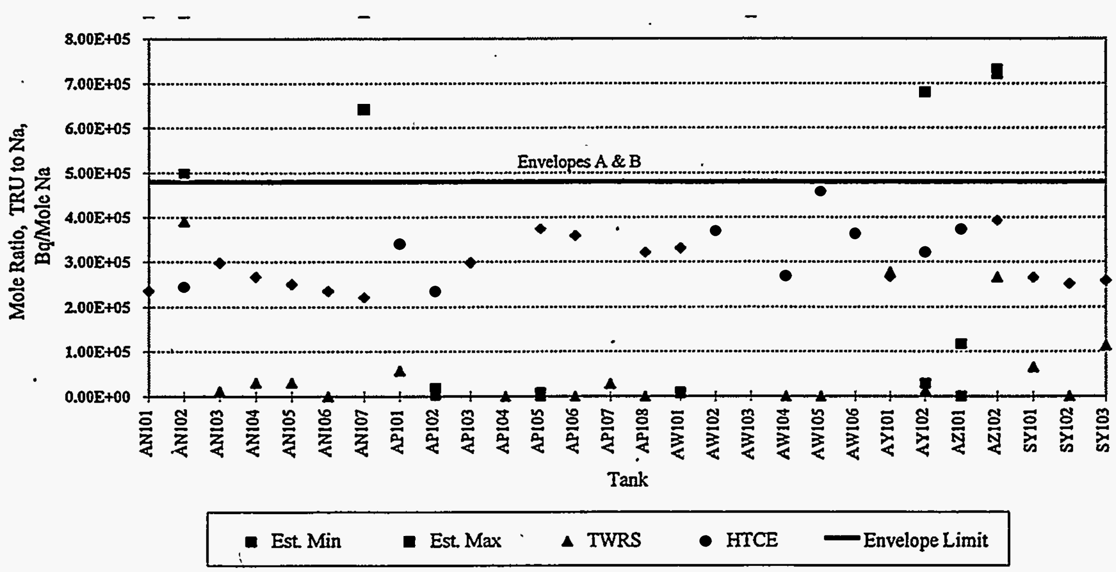

Figure C.70. TRU in Double-Shelled Tank Waste Supernatant Ratioed to Sodium. For the assessment of envelope limits, waste containing less than 50 MT Na and evaporator feed and product tanks were excluded (refer to Section 4.0).

Appendix D

Original Data and Output Plots

Appendix D

Original Data and Output Plots

The original data in g/L (chemical analytes) and Bq/L (radionuclides) from the three source inventory estimates (Privatization inventory, TWRS inventory, and HTCE inventory) used to generate the ratioed data are presented in the tables and figures of this appendix. No envelope limits are shown on the plots because limits were developed for the ratioed data only.

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Table D.1. Silver (Ag) Concentration in g/L

Silver				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			3.20E-03	
AN102				
AN103				
AN104				
AN105				
AN106			1.19E-04	
AN107				
AP101			1.32E-03	
AP102		<5.00E-03		
AP103				
AP104			2.79E-14	
AP105			3.17E-07	
AP106			1.36E-09	
AP107			8.39E-06	
AP108				
AW101				
AW102				
AW103				
AW104			5.35E-10	
AW105				
AW106				
AY101				
AY102			7.39E-06	
AZ101				
AZ102		6.38E-03		
SY101				
SY102				
SY103				

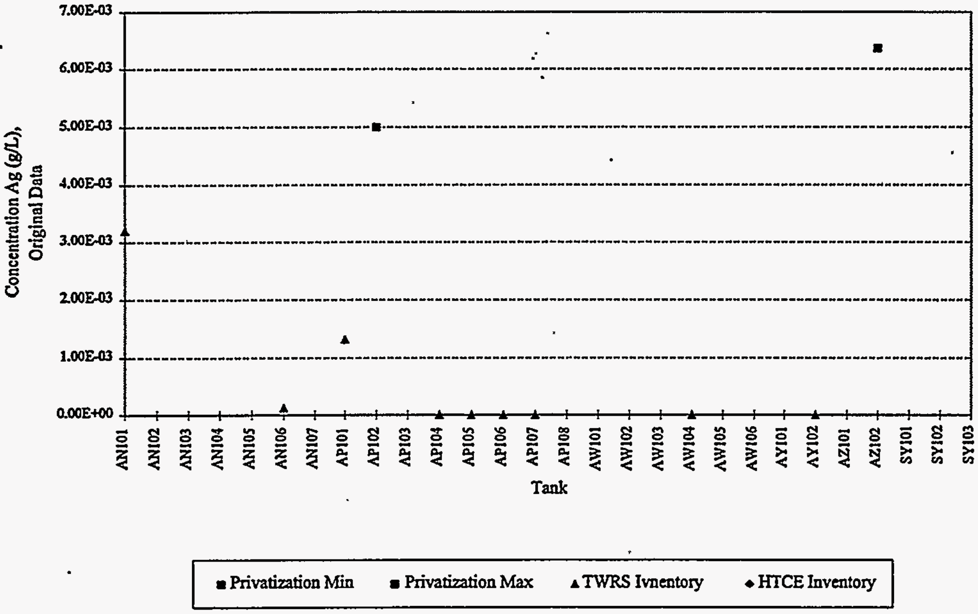

Figure D.1. Silver Concentration in Double-Shelled Tank Waste Supernatant

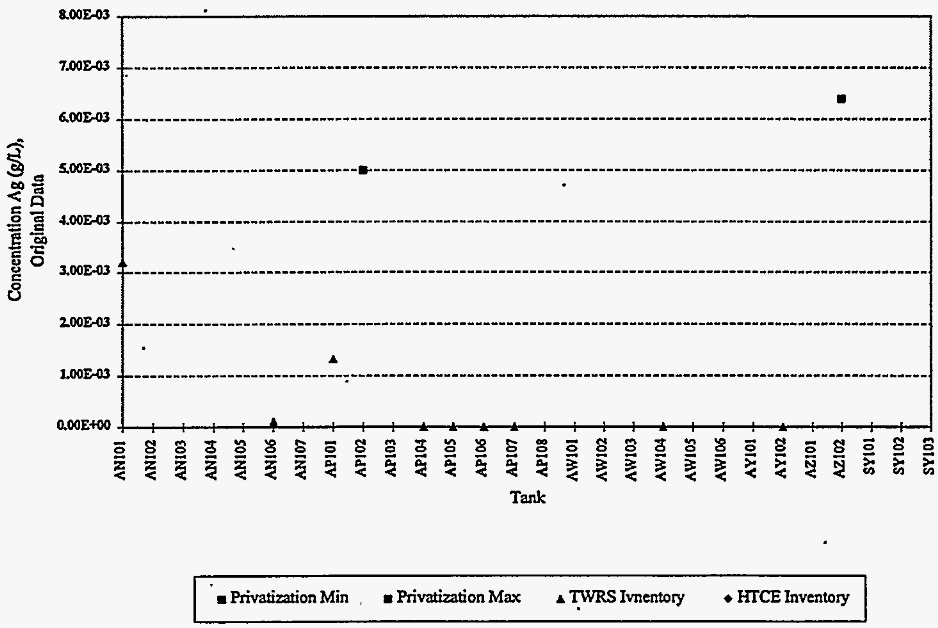

Figure D.2. Silver Concentration in Double-Shelled Tank Waste Supernatant

Table D.2. $Al(OH)_4^-$ Concentration in g/L

	$Al(OH)_4^-$			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			8.60E+00	1.73E+01
AN102	1.24E+01	1.51E+01	5.12E+01	5.58E+01
AN103			2.03E+02	4.46E+01
AN104			1.32E+02	3.53E+01
AN105			1.65E+02	6.62E+01
AN106			7.03E+01	2.97E+01
AN107	1.63E-01	5.69E+00	4.01E+00	4.53E+01
AP101			3.02E+01	2.20E+00
AP102	1.11E+01	1.21E+01	4.08E+01	2.09E+01
AP103			8.66E-01	5.50E+00
AP104			2.69E+01	
AP105	9.72E+00	1.40E+01	6.26E+01	2.90E+01
AP106			1.16E+02	1.08E+01
AP107			6.66E+01	
AP108			7.66E-01	5.91E+00
AW101	2.05E+01	3.51E+01	9.82E+01	4.77E+01
AW102				1.72E+01
AW103			1.46E-01	4.10E-02
AW104			9.28E-01	2.05E-02
AW105			1.89E-02	9.50E+00
AW106				1.83E+01
AY101			2.48E+01	9.56E+00
AY102	1.31E-02	1.40E-02	6.34E-03	5.51E+00
AZ101	9.22E+00	9.48E+00	7.78E+00	7.97E+00
AZ102	1.54E+00	1.56E+00	5.59E-02	4.01E+00
SY101			8.84E+01	5.32E+01
SY102			8.50E+00	1.03E+00
SY103			1.11E+02	4.17E+01

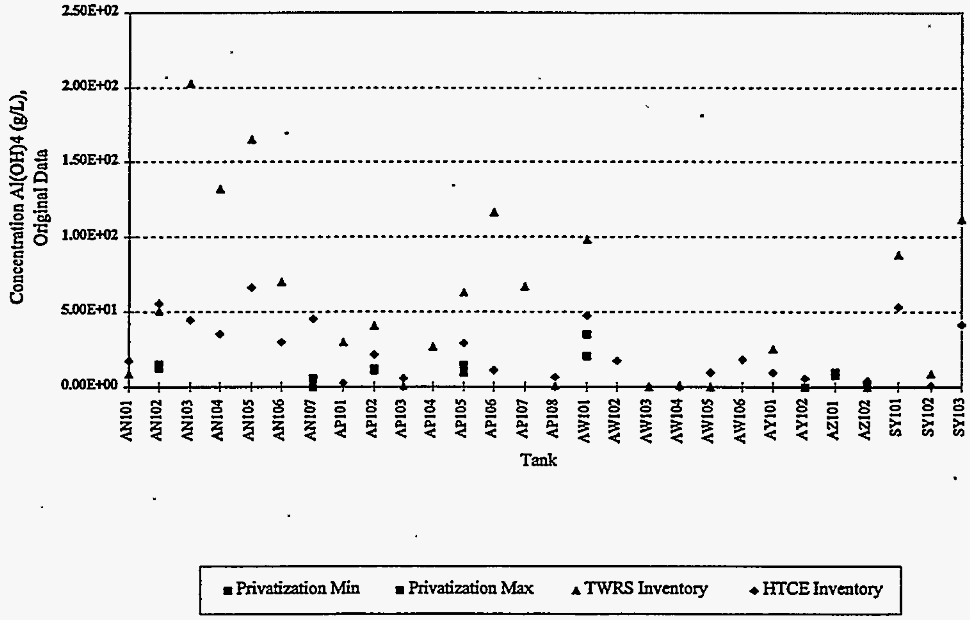

Figure D.3. $Al(OH)_4^-$ Concentration in Double-Shelled Tank Waste Supernatant

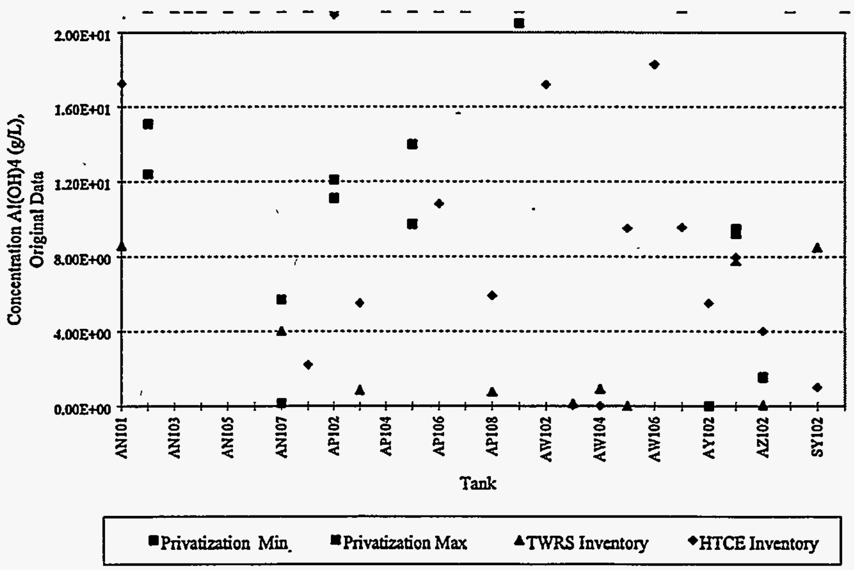

Figure D.4. $Al(OH)_4^-$ Concentration in Double-Shelled Tank Waste Supernatant

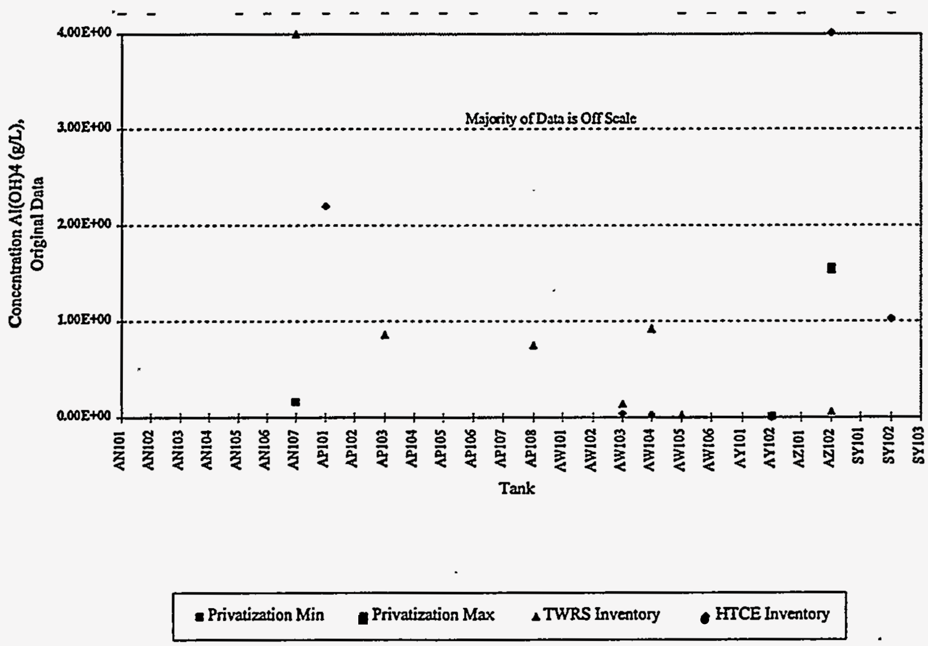

Figure D.5. $Al(OH)_4^-$ Concentration in Double-Shelled Tank Waste Supernatant

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Table D.3. Arsenic (As) Concentration in g/L

DST	Arsenic			
	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			1.58E-03	
AN102				
AN103				
AN104				
AN105				
AN106			6.21E-05	
AN107				
AP101			1.24E-03	
AP102		1.02E-04	8.87E-05	
AP103			4.84E-05	
AP104			2.79E-15	
AP105		1.03E-03	2.07E-06	
AP106			1.36E-10	
AP107			5.46E-05	
AP108				
AW101		<1.00E-05		
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		7.15E-03	1.44E-03	
AZ102		4.27E-03	3.80E-04	
SY101				
SY102				
SY103				

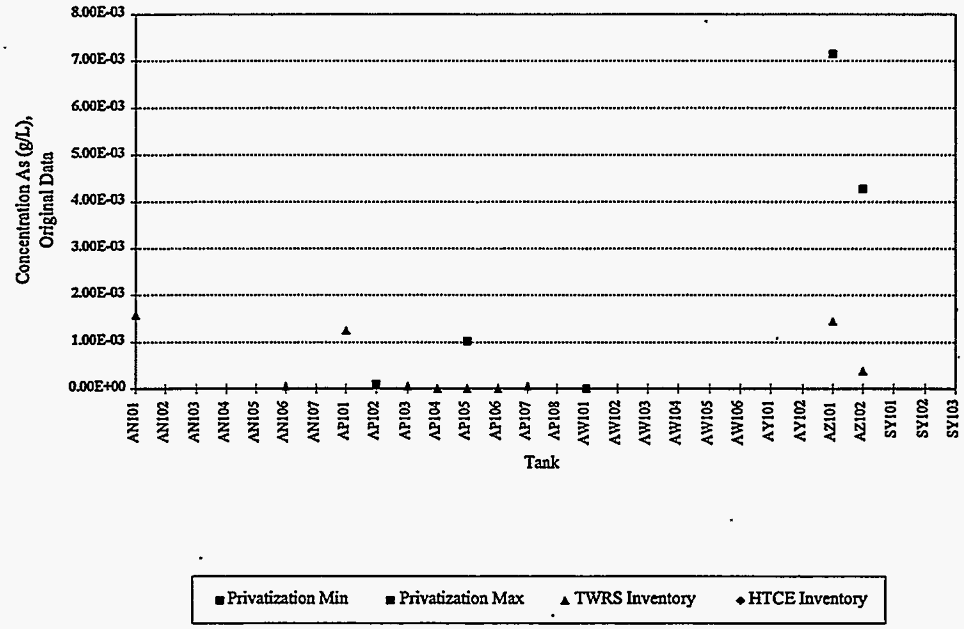

Figure D.6. Arsenic Concentration in Double-Shelled Tank Waste Supernatant

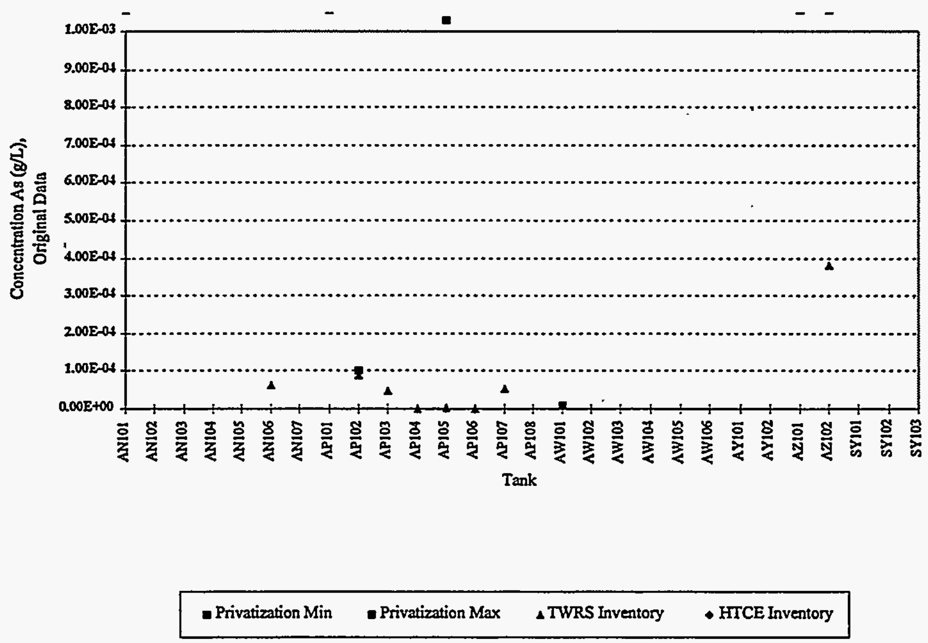

Figure D.7. Arsenic Concentration in Double-Shelled Tank Waste Supernatant

Table D.4. Barium (Ba) Concentration in g/L

Barium				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			3.05E-03	
AN102		1.83E-02		
AN103				
AN104				
AN105				
AN106			5.60E-05	
AN107		6.87E-01		
AP101			2.30E-03	
AP102		4.19E-04	2.84E-04	
AP103				
AP104			1.88E-13	
AP105		1.45E-03	6.61E-05	
AP106			3.10E-05	
AP107			1.75E-03	
AP108			1.60E-04	
AW101		8.58E-04		
AW102				
AW103			5.60E-04	
AW104			2.79E-06	
AW105			9.53E-07	
AW106				
AY101			5.01E-05	
AY102			6.79E-06	
AZ101		2.55E-03	5.18E-05	
AZ102		7.83E-04	2.94E-05	
SY101				
SY102				
SY103			6.64E-03	

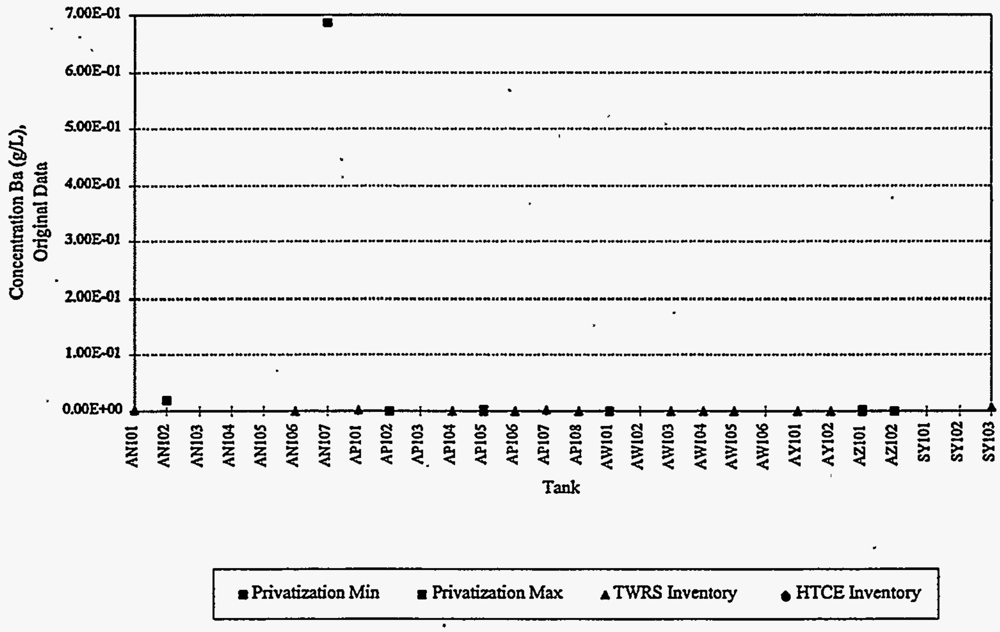

Figure D.8. Barium Concentration in Double-Shelled Tank Waste Supernatant

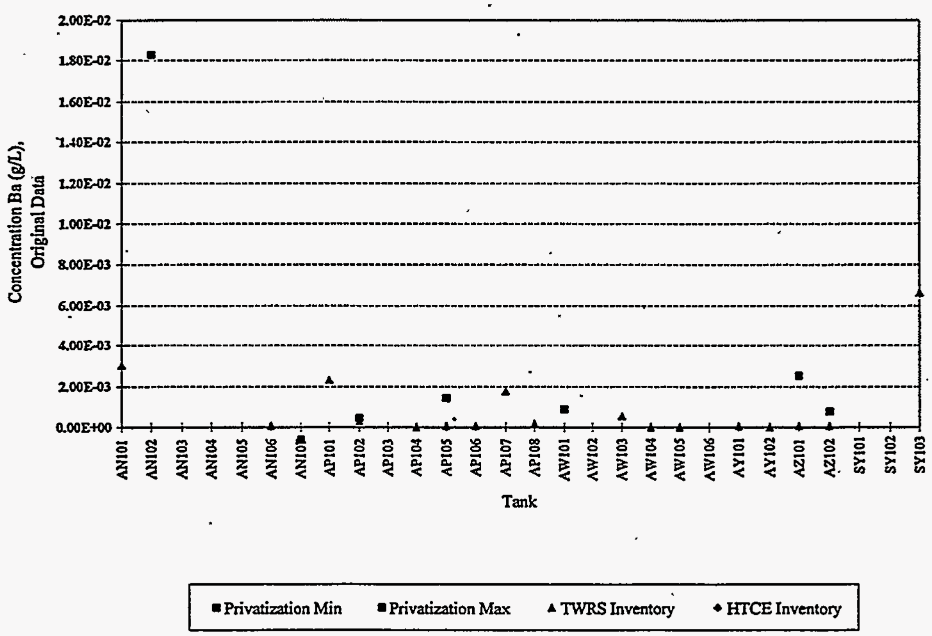

Figure D.9. Barium Concentration in Double-Shelled Tank Waste Supernatant

Table D.5. Beryllium (Be) Concentration in Double-Shelled Tank Waste Supernatant

Beryllium				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			5.69E-06	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102		1.68E-04	1.46E-04	
AP103				
AP104			1.69E-14	
AP105		1.68E-03		
AP106			1.08E-05	
AP107				
AP108			6.62E-07	
AW101				
AW102				
AW103				
AW104				
AW105			3.31E-07	
AW106				
AY101				
AY102				
AZ101		1.12E-04	5.88E-07	
AZ102		1.13E-04	1.94E-06	
SY101				
SY102				
SY103				

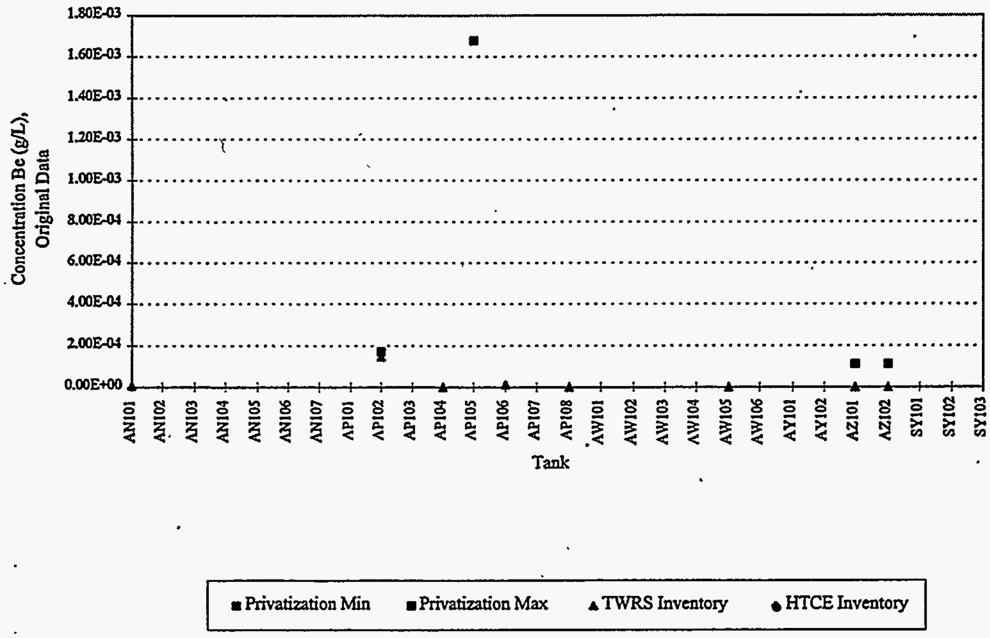

Figure D.10. Beryllium Concentration in Double-Shelled Tank Waste Supernatant

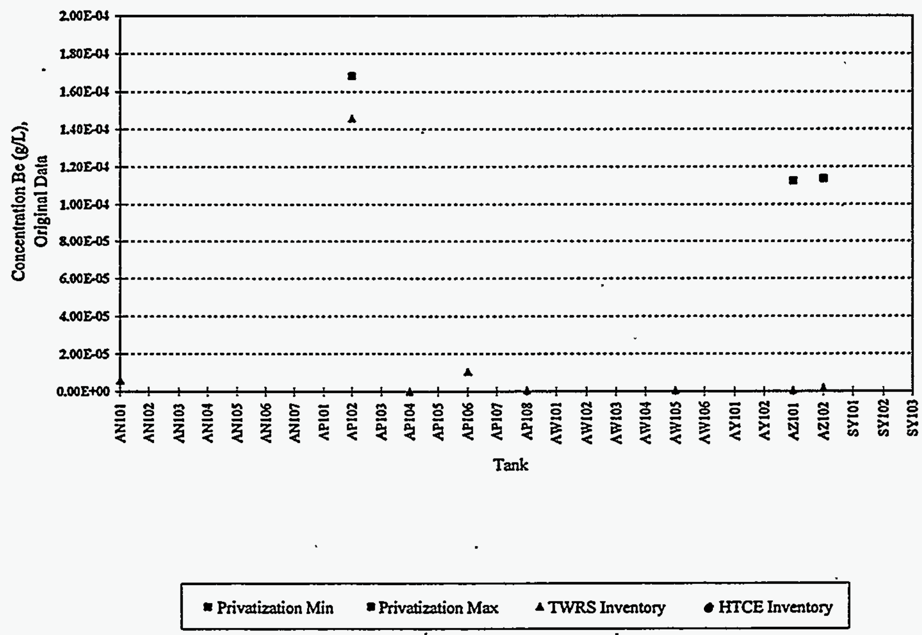

Figure D.11. Beryllium Concentration in Double-Shelled Tank Waste Supernatant

Table D.6. Bismuth (Bi) Concentration in g/L

Bismuth				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			4.01E-02	1.19E-01
AN102				3.04E-01
AN103				2.44E-01
AN104				2.00E-01
AN105				3.98E-01
AN106			1.97E-04	1.76E-01
AN107				2.55E-01
AP101				8.07E-03
AP102				1.24E-01
AP103				1.85E-03
AP104			8.36E-13	
AP105				1.06E-01
AP106			4.07E-08	2.78E-02
AP107				
AP108				3.28E-04
AW101				2.40E-01
AW102				7.28E-02
AW103				2.08E-04
AW104				1.09E-04
AW105				3.71E-02
AW106				6.48E-02
AY101				3.91E-02
AY102			9.25E-05	1.57E-04
AZ101				9.90E-03
AZ102				4.48E-04
SY101				3.65E-01
SY102				8.01E-05
SY103				2.72E-01

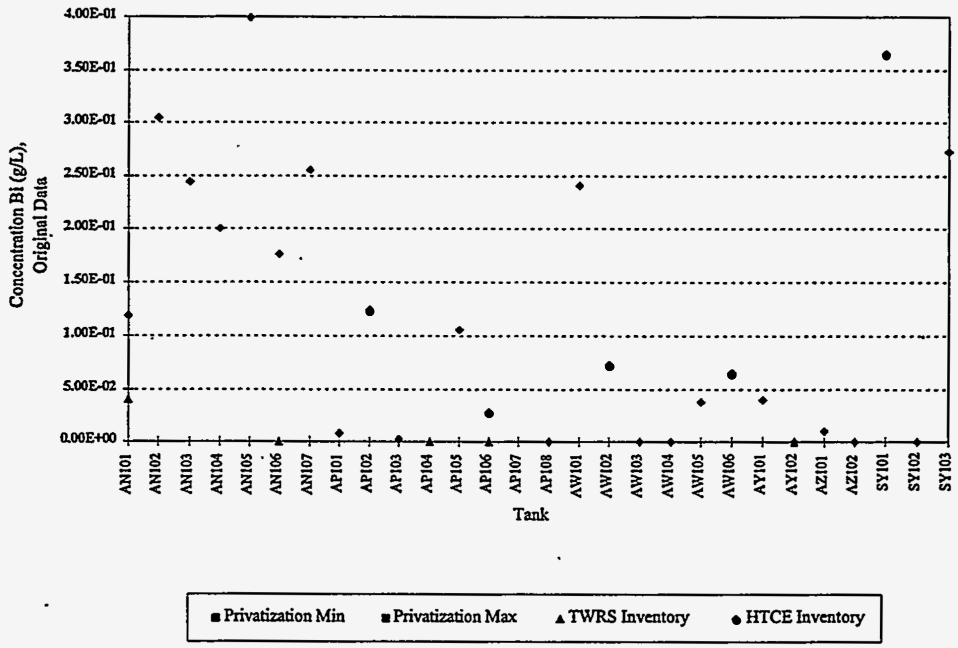

Figure D.12. Bismuth Concentration in Double-Shelled Tank Waste Supernatant

Table D.7. Calcium (Ca) Concentration in g/L

Calcium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.11E-01	4.99E-01
AN102		8.12E-01	4.32E-01	1.54E+00
AN103			8.64E-02	1.88E+00
AN104				1.28E+00
AN105				2.23E+00
AN106			1.23E-04	1.15E+00
AN107		6.92E-01	5.22E-01	1.03E+00
AP101			9.88E-02	4.76E-01
AP102				8.29E-01
AP103				2.54E-01
AP104			2.30E-09	3.12E-01
AP105			2.49E-03	2.22E+00
AP106			1.14E-02	7.05E-01
AP107			6.61E-02	3.63E-01
AP108			6.63E-04	2.50E-01
AW101		1.03E-01	3.31E-02	2.60E+00
AW102				1.32E+00
AW103			6.17E-03	2.96E-01
AW104			2.68E-05	3.31E-01
AW105			3.31E-04	8.14E-01
AW106				1.33E+00
AY101			1.81E-03	3.39E-01
AY102			2.48E-04	1.86E-01
AZ101		1.04E-02	8.72E-04	3.11E-01
AZ102		6.03E-03	1.02E-03	1.66E-01
SY101			4.99E-01	1.78E+00
SY102			5.36E-11	2.23E-01
SY103			1.91E-01	1.31E+00

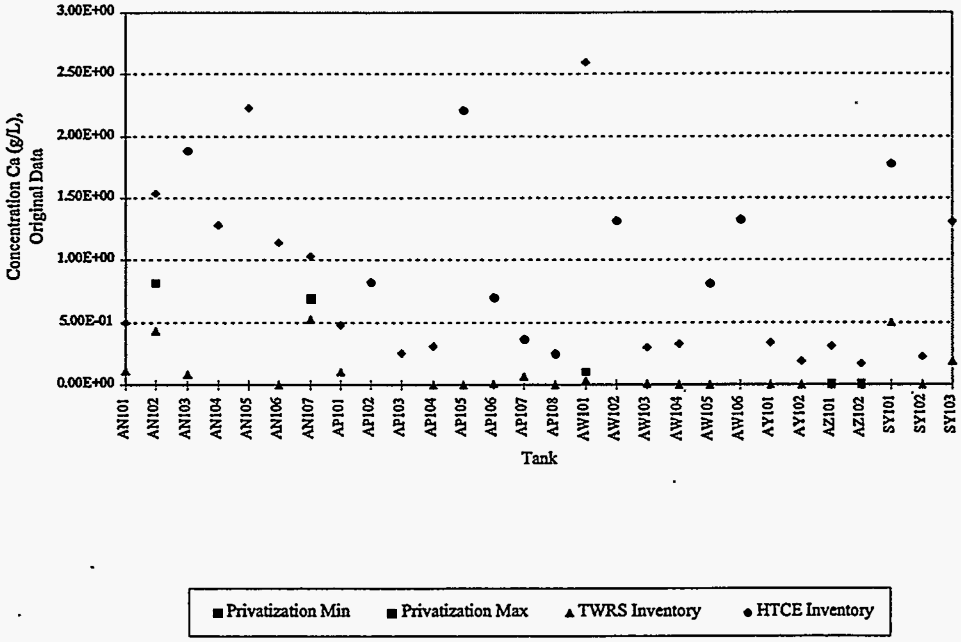

Figure D.13. Calcium Concentration in Double-shelled Tank Waste Supernatant

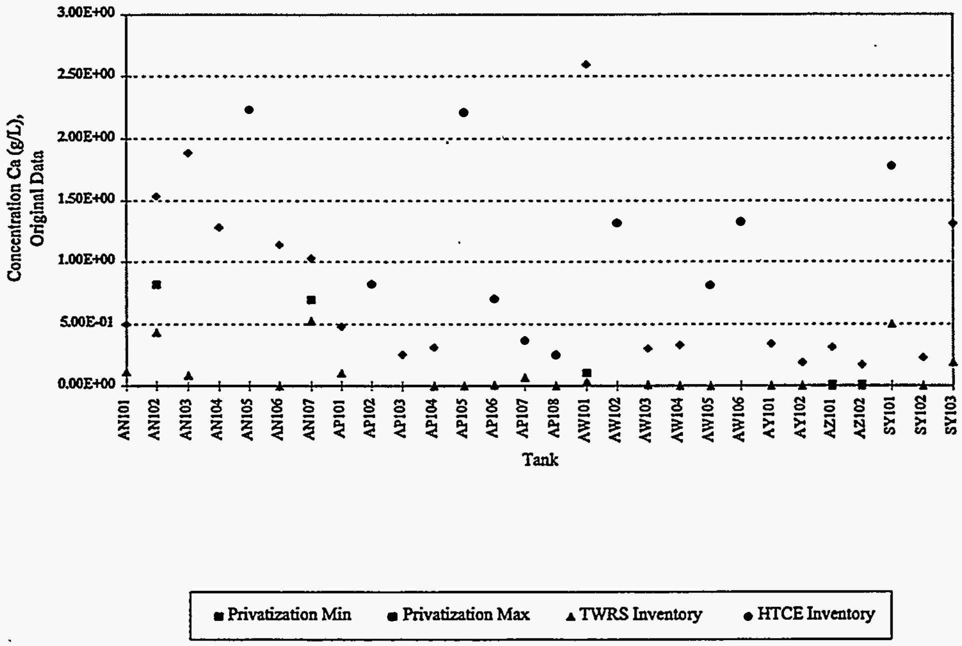

Figure D.14. Calcium Concentration in Double-Shelled Tank Waste Supernatant

Table D.8. Cadmium (Cd) Concentratin in g/L

Cadmium				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			1.73E-02	
AN102		5.65E-02		
AN103			1.60E-02	
AN104				
AN105				
AN106			1.38E-04	
AN107		7.00E-02		
AP101			1.88E-03	
AP102		1.79E-03	1.47E-03	
AP103			1.11E-04	
AP104			5.57E-14	
AP105		2.05E-03	4.03E-06	
AP106			2.71E-09	
AP107			1.06E-04	
AP108			5.80E-03	
AW101		7.06E-03		
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102			3.96E-05	
AZ101		4.46E-03	3.20E-05	
AZ102		1.92E-03	3.30E-05	
SY101				
SY102				
SY103				

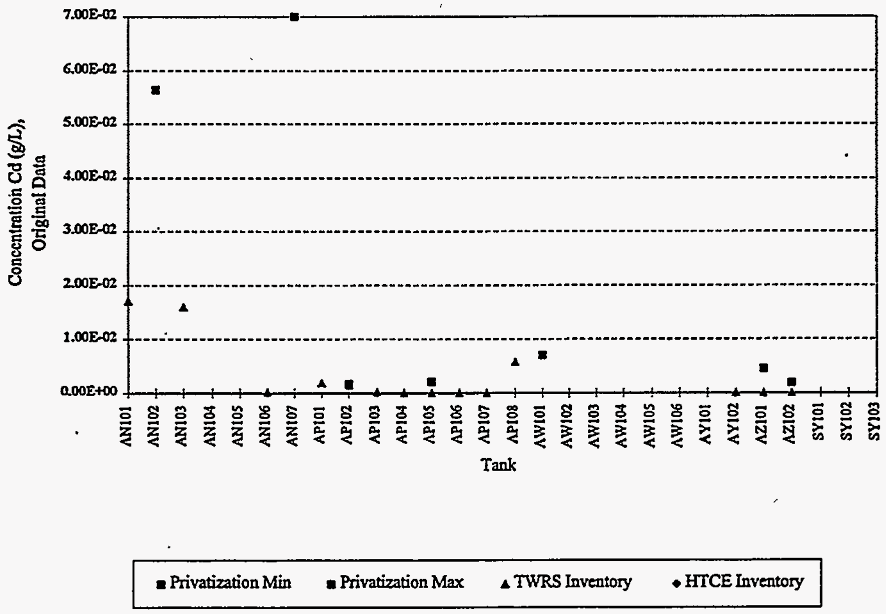

Figure D.15. Cadmium Concentration in Double-Shelled Tank Waste Supernatant

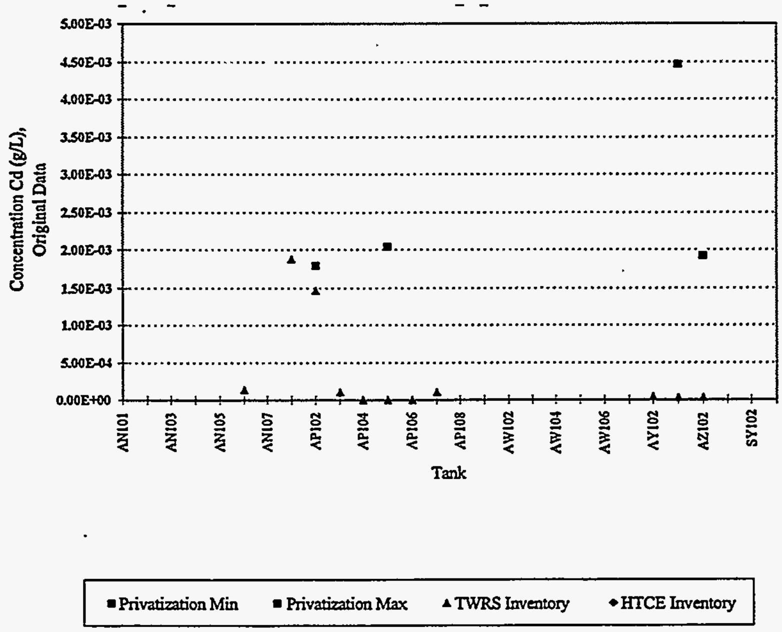

Figure D.16. Cadmium Concentration in Double-Shelled Tank Waste Supernatant

Table D.9. Cerium (Ce) Concentration in g/L

Cerium				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			1.51E-03	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107		5.80E-02		
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101			1.32E-03	
AZ102		1.18E-02	3.72E-04	
SY101				
SY102				
SY103				

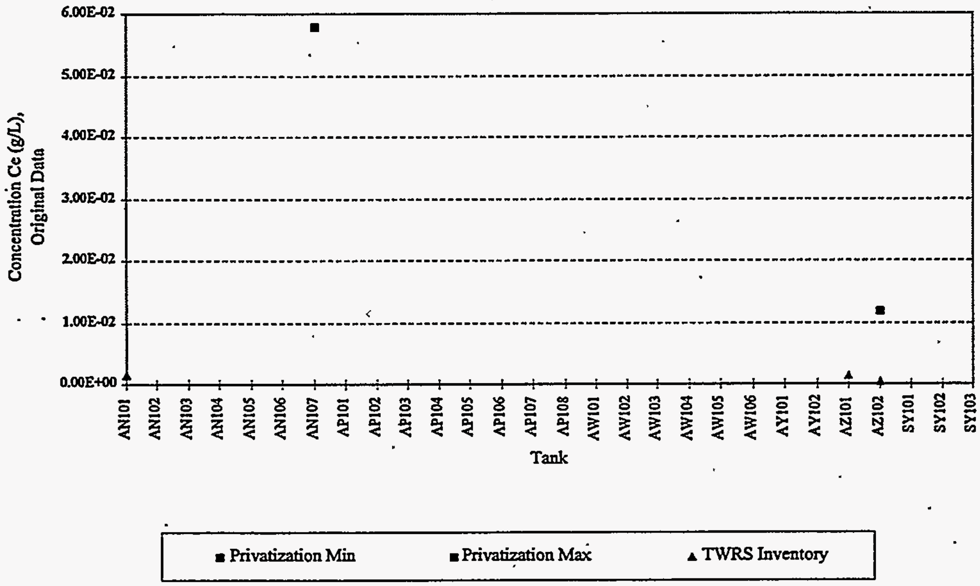

Figure D.17. Cerium Concentration in Double-Shelled Tank Waste Supernatant

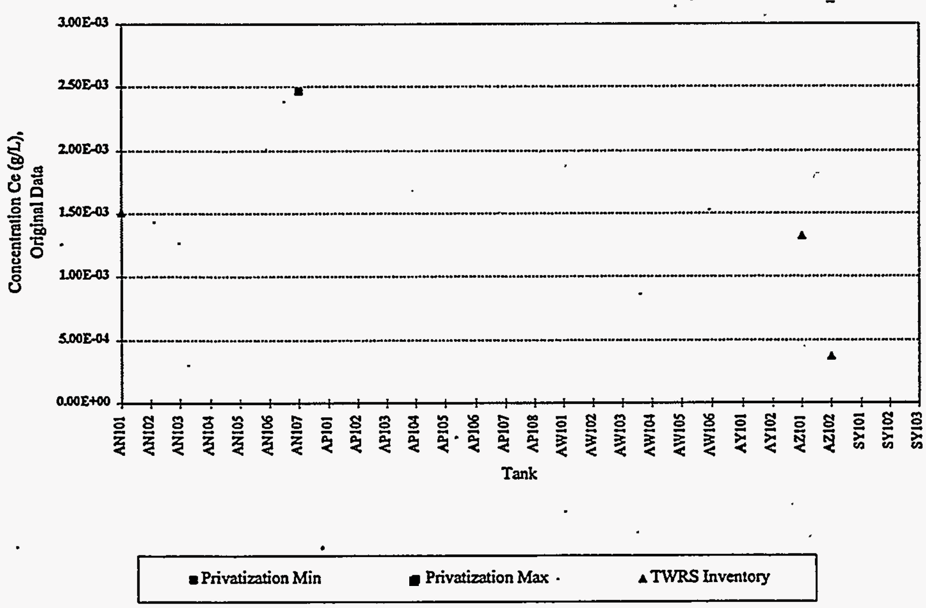

Figure D.18. Cerium Concentration in Double-Shelled Tank Waste Supernatant

Table D.10. Chlorine (Cl) Concentration in g/L

Chlorine				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			3.68E-01	2.71E+00
AN102	1.50E+00	4.25E+00	3.82E+00	9.46E+00
AN103			9.60E+00	7.77E+00
AN104			7.52E+00	6.08E+00
AN105			8.51E+00	1.17E+01
AN106			1.60E-02	5.10E+00
AN107	8.40E-01	2.13E+00	2.94E+00	7.32E+00
AP101			1.74E+00	4.50E-01
AP102	2.36E+00	4.56E+00	2.90E+00	3.60E+00
AP103			4.95E-02	1.08E+00
AP104			2.90E+00	9.74E-02
AP105	1.14E+00	4.07E+00	1.04E-02	5.62E+00
AP106			1.22E+01	2.04E+00
AP107			2.75E-01	3.28E-02
AP108			5.80E-02	9.75E-01
AW101	4.25E+00	8.15E+00	5.18E+00	8.90E+00
AW102				3.32E+00
AW103			1.35E-01	1.41E-01
AW104			1.86E-01	1.31E-01
AW105			4.10E-02	1.92E+00
AW106				3.46E+00
AY101			1.33E-01	2.21E+00
AY102	6.16E-02	1.22E-01	1.97E-04	8.88E-01
AZ101	1.73E-01	1.87E-01	2.33E-02	1.60E+00
AZ102	6.83E-02	6.83E-02		8.27E-01
SY101			6.54E+00	9.42E+00
SY102			1.02E+00	6.65E-01
SY103			7.06E+00	7.19E+00

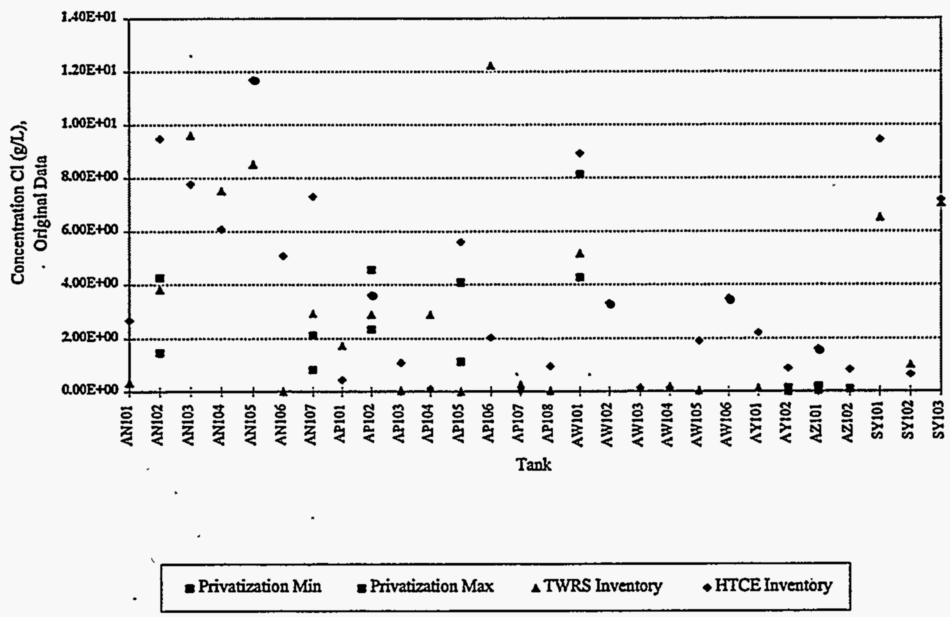

Figure D.19. Chlorine Concentration in Double-Shelled Tank Waste Supernatant

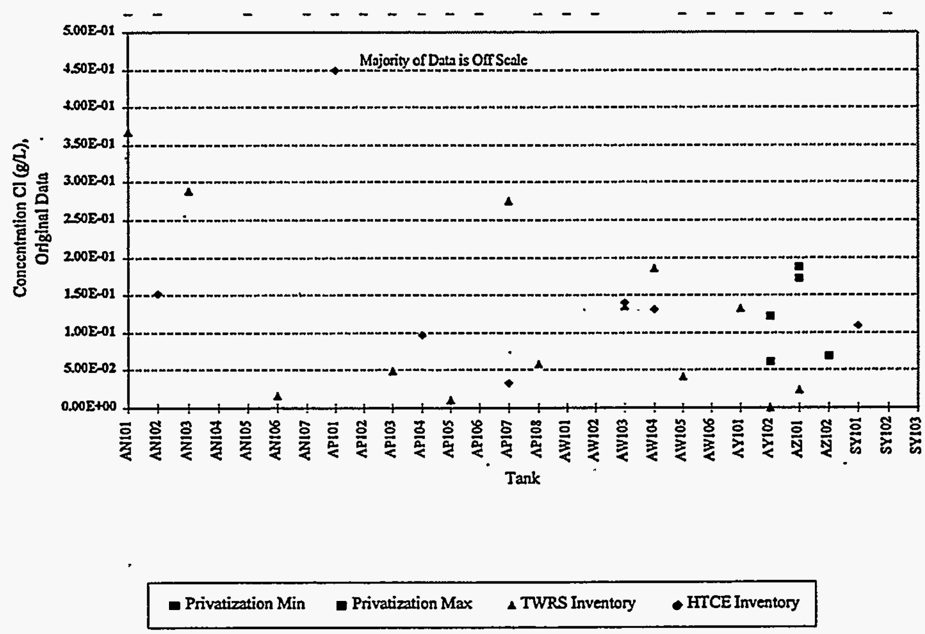

Figure D.20. Chlorine Concentration in Double-Shelled Tank Waste Supernatant

Table D.11. Cyanide (CN) Concentration in g/L

DST	Cyanide			
	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102		2.46E-02		
AP103				
AP104				
AP105		1.89E-02		
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101				
AZ102				
SY101				
SY102				
SY103				

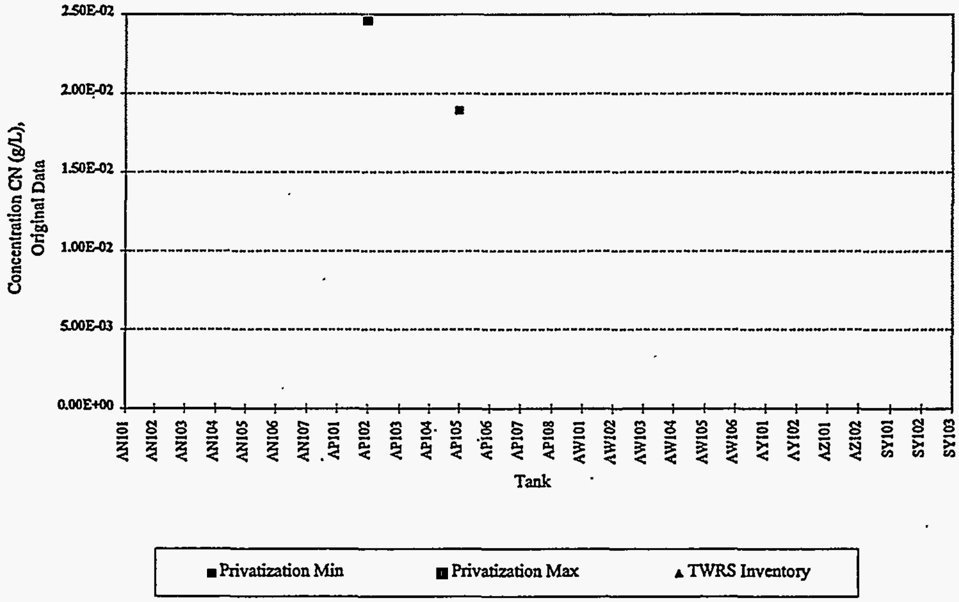

Figure D.21. Cyanide Concentration in Double-Shelled Tank Waste Supernatant

Table D.12. Cobalt (Co) Concentration in g/L

Cobalt				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101				
AZ102		8.53E-03		
SY101				
SY102				
SY103				

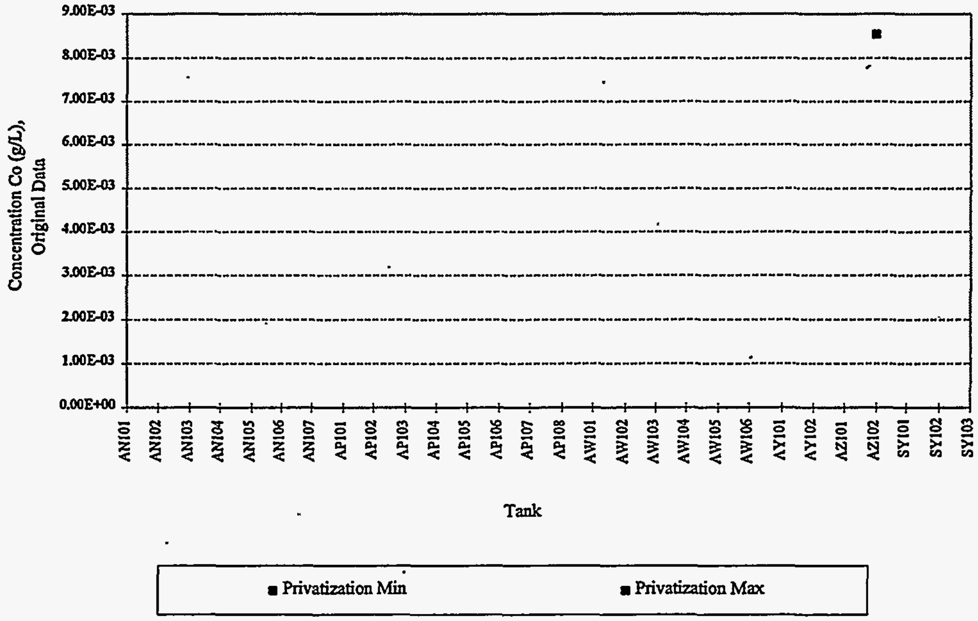

Figure D.22. Cobalt Concentration in Double-Shelled Tank Waste Supernatant

Table D.13. $Cr(OH)_4^-$ Concentration in g/L

$Cr(OH)_4^-$				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			7.86E-01	1.28E+00
AN102	3.12E-01	5.25E-01	6.47E-01	3.44E+00
AN103			1.96E+00	2.68E+00
AN104			1.56E+00	2.11E+00
AN105			1.56E+00	3.76E+00
AN106			3.02E-03	2.18E+00
AN107	2.23E-01	2.67E-01	3.72E-01	2.24E+00
AP101			3.12E-01	1.39E-01
AP102	5.91E-01	7.16E-01	1.43E+00	1.55E+00
AP103			1.01E-02	1.39E-01
AP104			1.76E-08	3.60E-01
AP105	1.45E-01	2.19E-01	1.79E-03	1.93E+00
AP106			3.23E-02	5.44E-01
AP107			4.79E-02	
AP108			1.24E-02	7.54E-02
AW101	1.15E-01	3.73E-01	3.72E-01	3.25E+00
AW102				1.21E+00
AW103			1.68E-01	1.71E-02
AW104			1.57E-05	3.83E-01
AW105			8.46E-04	6.84E-01
AW106				1.19E+00
AY101			2.47E+00	8.35E-01
AY102			3.43E-04	5.29E-02
AZ101	8.51E-02	8.11E-01	4.59E-01	1.05E-01
AZ102	1.00E+00	1.00E+00	1.67E-01	1.16E-02
SY101			3.69E-01	3.79E+00
SY102			4.12E-10	2.70E-01
SY103			1.09E+01	2.87E+00

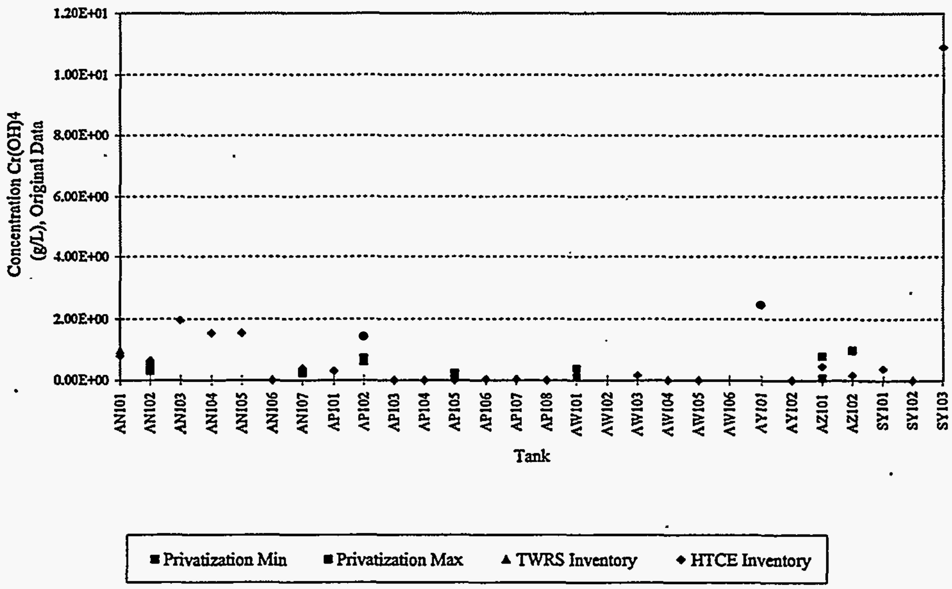

Figure D.23. $Cr(OH)_4^-$ Concentration in Double-Shelled Tank Waste Supernatant

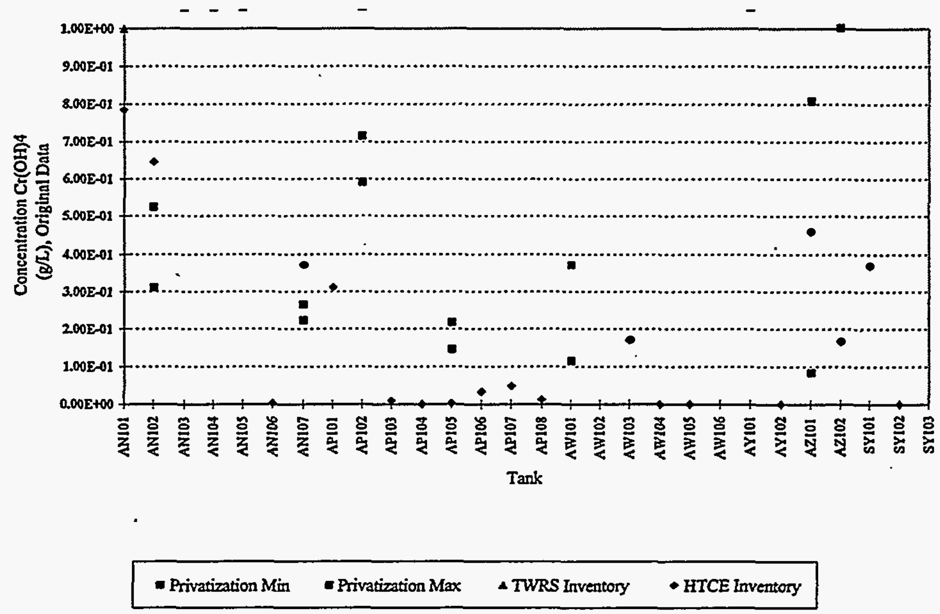

Figure D.24. $Cr(OH)_4^-$ Concentration in Double-Shelled Tank Waste Supernatant

Table D.14. Fluorine (F) Concentration in g/L

DST	Fluorine: Privatization Inventory Min	Fluorine: Privatization Inventory Max	Fluorine: TWRS Inventory	Fluorine: HTCE Inventory
AN101			6.35E-01	7.26E-01
AN102	1.90E+00	2.50E+00	2.05E+00	1.66E+00
AN103			7.36E-01	3.66E+00
AN104				2.02E+00
AN105				2.31E+00
AN106			2.96E+00	9.58E-01
AN107		<4.22E+00		1.46E+00
AP101			3.97E+00	3.46E-01
AP102	<1.32E-02	<2.09E-01		6.76E-01
AP103			1.29E-01	8.50E-02
AP104			1.98E+00	
AP105	<1.01E-02	8.86E+00	2.51E+00	5.00E+00
AP106			1.18E+01	1.29E+00
AP107			2.81E+00	
AP108			3.59E-01	1.64E-02
AW101		<7.81E-02		6.10E+00
AW102				2.91E+00
AW103			1.74E+01	3.55E+00
AW104			6.77E-03	1.75E-03
AW105			9.45E-02	3.13E+00
AW106				2.80E+00
AY101			1.80E+00	2.07E-01
AY102	1.07E-02	1.43E-02	2.96E-04	7.86E-03
AZ101	1.54E+00	1.62E+00	4.28E-01	4.63E-01
AZ102	7.98E-01	1.08E+00	6.55E-02	2.39E-01
SY101			9.43E-02	1.87E+00
SY102			6.04E-01	4.98E-04
SY103			7.51E-01	1.41E+00

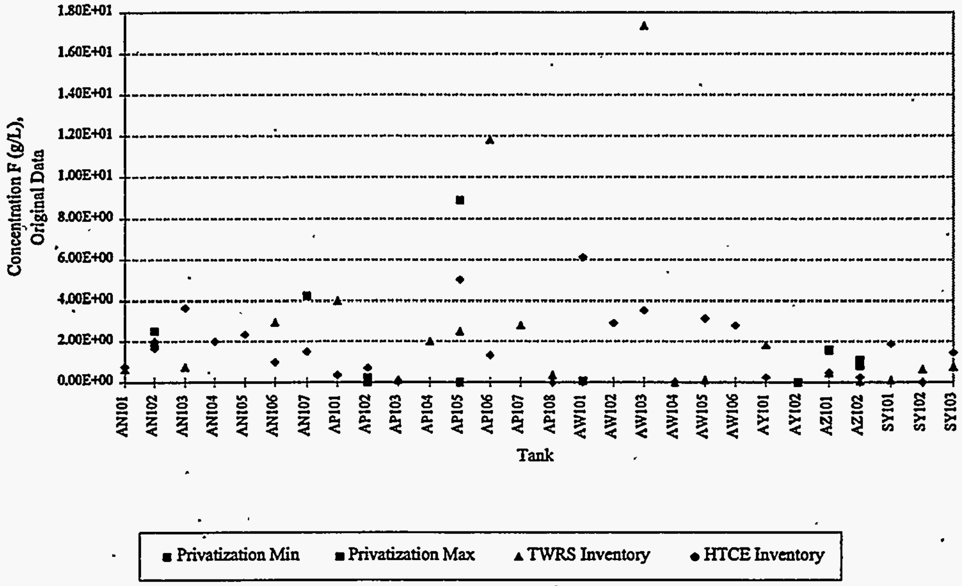

Figure D.25. Fluorine Concentration in Double-Shelled Tank Waste Supernatant

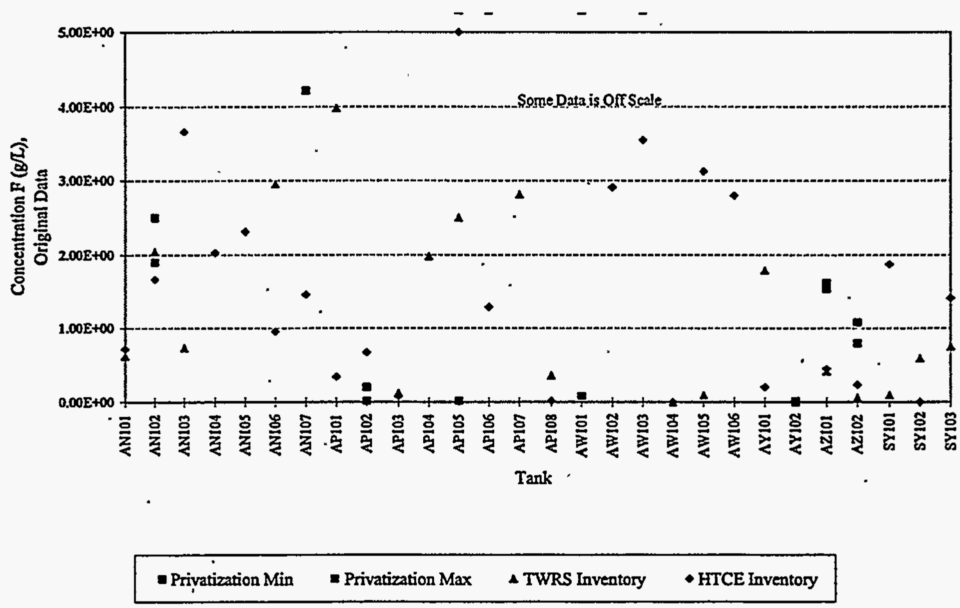

Figure D.26. Fluorine Concentration in Double-Shelled Tank Waste Supernatant

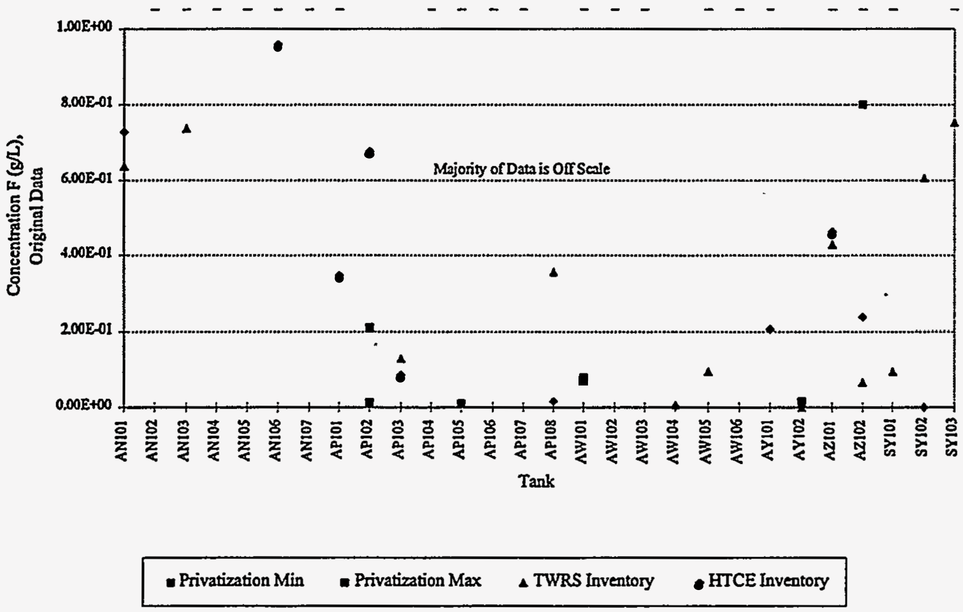

Figure D.27. Fluorine Concentration in Double-Shelled Tank Waste Supernatant

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Table D.15. Iron (Fe) Concentration in g/L

Iron				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.18E-01	1.53E-01
AN102		2.99E-01		4.72E-01
AN103			7.04E-02	5.80E-01
AN104			1.12E-02	3.95E-01
AN105			1.12E-02	6.89E-01
AN106			1.78E-03	3.54E-01
AN107		2.94E+00	1.42E+00	3.19E-01
AP101			2.57E-02	1.47E-01
AP102		1.05E-02	3.81E-03	2.55E-01
AP103			1.23E-03	7.86E-02
AP104			2.58E-03	9.66E-02
AP105		9.67E-03	1.27E-04	6.85E-01
AP106			5.03E-03	2.18E-01
AP107			3.36E-03	1.12E-01
AP108			7.01E-03	7.76E-02
AW101		1.18E-01		8.03E-01
AW102				4.08E-01
AW103				9.14E-02
AW104			3.04E-04	1.03E-01
AW105			4.97E-02	2.52E-01
AW106				4.11E-01
AY101			8.68E-05	1.03E-01
AY102		<5.50E-01	2.71E-04	5.77E-02
AZ101		<1.01E-02	2.64E-04	9.60E-02
AZ102		1.08E-02	2.79E-04	5.15E-02
SY101			1.94E-02	5.47E-01
SY102			3.63E-03	6.92E-02
SY103			1.25E+00	4.02E-01

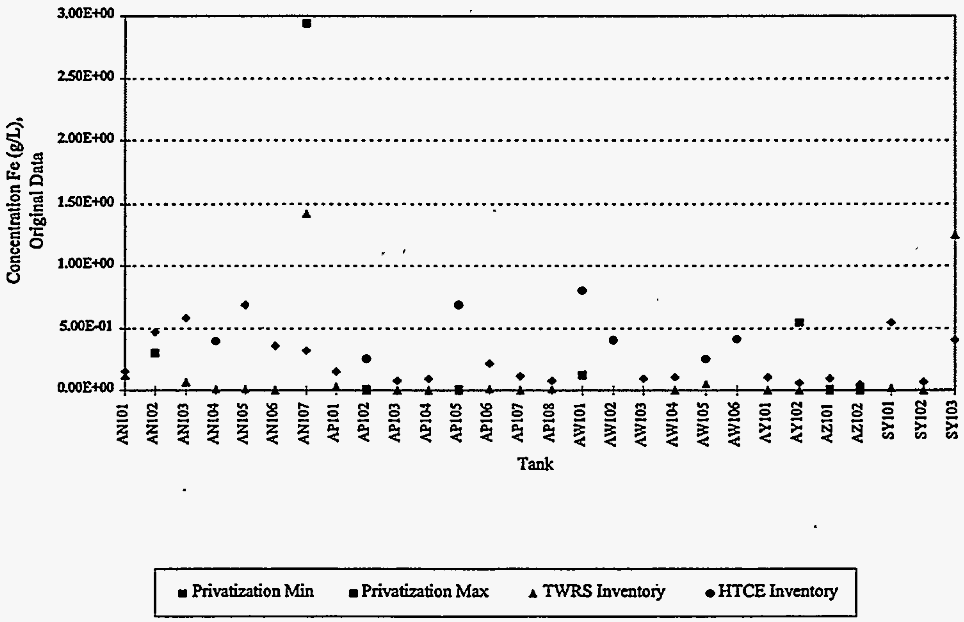

Figure D.28. Iron Concentration in Double-Shelled Tank Waste Supernatant

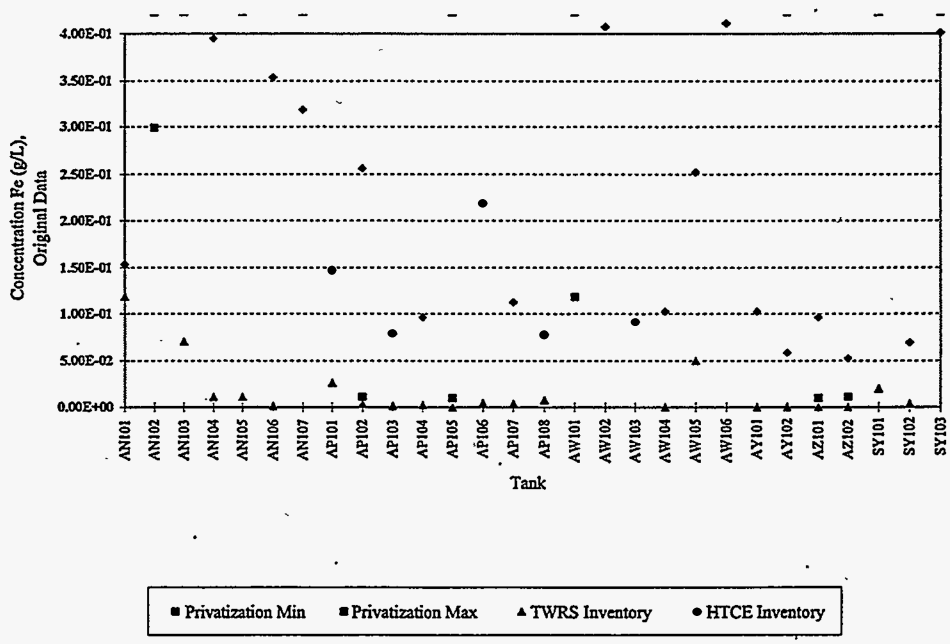

Figure D.29. Iron Concentration in Double-Shelled Tank Waste Supernatant

Table D.16. Mercury (Hg) Concentration in g/L

Mercury				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			7.10E-04	7.28E-04
AN102				2.30E-03
AN103			1.60E-02	2.78E-03
AN104				1.84E-03
AN105				2.79E-03
AN106			3.15E-07	1.26E-03
AN107				2.05E-03
AP101			2.68E-06	1.93E-04
AP102		<1.00E-05		8.88E-04
AP103			5.00E-06	4.09E-05
AP104				
AP105				2.73E-03
AP106				7.09E-04
AP107				
AP108				5.63E-06
AW101		3.34E-05		3.93E-03
AW102				1.60E-03
AW103				1.57E-03
AW104				1.32E-06
AW105				1.57E-03
AW106				1.55E-03
AY101				3.15E-04
AY102			1.64E-06	2.70E-06
AZ101				7.34E-05
AZ102				3.55E-06
SY101				2.34E-03
SY102				5.74E-07
SY103				1.80E-03

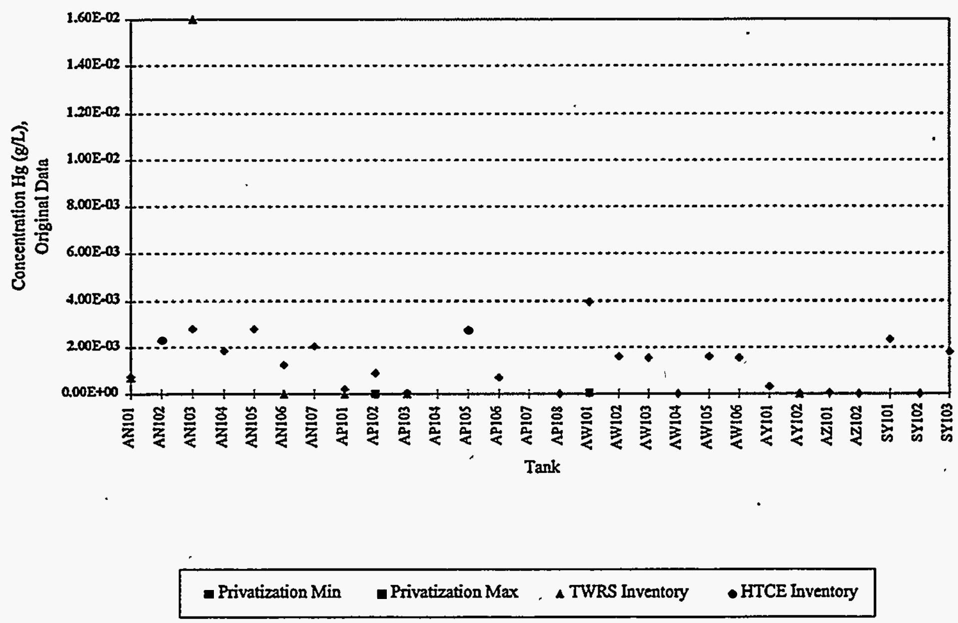

Figure D.30. Mercury Concentration in Double-Shelled Tank Waste Supernatant

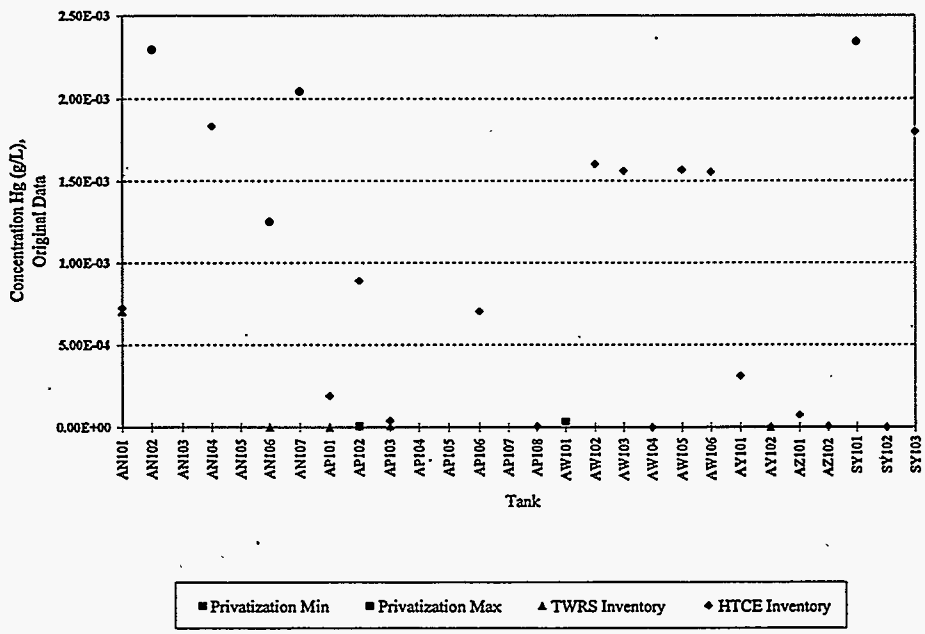

Figure D.31. Mercury Concentration in Double-Shelled Tank Waste Supernatant

Table D.17. Potassium (K) Concentration in g/L

Potassium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			4.27E-01	1.05E+00
AN102	1.60E+00	4.38E+00	3.83E+00	2.94E+00
AN103			1.52E+01	7.01E+00
AN104			7.15E+00	3.72E+00
AN105			6.14E+00	3.84E+00
AN106			1.47E-03	1.56E+00
AN107	7.33E-01	1.80E+00	2.01E+00	2.27E+00
AP101			2.09E+01	7.29E-01
AP102	1.19E+00	1.40E+00	1.29E+00	1.10E+00
AP103			1.52E+00	3.73E-01
AP104			1.92E-06	2.34E-02
AP105	2.83E+01	3.70E+01	7.42E-02	1.04E+01
AP106			3.87E+00	2.83E+00
AP107			2.03E+00	7.86E-03
AP108			1.01E+00	2.67E-01
AW101	2.31E+01	5.61E+01	4.18E+01	1.22E+01
AW102				5.99E+00
AW103			2.04E+01	6.85E+00
AW104			1.08E-04	2.49E-01
AW105			1.03E-01	6.28E+00
AW106				5.89E+00
AY101			3.00E+00	6.66E-01
AY102				2.19E-01
AZ101	2.99E+00	4.69E+00	9.14E-01	4.03E-01
AZ102	1.44E+00	1.44E+00	2.39E-02	2.02E-01
SY101			2.58E+00	2.82E+00
SY102			4.48E-08	1.20E-01
SY103			2.87E+00	2.15E+00

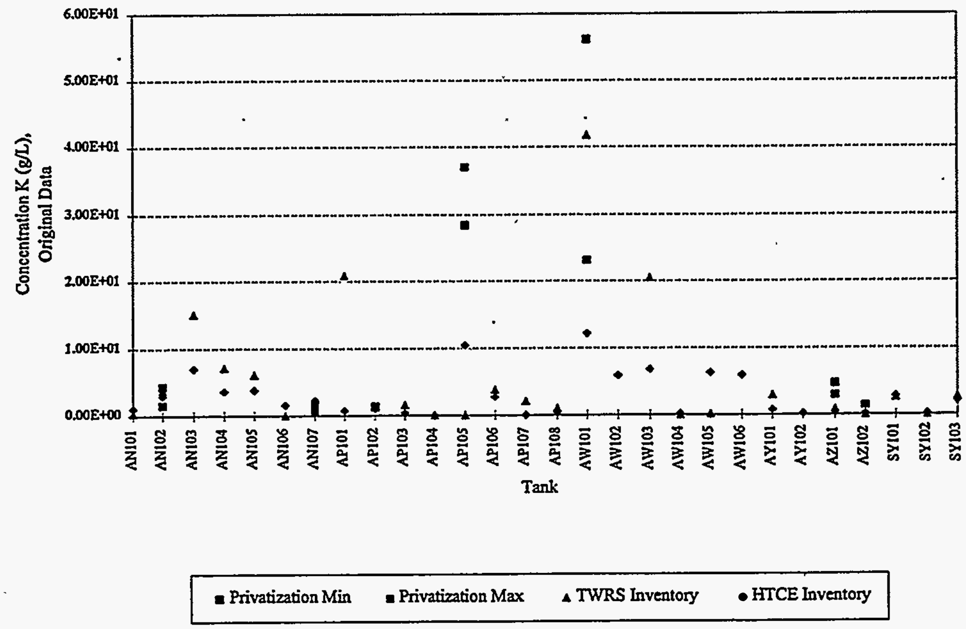

Figure D.32. Potassium Concentration in Double-Shelled Tank Waste Supernatant

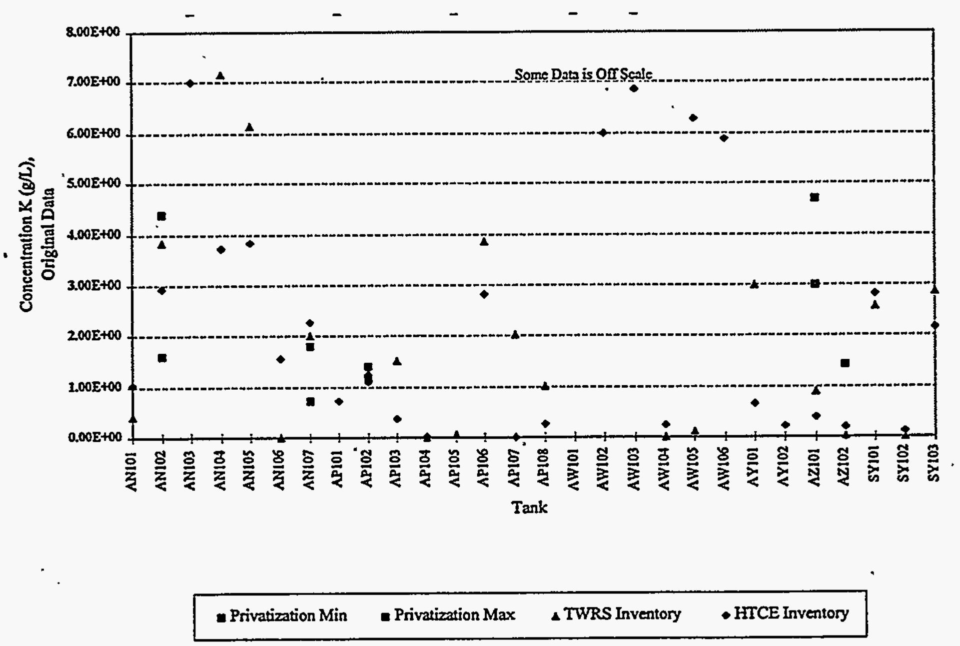

Figure D.33. Potassium Concentration in Double-Shelled Tank Waste Supernatant

Table D.18. Lanthanum (La) Concentration in g/L

Lanthanum				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			1.81E-02	4.16E-04
AN102				3.40E-03
AN103				1.87E-03
AN104				1.79E-03
AN105				2.89E-03
AN106				2.58E-03
AN107				1.69E-03
AP101			1.41E-02	1.54E-04
AP102				1.82E-03
AP103				2.70E-05
AP104				
AP105			6.89E-04	1.89E-03
AP106				4.73E-04
AP107			1.82E-02	
AP108				4.66E-06
AW101				2.28E-03
AW102				1.18E-03
AW103				1.17E-06
AW104				1.06E-06
AW105				4.59E-04
AW106				1.12E-03
AY101			5.34E-04	5.14E-04
AY102			4.14E-05	2.23E-06
AZ101		3.96E-03	9.93E-05	1.34E-04
AZ102		1.74E-03	5.98E-05	3.47E-06
SY101				8.46E-03
SY102				5.50E-07
SY103				5.33E-03

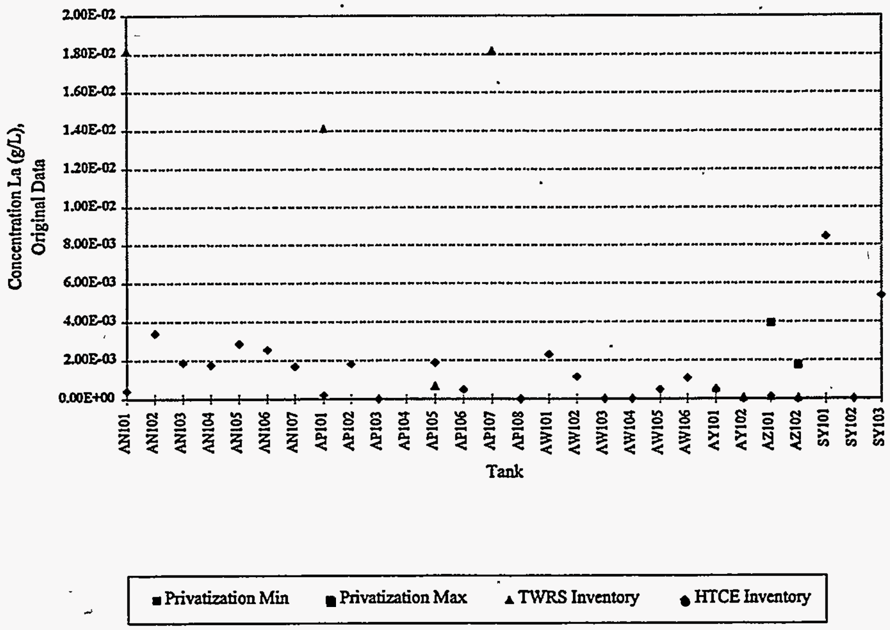

Figure D.34. Lanthanum Concentration in Double-Shelled Tank Waste Supernatant

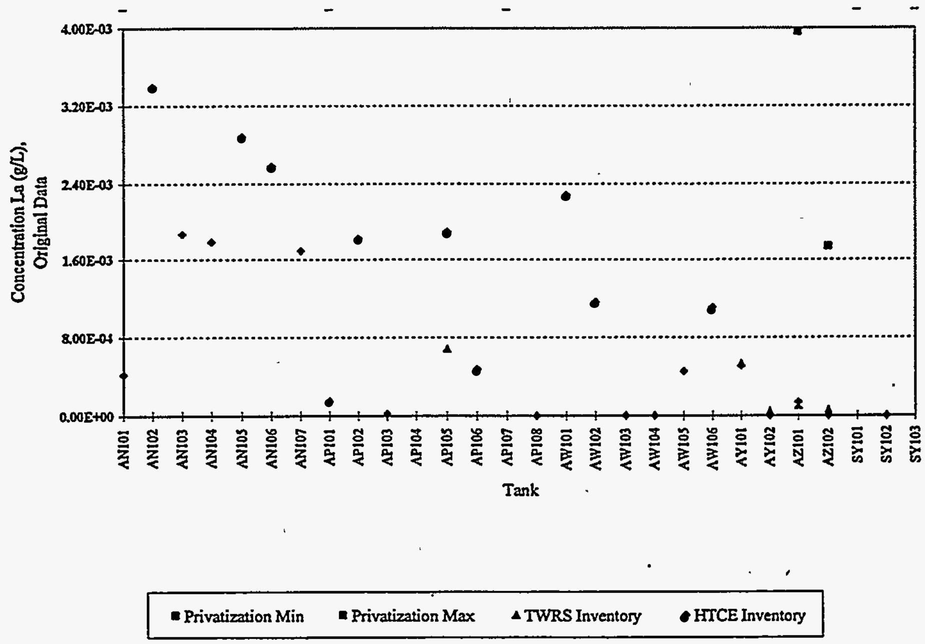

Figure D.35. Lanthanum Concentration in Double-Shelled Tank Waste Supernatant

Table D.19. Manganese (Mn) Concentration in g/L

Manganese				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			2.35E-02	9.22E-02
AN102				3.88E-01
AN103			2.88E-02	5.08E-01
AN104				3.69E-01
AN105				5.11E-01
AN106			2.34E-04	1.57E-01
AN107			4.74E-01	2.72E-01
AP101			1.72E-03	4.66E-02
AP102				1.11E-01
AP103			4.31E-05	1.08E-02
AP104			3.59E-02	
AP105				6.94E-01
AP106			7.01E-03	1.83E-01
AP107			6.22E-08	
AP108				2.83E-02
AW101			2.61E-02	8.77E-01
AW102				4.34E-01
AW103				1.22E-02
AW104			5.77E-08	3.03E-01
AW105				2.54E-01
AW106				4.17E-01
AY101				1.13E-01
AY102			5.39E-05	6.90E-04
AZ101			2.41E-05	1.31E-02
AZ102			2.53E-05	4.76E-03
SY101				2.83E-01
SY102			5.89E-02	1.93E-04
SY103				2.19E-01

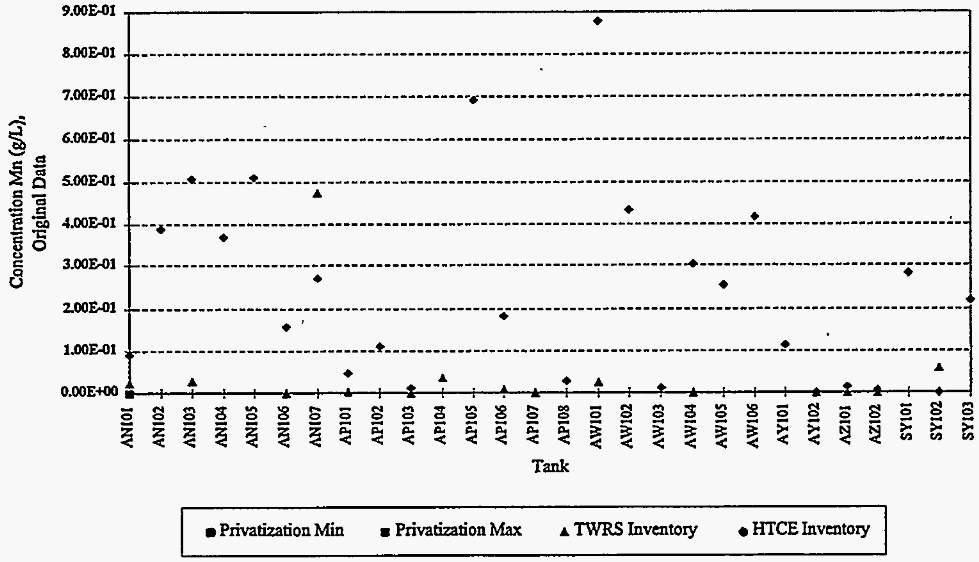

Figure D.36. Manganese Concentration in Double-Shelled Tank Waste Supernatant

Table D.20. Sodium (Na) Concentration in g/L

Sodium				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			6.33E+01	1.01E+02
AN102	1.75E+02	2.71E+02	2.61E+02	3.45E+02
AN103			3.36E+02	2.89E+02
AN104			2.76E+02	2.24E+02
AN105			2.76E+02	4.15E+02
AN106			3.71E+02	1.93E+02
AN107	1.89E+02	2.32E+02	2.11E+02	2.63E+02
AP101			1.39E+02	1.73E+01
AP102	9.80E+01	1.06E+02	1.02E+02	1.37E+02
AP103			5.31E+00	3.56E+01
AP104			5.58E+01	1.26E+01
AP105	1.46E+02	1.93E+02	3.31E+02	2.18E+02
AP106			2.44E+02	7.62E+01
AP107			3.55E+02	1.39E+00
AP108			5.81E+00	3.52E+01
AW101	1.59E+02	3.08E+02	2.30E+02	3.36E+02
AW102				1.30E+02
AW103			1.96E+01	9.58E+00
AW104			4.53E+00	1.36E+01
AW105			2.18E+00	7.63E+01
AW106				1.34E+02
AY101			1.04E+02	8.01E+01
AY102	2.42E+00	2.47E+00	2.89E+00	3.15E+01
AZ101	9.36E+01	9.73E+01	2.29E+01	5.65E+01
AZ102	5.29E+01	5.37E+01	6.59E+00	2.90E+01
SY101			1.61E+02	3.45E+02
SY102			2.00E+01	1.52E+01
SY103			1.61E+02	2.63E+02

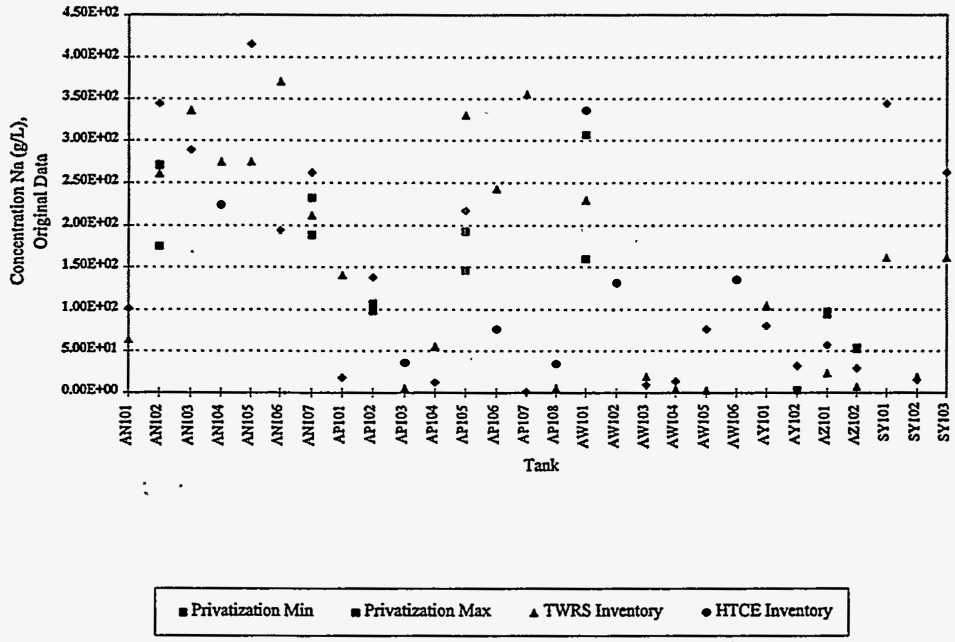

Figure D.37. Sodium Concentration in Double-Shelled Tank Waste Supernatant

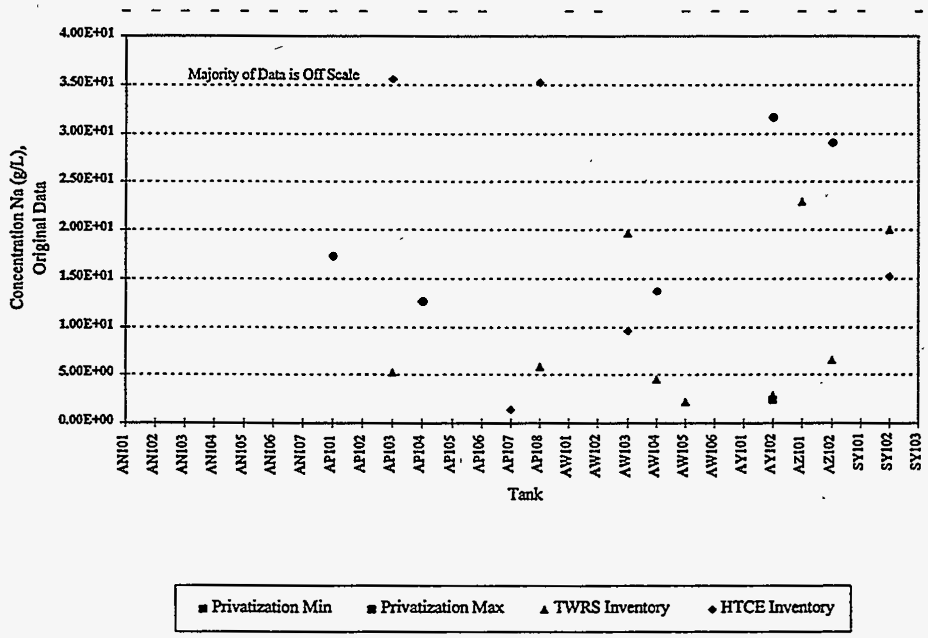

Figure D.38. Sodium Concentration in Double-Shelled Tank Waste Supernatant

Table D.21. Neodymium (Nd) Concentration in g/L

Neodymium				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107		1.13E-01		
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		1.43E-03		
AZ102		5.42E-03		
SY101				
SY102				
SY103				

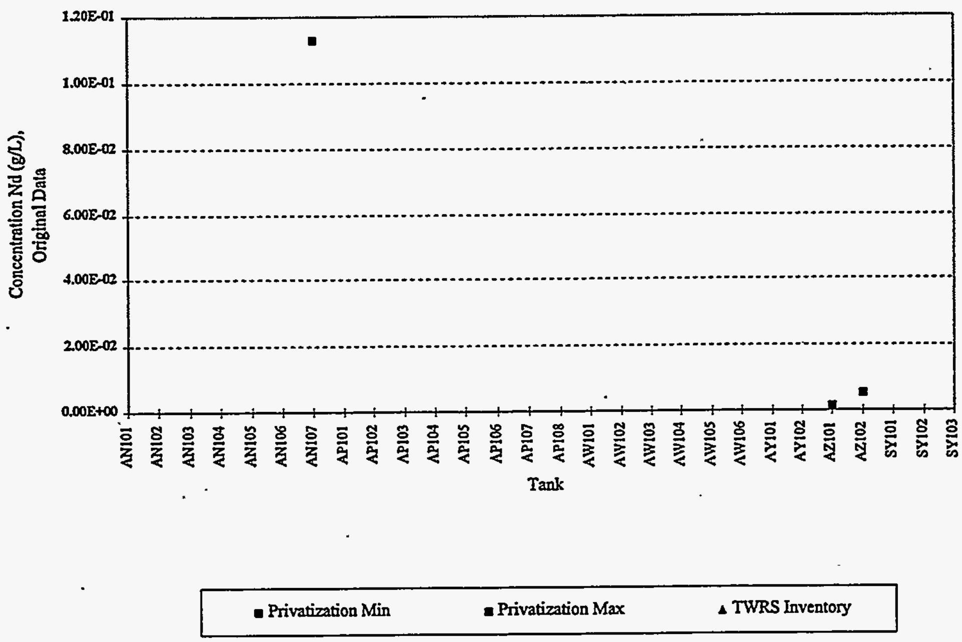

Figure D.39. Neodymium Concentration in Double-Shelled Tank Waste Supernatant

Table D.22. NH_3/NH_4^+ Concentration in g/L

	NH_3/NH_4^+			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101				7.21E-01
AN102				9.84E-01
AN103				7.58E+00
AN104				3.25E+00
AN105				1.47E+00
AN106				5.91E-01
AN107				5.43E-01
AP101				1.70E+00
AP102	<4.00E-02	4.13E-01		4.21E-01
AP103				2.25E-01
AP104				
AP105				1.39E+01
AP106				3.63E+00
AP107				8.55E-01
AP108				1.12E-01
AW101		5.10E-01		1.46E+01
AW102				7.92E+00
AW103				1.04E+01
AW104				3.89E-03
AW105				8.73E+00
AW106				7.76E+00
AY101				2.48E-01
AY102				1.48E-02
AZ101				2.37E-01
AZ102				1.22E-01
SY101				1.24E+00
SY102				4.03E-04
SY103				9.03E-01

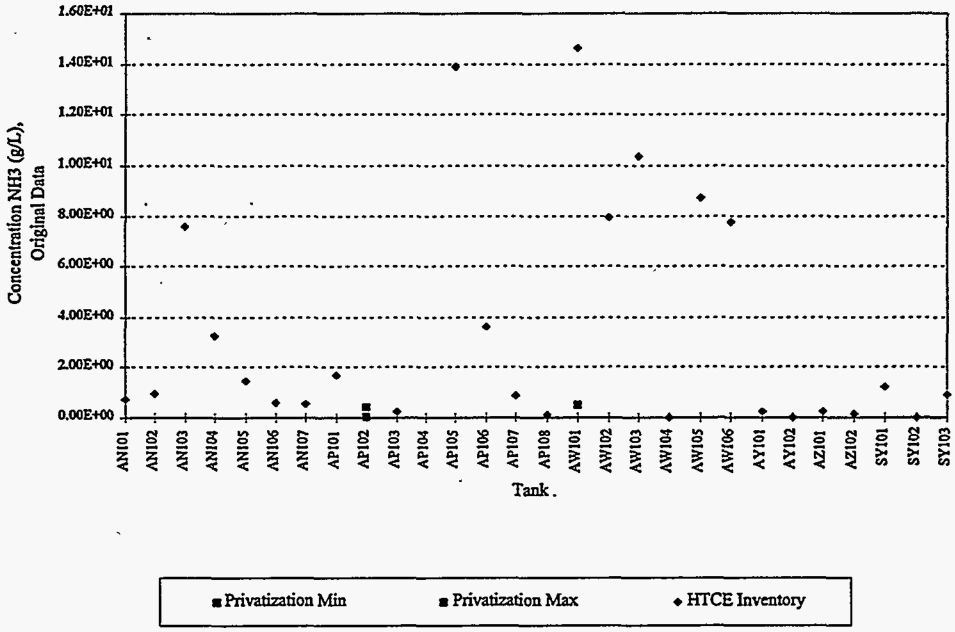

Figure D.40. NH_3/NH_4^+ Concentration in Double-Shelled Tank Waste Supernatant

Table D.23. Nickel (Ni) Concentration in g/L

Nickel				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			2.42E-04	1.38E-01
AN102		4.11E-01	3.45E-01	4.16E-01
AN103			2.40E-02	4.76E-01
AN104				3.34E-01
AN105				6.20E-01
AN106				3.19E-01
AN107		5.87E-01	4.27E-01	2.75E-01
AP101			2.14E-02	3.24E-02
AP102		3.45E-02	2.66E-02	2.30E-01
AP103				6.66E-02
AP104			5.58E-14	9.14E-02
AP105		1.23E-02	7.27E-04	4.54E-01
AP106			2.71E-09	1.51E-01
AP107			1.92E-02	
AP108			4.00E-04	6.13E-02
AW101				6.28E-01
AW102				2.76E-01
AW103			2.96E-03	4.19E-03
AW104			1.22E-07	9.69E-02
AW105				1.56E-01
AW106				2.76E-01
AY101			5.44E-04	7.73E-02
AY102				5.37E-02
AZ101			6.92E-05	1.45E-02
AZ102		2.14E-03	6.42E-05	5.24E-03
SY101			2.31E-02	4.89E-01
SY102				6.54E-02
SY103			6.25E-02	3.59E-01

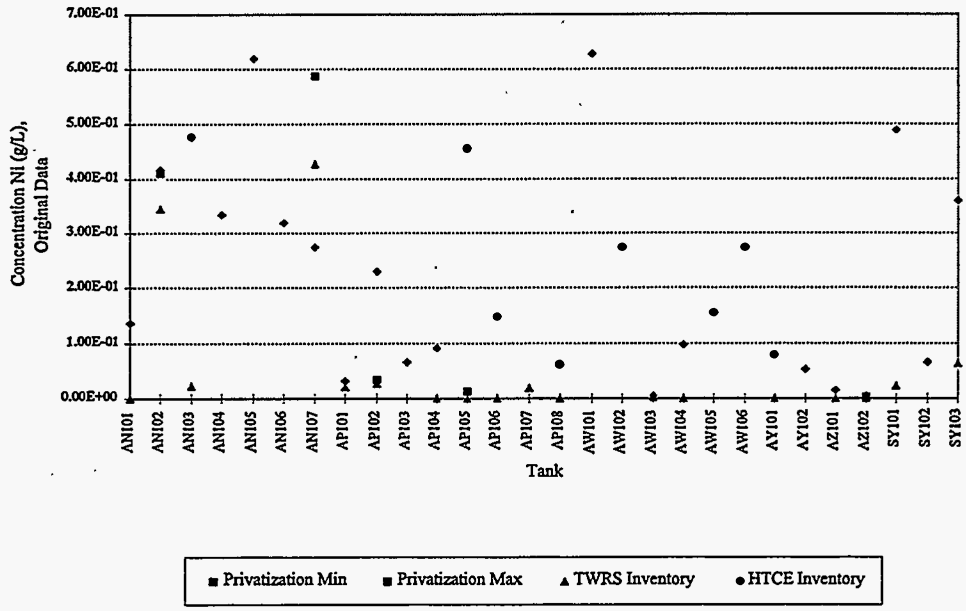

Figure D.41. Nickel Concentration in Double-Shelled Tank Waste Supernatant

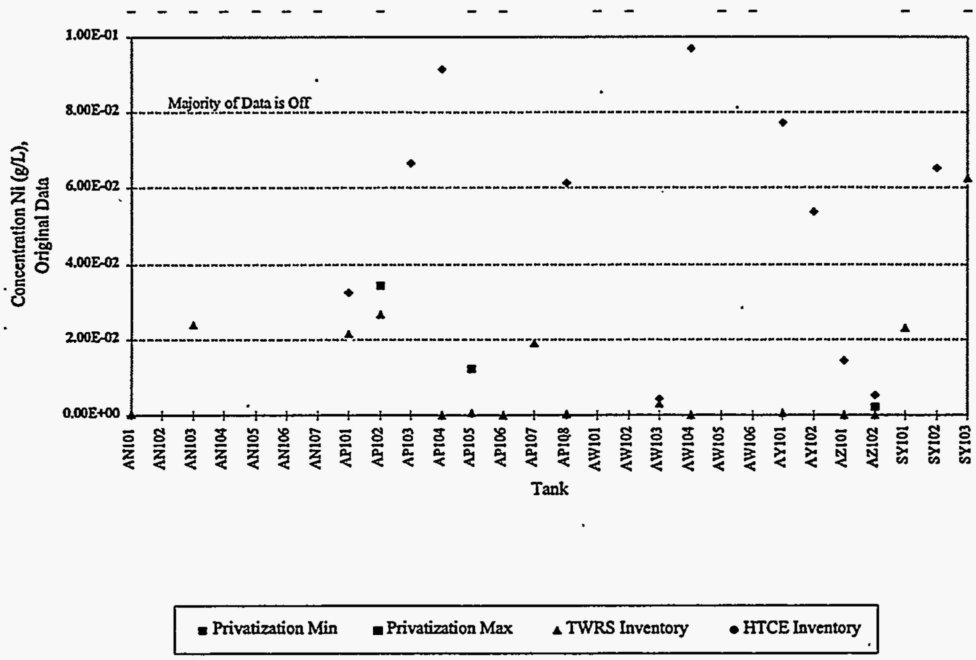

Figure D.42. Nickel Concentration in Double-Shelled Tank Waste Supernatant

Table D.24. Nitrite (NO_2^-) Concentration in g/L

Nitrite				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			1.35E+01	4.54E+01
AN102	1.40E+01	8.46E+01	8.20E+01	1.39E+02
AN103			1.38E+02	8.98E+01
AN104			8.83E+01	7.74E+01
AN105			1.20E+02	1.39E+02
AN106			1.18E+02	7.31E+01
AN107	1.19E+01	6.38E+01	4.68E+01	1.07E+02
AP101			3.86E+01	3.42E+00
AP102	3.09E+01	5.51E+01	3.80E+01	5.16E+01
AP103			1.30E+00	2.87E+00
AP104			2.09E+01	5.58E-01
AP105	3.60E+01	6.23E+01	1.05E+02	4.52E+01
AP106			9.08E+01	1.30E+01
AP107			1.11E+02	
AP108			1.15E+00	2.32E+00
AW101	6.30E+01	1.09E+02	1.02E+02	9.31E+01
AW102				2.84E+01
AW103			1.22E+00	3.85E-01
AW104			5.09E-01	7.49E-01
AW105			6.46E-01	1.58E+01
AW106				2.89E+01
AY101			5.93E+01	3.08E+01
AY102	6.58E-01	1.04E+00	5.07E-01	2.00E+00
AZ101	5.51E+01	5.90E+01	1.04E+01	1.90E+01
AZ102	2.22E+01	2.96E+01	2.36E+00	8.81E+00
SY101			3.09E+01	1.35E+02
SY102			6.71E+00	6.44E-01
SY103			8.44E+01	1.06E+02

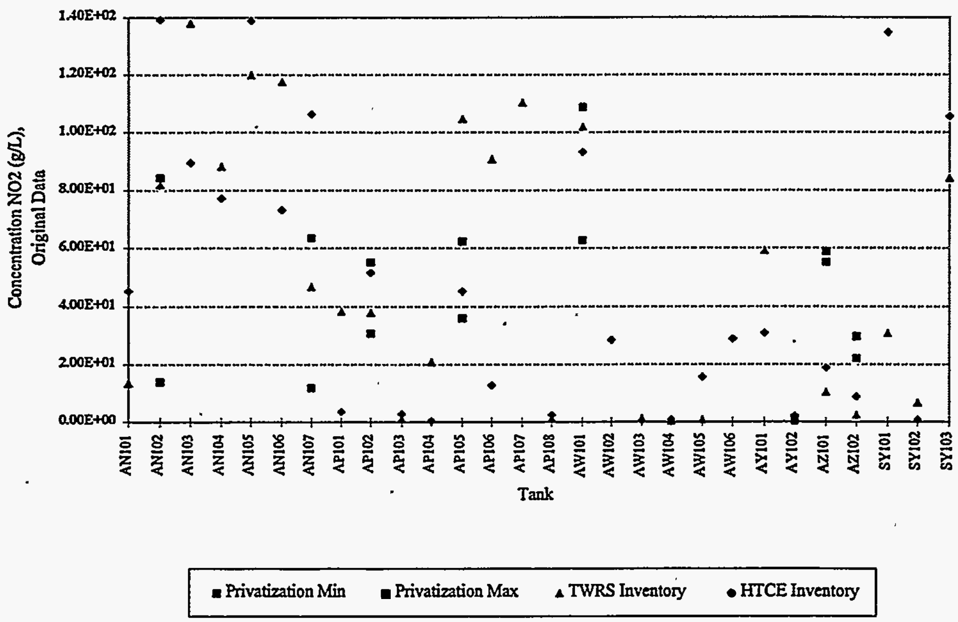

Figure D.44. Nitrite Concentration in Double-Shelled Tank Waste Supernatant

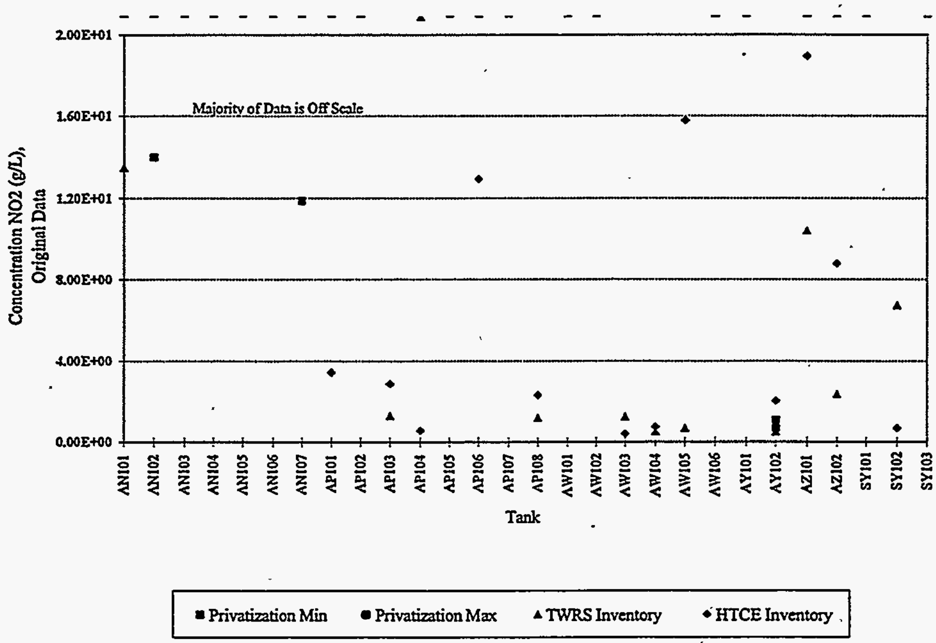

Figure D.43. Nitrite Concentration in Double-Shelled Tank Waste Supernatant

Table D.25. Nitrate (NO_3^-) Concentration in Double-Shelled Tank Waste Supernatant

Nitrate				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.59E+01	1.19E+02
AN102	4.10E+01	2.24E+02	2.17E+02	3.63E+02
AN103			1.60E+02	3.44E+02
AN104			1.92E+02	2.51E+02
AN105			1.93E+02	4.81E+02
AN106			2.84E+02	2.11E+02
AN107	8.48E+01	2.53E+02	2.25E+02	2.61E+02
AP101			1.32E+02	2.42E+01
AP102	5.37E+01	9.73E+01	7.82E+01	1.49E+02
AP103			4.04E+00	4.85E+01
AP104			4.23E+01	8.42E+00
AP105	1.25E+02	2.23E+02	2.53E+02	2.78E+02
AP106			1.91E+02	9.88E+01
AP107			2.76E+02	4.13E+00
AP108			4.28E+00	4.52E+01
AW101	1.56E+02	2.36E+02	2.14E+02	4.10E+02
AW102				1.65E+02
AW103			3.51E+00	1.98E+01
AW104			3.88E+00	1.44E+01
AW105			1.97E+01	9.98E+01
AW106				1.70E+02
AY101			6.43E+01	7.31E+01
AY102	3.67E-01	6.14E-01	7.36E-03	4.09E+01
AZ101	6.47E+01	6.83E+01	1.18E+01	1.99E+01
AZ102	1.91E+01	2.59E+01	1.38E+00	8.25E+00
SY101			3.59E+01	4.11E+02
SY102			1.37E+01	3.05E+01
SY103			1.11E+01	3.08E+02

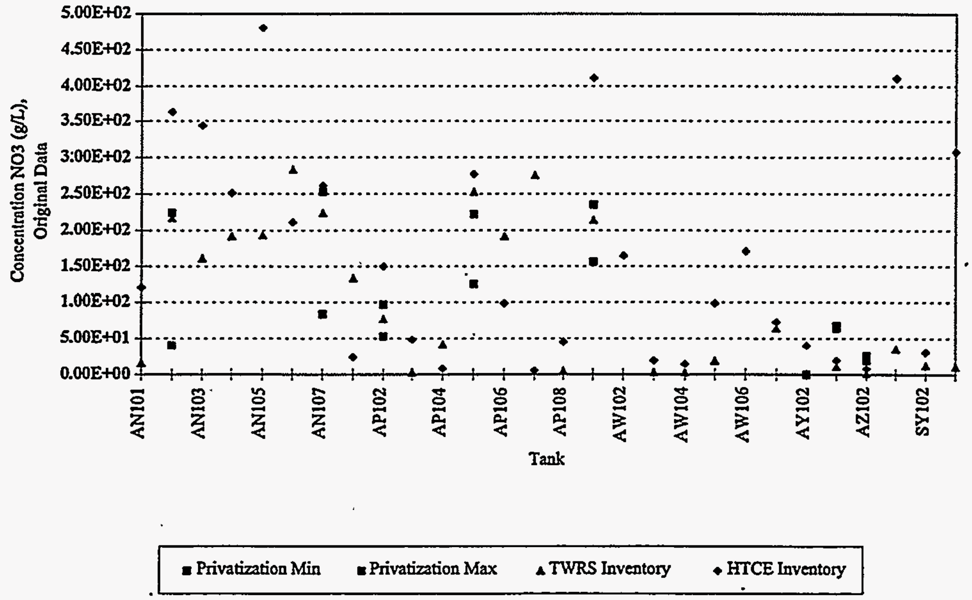

Figure D.45. Nitrate Concentration in Double-Shelled Tank Waste Supernatant

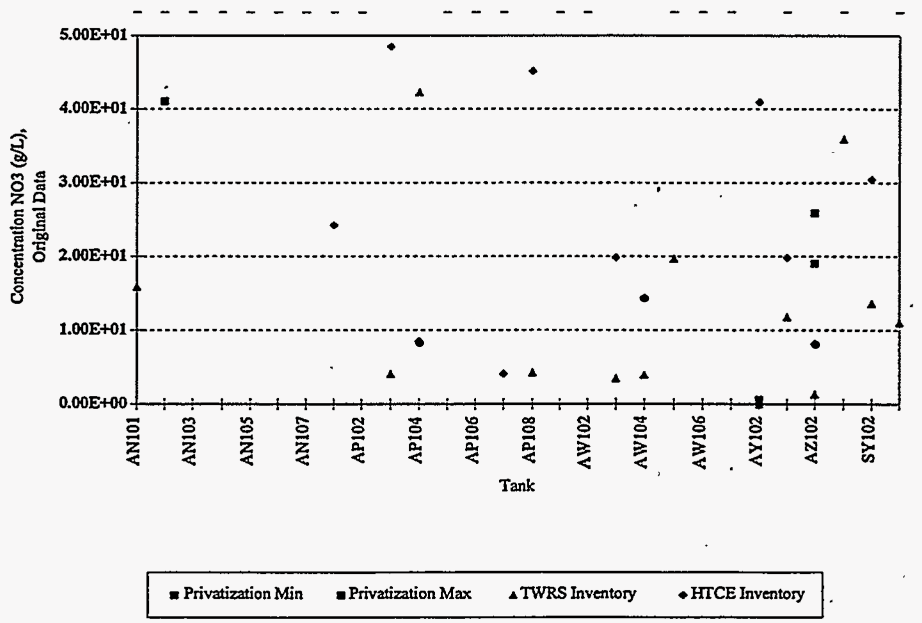

Figure D.46. Nitrate Concentrations in Double-Shelled Tank Waste Supernatant

Table D.26. Hydroxide (OH^-) Concentration in g/L

DST	Hydroxide: Privatization Inventory Min	Hydroxide: Privatization Inventory Max	Hydroxide: TWRS Inventory	Hydroxide: HTCE Inventory
AN101			2.78E+01	4.66E+01
AN102	8.04E+00	2.59E+01	1.05E+01	1.55E+02
AN103			9.76E+01	1.24E+02
AN104			6.95E+01	9.77E+01
AN105			6.19E+01	1.83E+02
AN106			1.01E+01	8.23E+01
AN107	8.93E-01	9.72E+00	1.70E+01	1.24E+02
AP101			3.93E+01	6.50E+00
AP102	7.91E+00	9.52E+00	9.15E+00	5.81E+01
AP103			1.69E+00	1.61E+01
AP104			1.43E+01	7.60E-01
AP105	5.31E+01	5.48E+01	8.94E+00	8.29E+01
AP106			5.91E+01	3.07E+01
AP107			1.42E+01	2.73E-01
AP108			1.56E+00	1.67E+01
AW101	5.66E+01	9.49E+01	8.63E+01	1.34E+02
AW102				4.91E+01
AW103			3.20E+00	1.55E+00
AW104			1.69E+00	3.12E-01
AW105			7.50E-01	2.78E+01
AW106				5.19E+01
AY101			9.69E+00	2.85E+01
AY102	<2.50E-01	3.19E-01	9.47E+00	1.54E+01
AZ101	1.12E+01	1.14E+01	3.00E+00	3.79E+01
AZ102	1.83E+00	1.99E+00	1.77E+00	2.03E+01
SY101			9.84E+01	1.46E+02
SY102			6.13E+00	3.76E+00
SY103			1.68E+01	1.14E+02

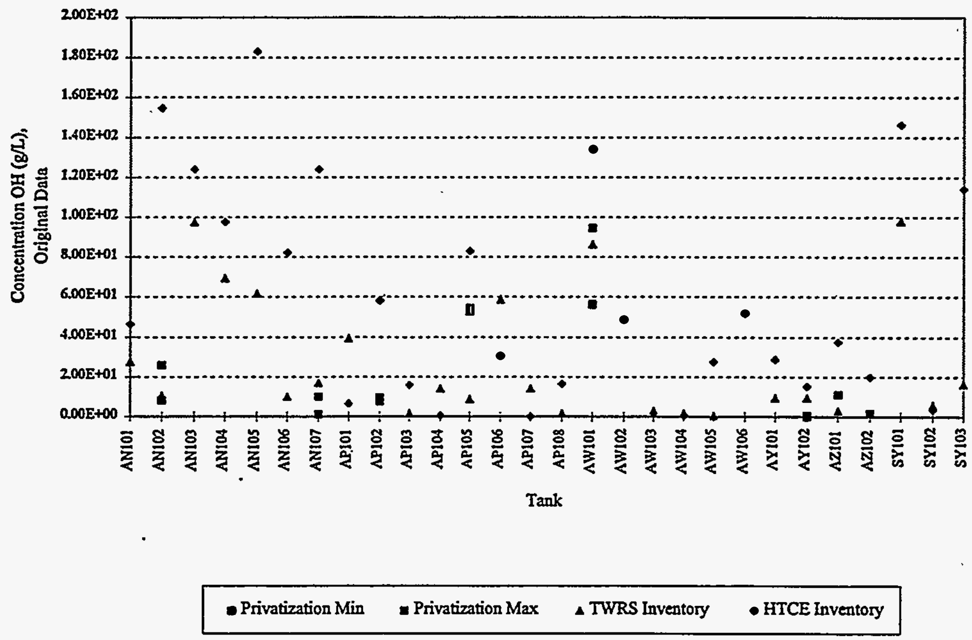

Figure D.47. Hydroxide Concentration in Double-Shelled Tank Waste Supernatant

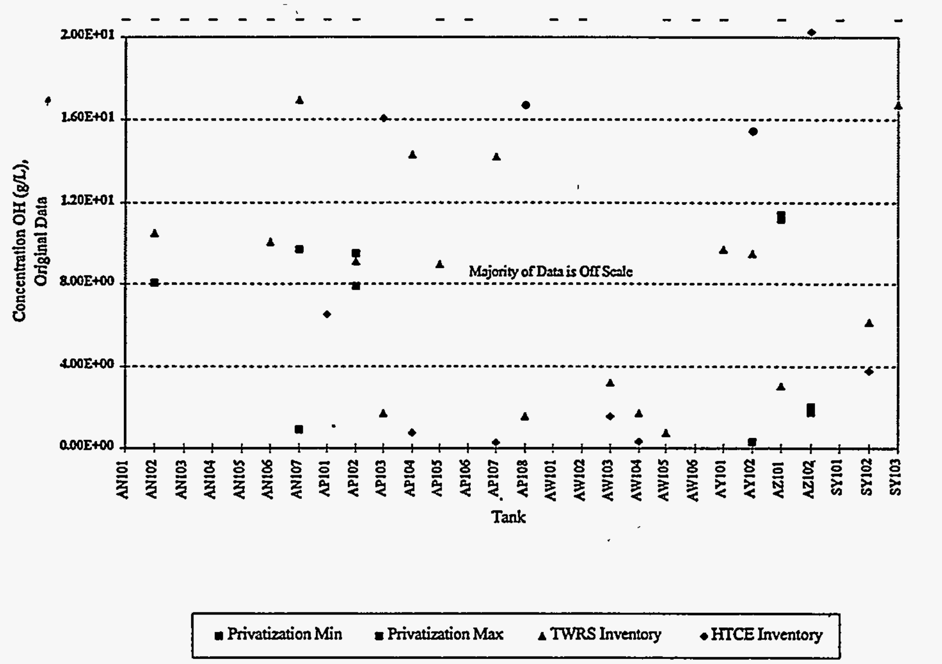

Figure D.48. Hydroxide Concentration in Double-Shelled Tank Waste Supernatant

Table D.27. Lead (Pb) Concentration in Double-Shelled Tank Waste Supernatant

Lead				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			2.40E-02	7.59E-02
AN102		2.69E-01		3.17E-01
AN103			7.20E-02	2.38E-01
AN104				1.95E-01
AN105				3.59E-01
AN106			6.26E-04	1.61E-01
AN107		4.61E-01	3.13E-01	3.05E-01
AP101			3.57E-03	8.95E-03
AP102		5.33E-03	3.29E-03	1.14E-01
AP103				2.05E-03
AP104			1.11E-12	
AP105		7.62E-03	1.23E-05	1.20E-01
AP106			5.42E-08	3.14E-02
AP107			3.35E-04	
AP108				1.09E-03
AW101		<3.03E-01	3.03E-01	2.62E-01
AW102				7.19E-02
AW103				5.67E-04
AW104			6.19E-07	8.37E-03
AW105				4.32E-02
AW106				7.14E-02
AY101				4.32E-02
AY102			5.36E-05	1.69E-04
AZ101		8.29E-02	5.20E-04	1.00E-02
AZ102		5.91E-03	1.32E-04	6.20E-04
SY101				2.63E-01
SY102				7.35E-05
SY103				2.12E-01

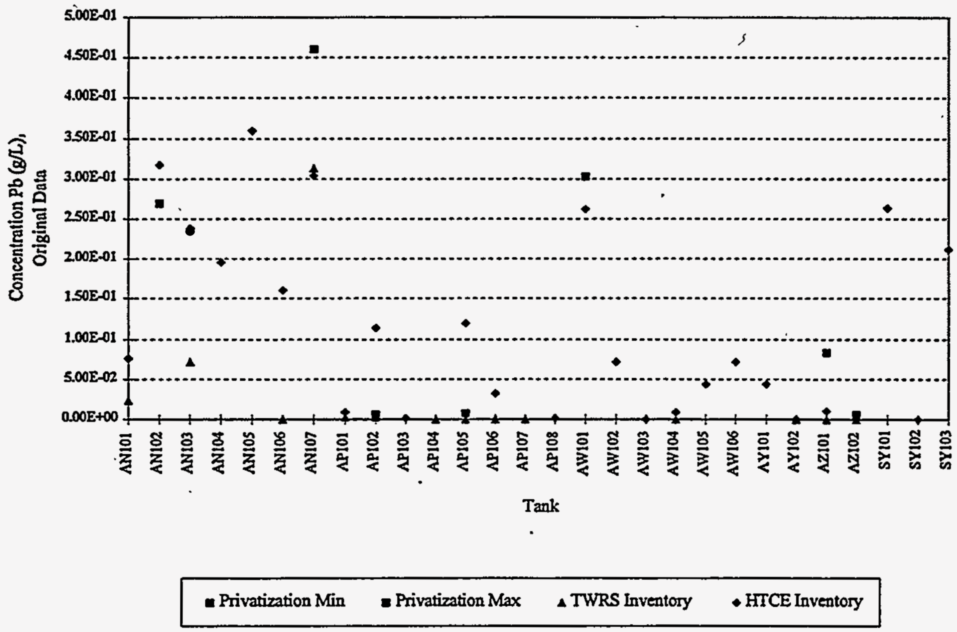

Figure D.49. Lead Concentration in Double-Shelled Tank Waste Supernatant

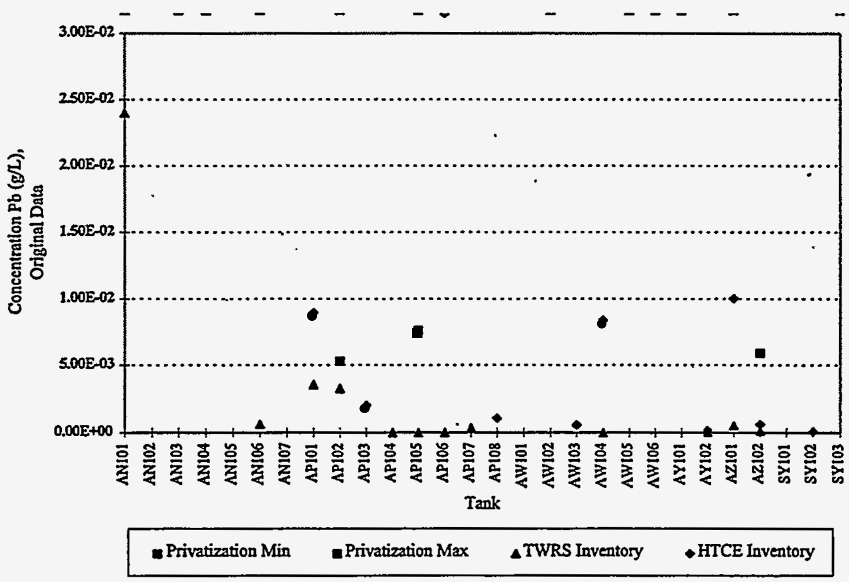

Figure D.50. Lead Concentration in Double-Shelled Tank Waste Supernatant

Table D.28. Phosphate (PO_4^{-3}) Concentration in Double-Shelled Tank Waste Supernatant

Phosphate				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.16E+01	3.70E+00
AN102	3.20E+00	5.22E+00	4.84E+00	1.18E+01
AN103			9.28E-01	1.55E+01
AN104			2.79E+00	1.10E+01
AN105			1.90E+00	1.76E+01
AN106			7.43E+00	1.71E+01
AN107	1.97E+00	6.35E+00	5.03E-01	9.31E+00
AP101			8.31E-01	1.14E+00
AP102	8.09E+00	1.37E+01	1.16E+01	1.28E+01
AP103			1.39E-01	5.63E-01
AP104			1.51E+00	1.23E+01
AP105	2.16E-01	6.76E-01	6.59E+00	1.66E+01
AP106			4.80E+00	4.59E+00
AP107			6.88E+00	0.00E+00
AP108			2.10E-01	9.58E-01
AW101	1.21E+00	1.04E+01	2.11E+00	2.28E+01
AW102				1.04E+01
AW103			5.80E-02	2.49E-01
AW104			2.47E-01	6.07E+00
AW105			2.29E-01	6.03E+00
AW106				1.01E+01
AY101			9.86E-01	1.65E+00
AY102	5.57E-02	7.08E-02	2.63E-02	3.82E-01
AZ101	1.22E+00	1.37E+00	1.97E-01	4.23E-01
AZ102	1.47E-01	1.47E-01	3.02E-03	1.30E-01
SY101			5.44E+00	1.15E+01
SY102			1.06E+00	7.43E-03
SY103			9.07E+00	8.63E+00

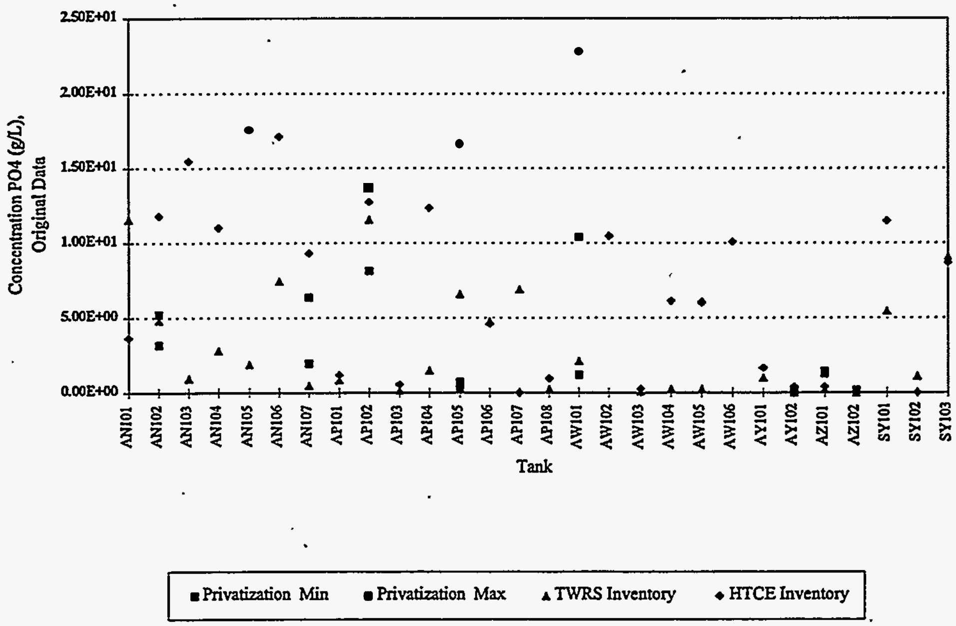

Figure D.51. Phosphate Concentration in Double-Shelled Tank Waste Supernatant

Table D.29. Antimony (Sb) Concentration in g/L

Antimony				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			3.96E-04	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102		9.47E-03		
AP103				
AP104				
AP105		6.76E-03		
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101			1.13E-03	
AZ102		<1.03E-02		
SY101				
SY102				
SY103				

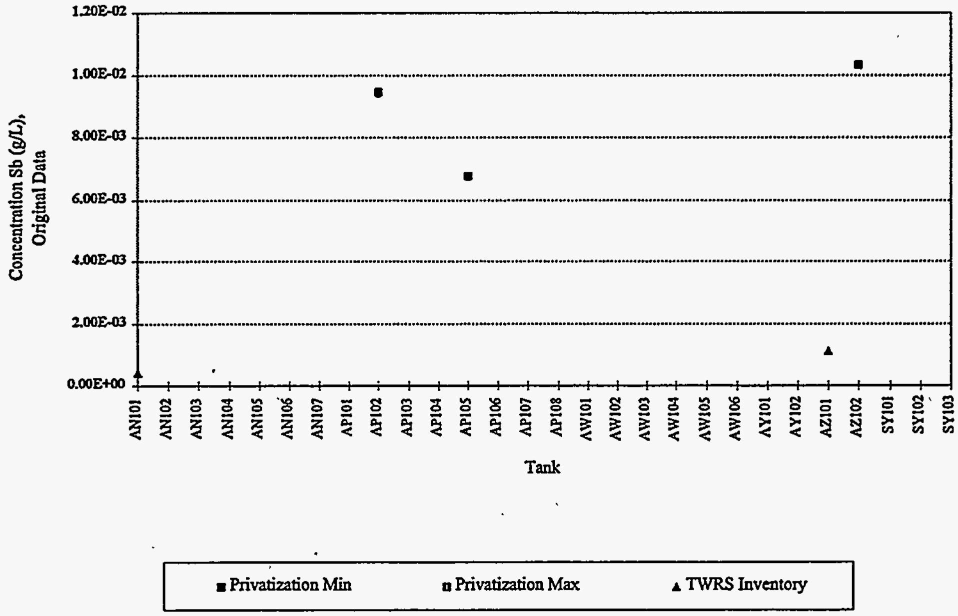

Figure D.52. Antimony Concentration in Double-Shelled Tank Waste Supernatant

Table D.30. Selenium (Se) Concentration in g/L

Selenium				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			1.62E-03	
AN102				
AN103				
AN104				
AN105				
AN106			3.77E-07	
AN107				
AP101			9.05E-05	
AP102		6.79E-04	3.67E-07	
AP103				
AP104				
AP105		1.95E-04	3.21E-07	
AP106				
AP107			8.47E-06	
AP108				
AW101			3.31E-05	
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		2.84E-01	2.12E-03	
AZ102		1.08E-02	3.12E-04	
SY101				
SY102				
SY103				

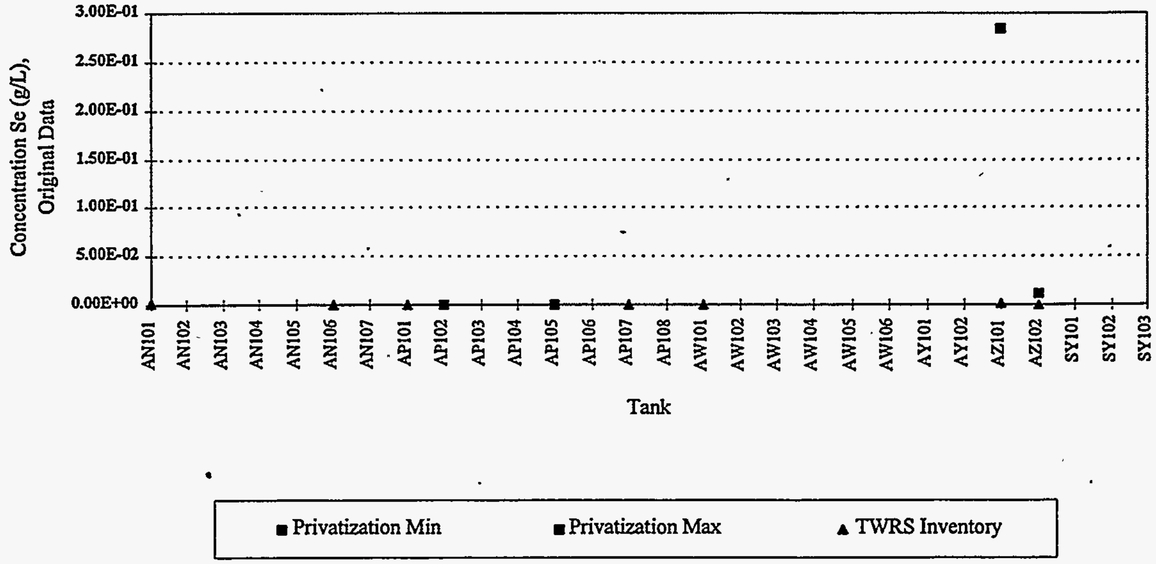

Figure D.53. Selenium Concentration in Double-Shelled Tank Waste Supernatant

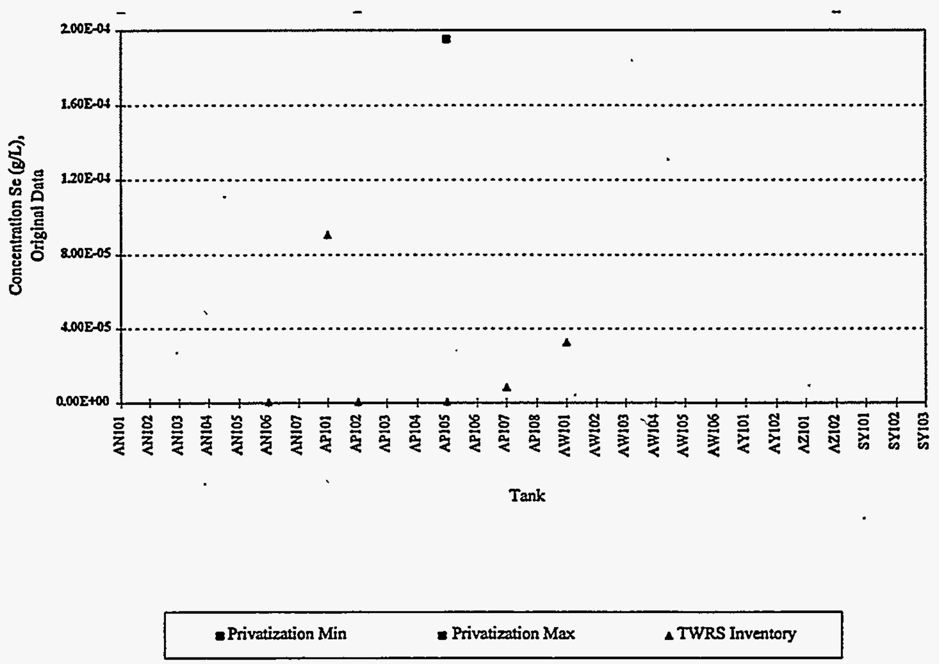

Figure D.54. Selenium Concentration in Double-Shelled Tank Waste Supernatant

Table D.31. Sulfate (SO_4^{-2}) Concentration in g/L

Sulfate				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			4.77E+00	8.52E+00
AN102	1.88E+00	1.54E+01	1.41E+01	3.44E+01
AN103			1.60E+00	2.32E+01
AN104			6.55E+00	2.00E+01
AN105			6.55E+00	3.64E+01
AN106			1.14E+01	1.74E+01
AN107	5.04E+00	1.25E+01	1.30E+01	2.76E+01
AP101			4.10E+00	1.06E+00
AP102	3.54E+00	5.17E+00	4.51E+00	1.23E+01
AP103			3.50E-01	1.97E+00
AP104			1.56E+00	3.33E-01
AP105	1.13E+00	4.88E+00	1.02E+01	1.40E+01
AP106			6.64E+00	4.66E+00
AP107			1.20E+01	
AP108			1.49E-01	1.98E+00
AW101	7.10E-01	2.26E+00	1.03E+00	2.52E+01
AW102				8.47E+00
AW103			5.63E-02	3.39E-02
AW104			2.53E-02	3.68E-01
AW105			2.34E-01	4.74E+00
AW106				8.63E+00
AY101			2.21E+01	9.25E+00
AY102	1.51E-01	1.69E-01	2.58E-03	1.77E+00
AZ101	1.51E+01	1.60E+01	2.08E+00	1.04E+01
AZ102	1.38E+01	1.88E+01	9.77E-01	5.54E+00
SY101			3.45E+00	3.09E+01
SY102			6.18E-01	2.86E-01
SY103			3.80E+00	2.38E+01

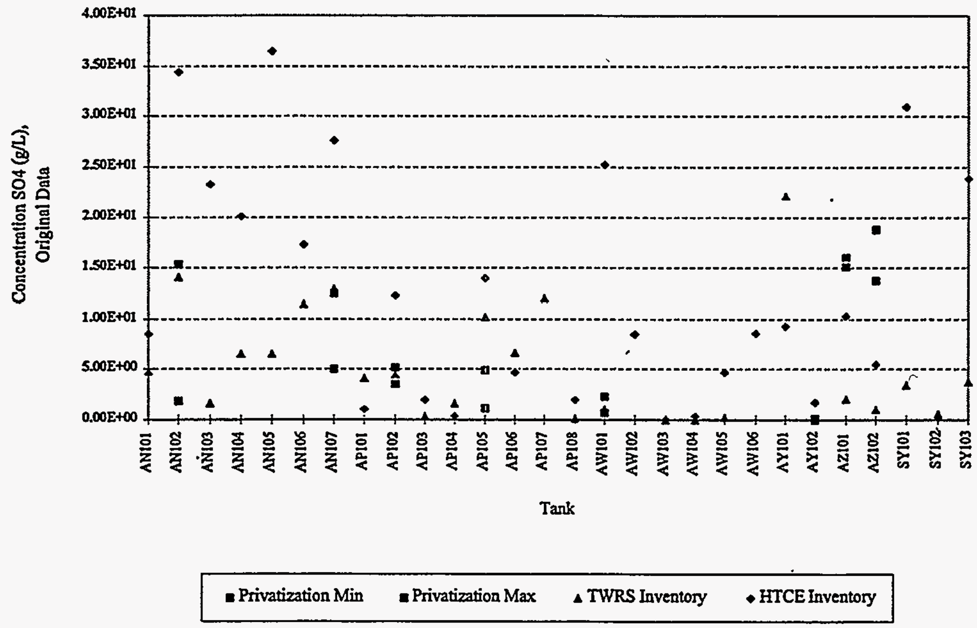

Figure D.55. Sulfate Concentration in Double-Shelled Tank Waste Supernatant

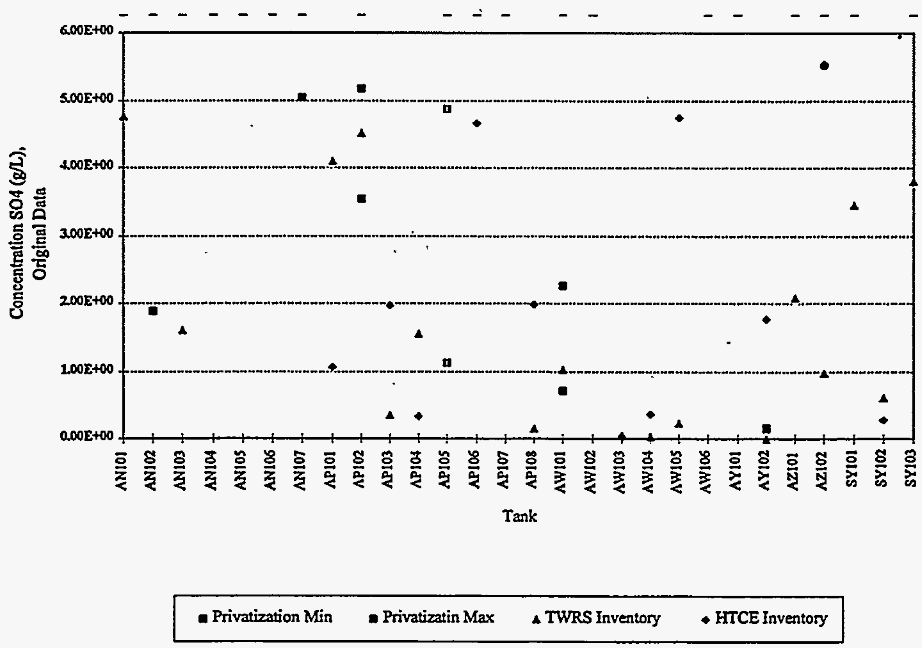

Figure D.56. Sulfate Concentration in Double-Shelled Tank Waste Supernatant

Table D.32. Total Strontium (Sr-tot) Concentration in g/L

	Total Strontium			
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101				
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101				
AZ102	2.00E-04	2.00E-04		
SY101				
SY102				
SY103				

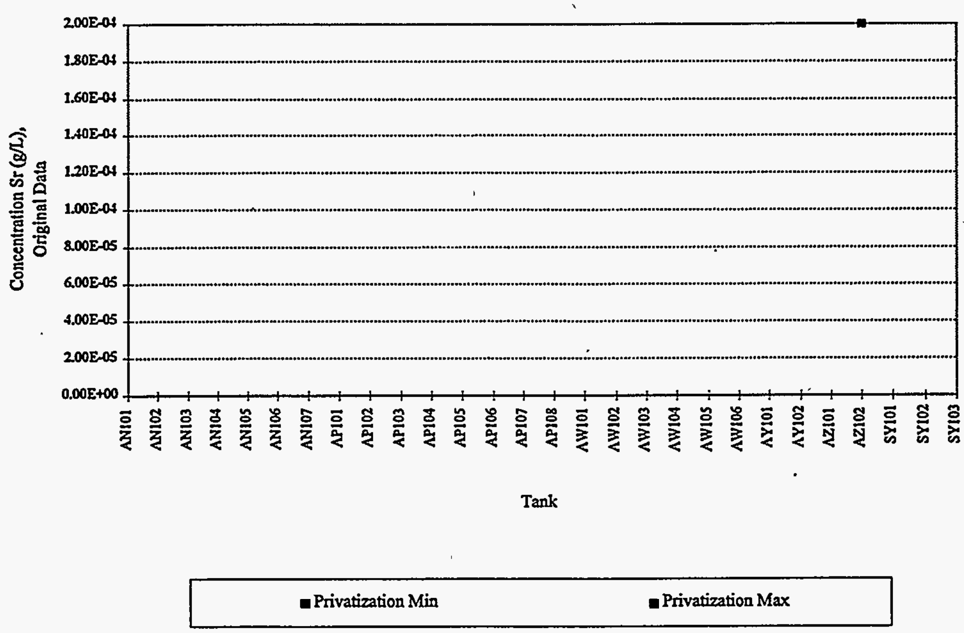

Figure D.57. Total Strontium Concentration in Double-Shelled Tank Waste Supernatant

Table D.33. Tellurium (Te) Concentration in g/L

Tellurium				
	Privatization Inventory		TWRS Inventory	HTCE Inventory
DST	Min	Max		
AN101			1.02E-03	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		2.69E-03	2.27E-03	
AZ102		2.62E-03	7.94E-05	
SY101				
SY102				
SY103				

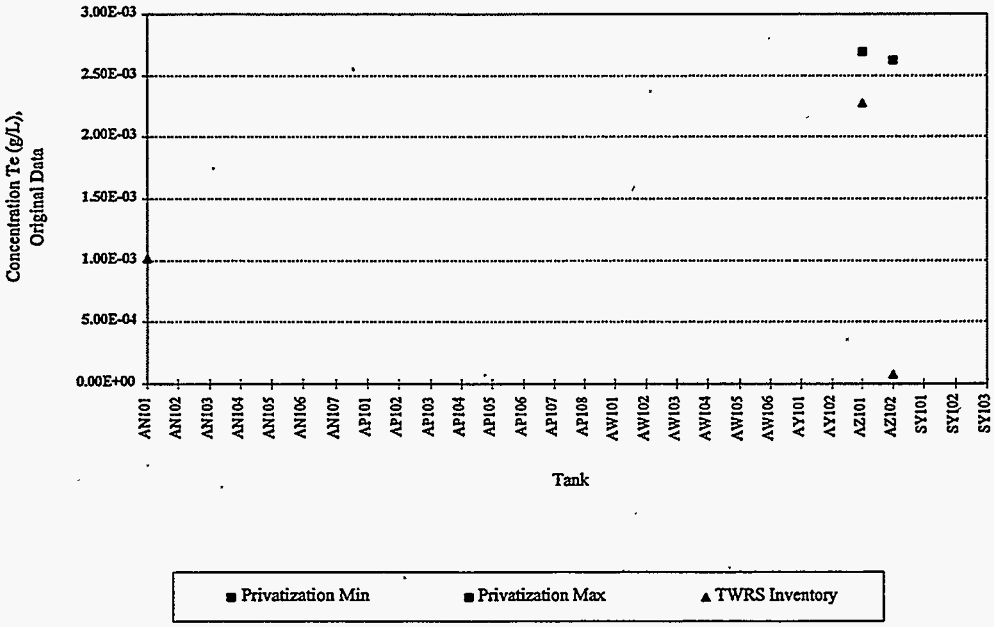

Figure D.58. Tellurium Concentration in Double-Shelled Tank Waste Supernatant

Table D.34. Total Inorganic Carbon (TIC) Concentration in g/L

Total Inorganic Carbon				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			1.92E+00	1.76E+00
AN102	1.01E+01	1.75E+01	1.32E+01	8.35E+00
AN103			1.79E+00	8.09E+00
AN104			5.67E+00	6.07E+00
AN105			4.36E+00	1.09E+01
AN106			1.18E+01	4.05E+00
AN107	1.22E+01	1.72E+01	1.42E+01	6.51E+00
AP101			4.02E+00	5.71E-01
AP102	4.36E+00	5.96E+00	5.36E+00	2.86E+00
AP103			5.14E-01	1.28E+00
AP104			1.49E+00	2.04E-02
AP105	3.48E+00	6.18E+00	1.05E+01	7.80E+00
AP106			6.49E+00	2.79E+00
AP107			1.17E+01	5.90E-03
AP108			5.15E-01	1.45E+00
AW101	1.90E+00	4.62E+00	2.46E+00	1.05E+01
AW102				4.62E+00
AW103			9.22E-01	1.39E-01
AW104			9.66E-02	1.23E+00
AW105			4.29E-03	2.66E+00
AW106				4.74E+00
AY101			7.87E+00	2.26E+00
AY102	4.80E-01	5.01E-01	1.24E-03	1.26E+00
AZ101	5.66E+00	5.99E+00	8.54E-01	3.61E-01
AZ102	5.37E+00	6.60E+00	3.27E-01	1.65E-01
SY101				7.17E+00
SY102			5.23E-01	3.58E-01
SY103			4.24E+00	5.45E+00

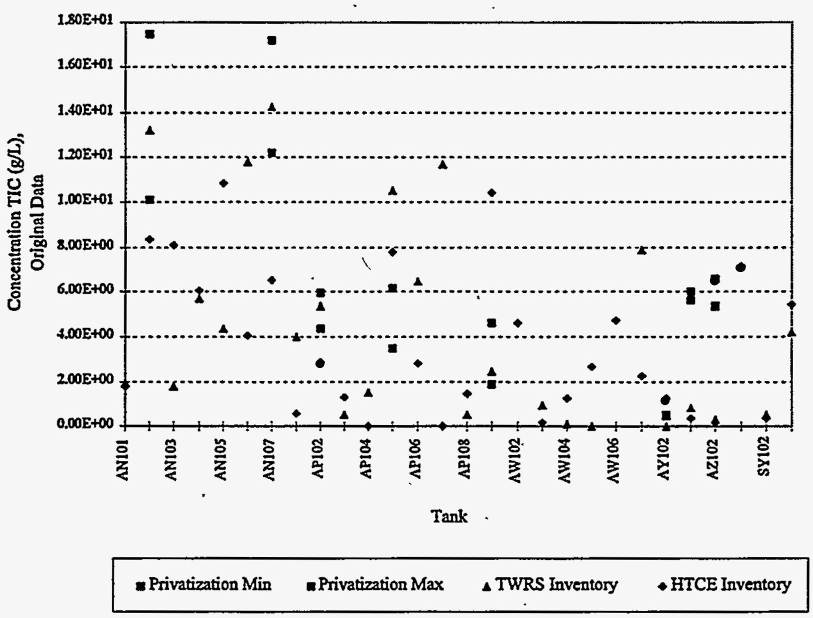

Figure D.59. Total Inorganic Carbon Concentration in Double-Shelled Tank Waste Supernatant

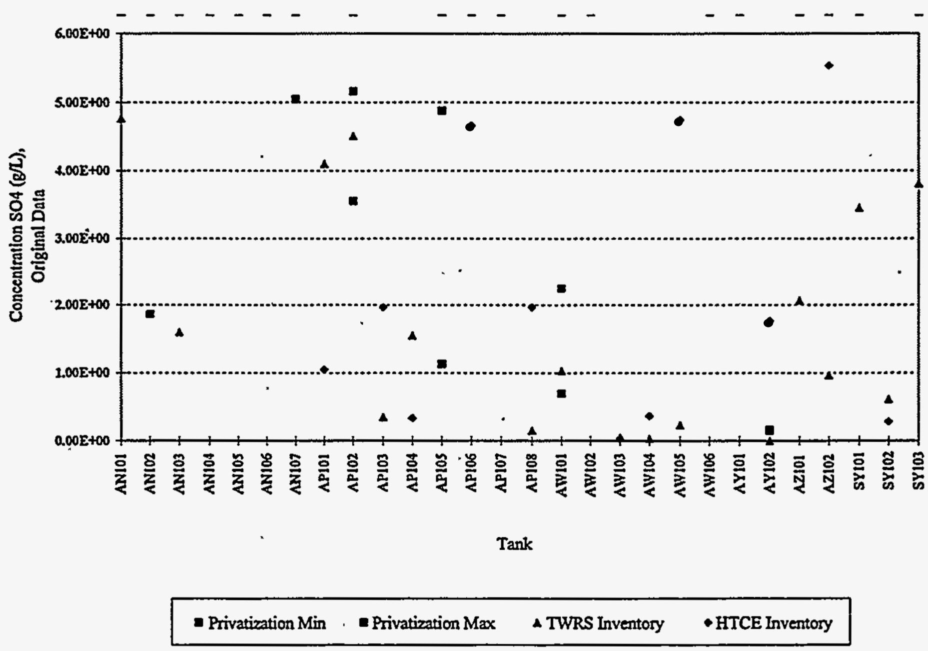

Figure D.60. Total Inorganic Carbon Concentration in Double-Shelled Tank Waste Supernatant

Table D.35. Thallium (Tl) Concentration in g/L

Thallium				
DST	Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			8.11E-03	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101			2.27E-02	
AZ102		3.80E-02	5.47E-05	
SY101				
SY102				
SY103				

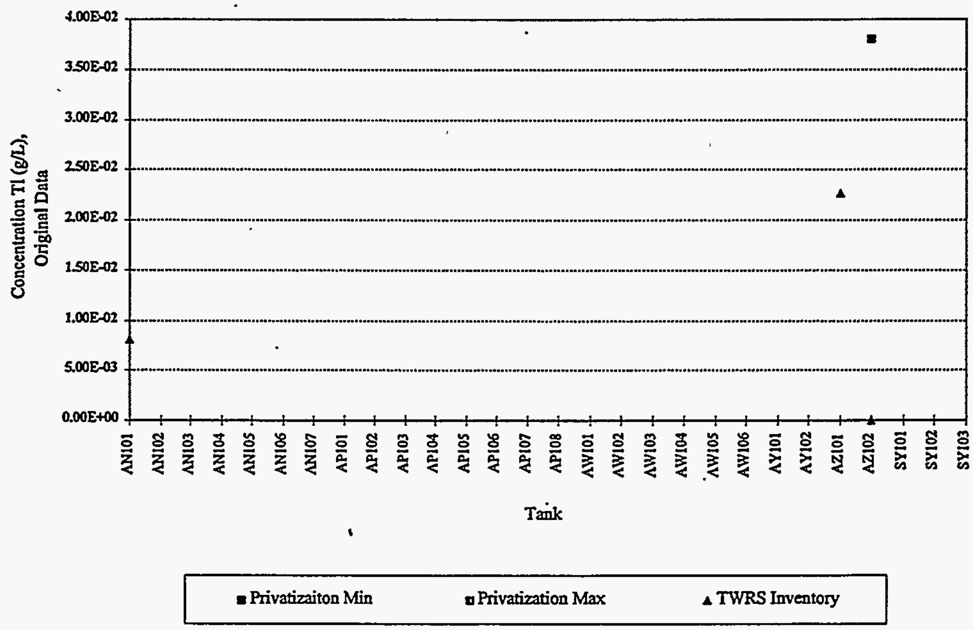

Figure D.61. Thallium Concentration in Double-Shelled Tank Waste Supernatant

Table D.36. Total Organic Carbon Concentration in g/L

Total Organic Carbon				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			2.14E+00	3.42E+00
AN102	2.73E+01	3.25E+01	2.58E+01	2.60E+01
AN103			7.36E+00	1.67E+01
AN104			4.61E+00	1.57E+01
AN105			3.88E+00	2.54E+01
AN106			5.37E+01	1.19E+01
AN107	1.67E+01	4.67E+01	4.07E+01	2.29E+01
AP101			4.45E+00	9.21E-01
AP102	3.00E+00	5.57E+00	3.28E+00	8.41E+00
AP103			1.12E-01	2.06E+00
AP104			1.50E+00	0.00E+00
AP105	1.85E+00	3.24E+00	4.79E+01	1.23E+01
AP106			5.45E+00	4.49E+00
AP107			4.95E+01	
AP108			4.99E-01	2.45E+00
AW101	2.39E+00	5.48E+00	2.46E+00	1.91E+01
AW102				7.19E+00
AW103			9.35E-01	3.12E-02
AW104			4.03E-01	4.59E-01
AW105			2.39E-01	4.05E+00
AW106				7.39E+00
AY101			1.77E+00	1.41E+01
AY102	7.68E-02	8.87E-02	3.93E-03	2.28E+00
AZ101	9.38E-01	1.09E+00	1.38E-01	8.69E-01
AZ102	1.40E+00	1.58E+00	9.55E-02	1.98E-01
SY101			1.28E+01	1.93E+01
SY102			9.31E-01	5.92E-03
SY103			1.59E+00	1.51E+01

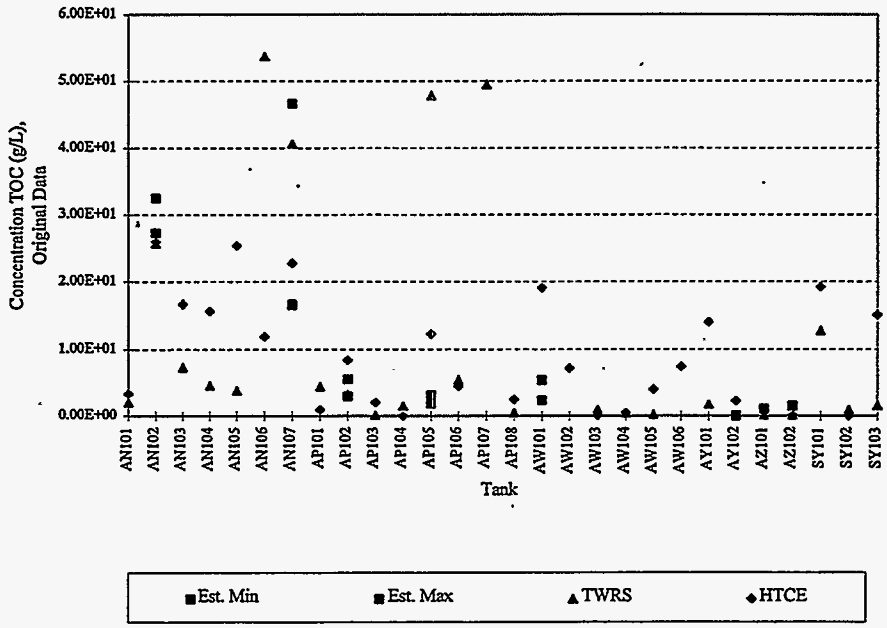

Figure D.62. Total Organic Carbon Concentration in Double-Shelled Tank Waste Supernatant

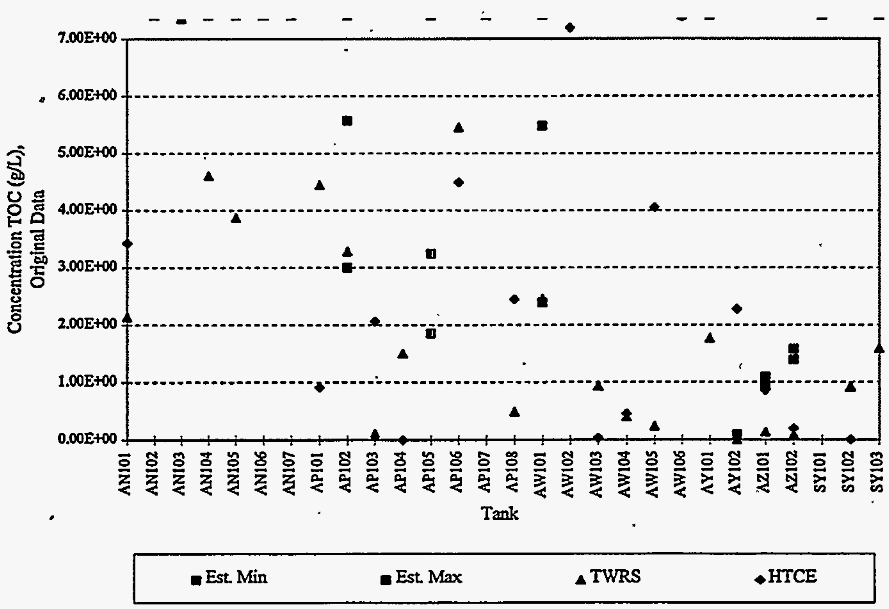

Figure D.63. Total Organic Carbon Concentration in Double-Shelled Tank Waste Supernatant

Table D.37. Uranium (U) Concentration in Double-Shelled Tank Waste Supernatant

Uranium				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			2.87E-01	1.09E+00
AN102		2.47E-02		3.32E+00
AN103			5.18E-04	3.15E+00
AN104				2.25E+00
AN105				3.86E+00
AN106			2.13E-04	1.84E+00
AN107		1.72E-01	2.13E-01	2.21E+00
AP101			3.49E-02	1.99E-01
AP102		7.09E-03	3.52E-03	1.29E+00
AP103			3.69E-03	3.64E-01
AP104			2.06E-03	
AP105		4.86E-02	3.17E-04	2.72E+00
AP106			6.31E-03	9.18E-01
AP107			8.40E-03	
AP108			3.85E-03	4.11E-01
AW101			2.24E-01	3.83E+00
AW102				1.62E+00
AW103			9.87E-03	5.95E-01
AW104			2.17E-02	1.02E-01
AW105			1.99E-02	1.13E+00
AW106				1.65E+00
AY101			9.46E-01	8.22E-01
AY102			1.25E-05	3.74E-01
AZ101		7.14E-03	4.47E-03	7.91E-01
AZ102		1.60E+00	9.89E-02	4.23E-01
SY101				3.80E+00
SY102			2.90E-03	8.82E-04
SY103			3.60E-01	2.82E+00

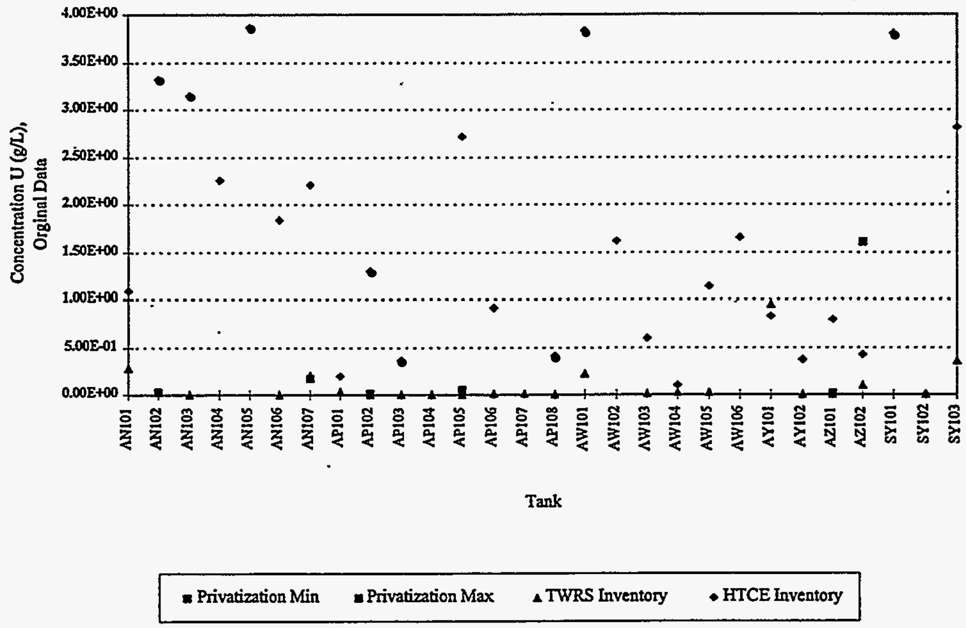

Figure D.64. Uranium Concentration in Double-Shelled Tank Waste Supernatant

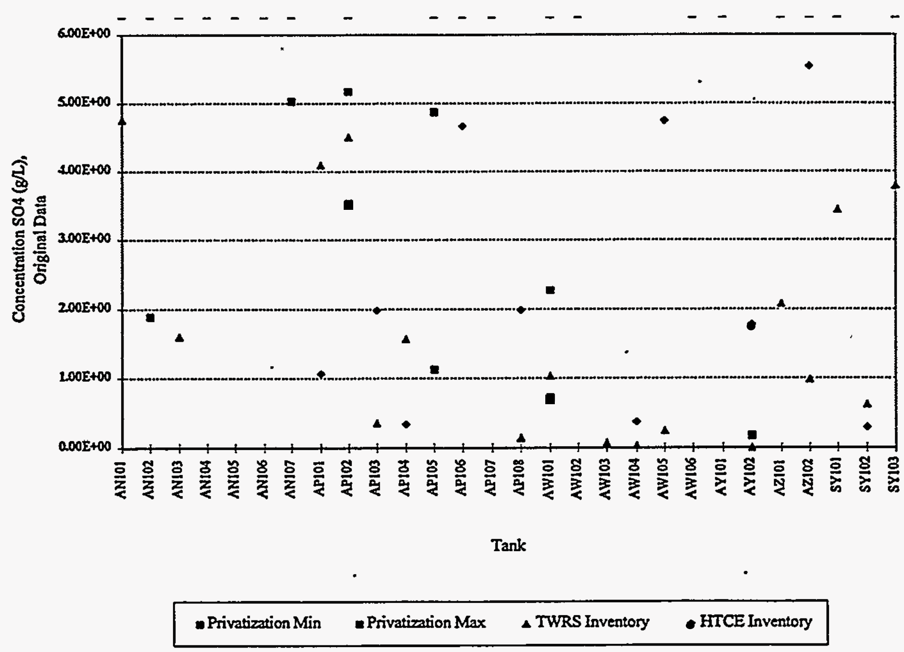

Figure D.65. Uranium Concentration in Double-Shelled Tank Waste Supernatant

Table D.38. Vanadium (V) Concentration in g/L

Vanadium				
	Privatization Inventory		TWRS	HTCE
DST	Min	Max	Inventory	Inventory
AN101			9.39E-05	
AN102				
AN103				
AN104				
AN105				
AN106				
AN107				
AP101				
AP102				
AP103				
AP104				
AP105				
AP106				
AP107				
AP108				
AW101				
AW102				
AW103				
AW104				
AW105				
AW106				
AY101				
AY102				
AZ101		8.84E-04	7.84E-05	
AZ102		2.03E-03	2.35E-05	
SY101				
SY102				
SY103				

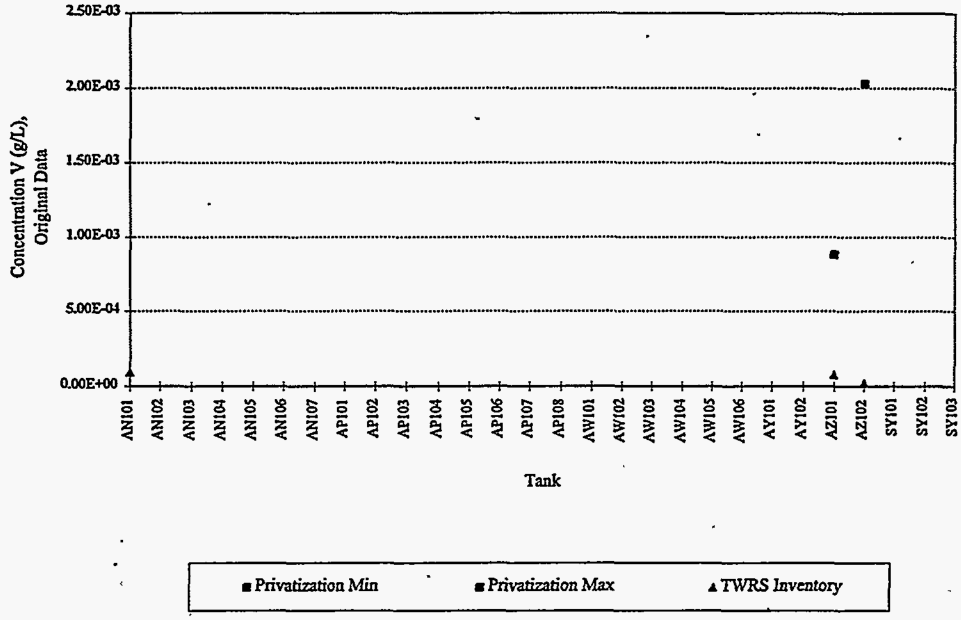

Figure D.66. Vanadium Concentration in Double-Shelled Tank Waste Supernatant

Table D.39. ^{241}Am Concentration in g/L

^{241}Am				
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Iventory
AN101			5.88E+06	
AN102	3.28E+06	9.77E+06	2.27E+06	
AN103			8.60E+04	
AN104			5.67E+04	
AN105			5.66E+04	
AN106			3.06E+01	
AN107	4.04E+06	3.19E+07	2.22E+07	
AP101			2.61E+05	
AP102	7.79E+03	3.63E+04	1.57E+04	
AP103				
AP104			4.24E-01	
AP105	9.76E+03	2.23E+04	1.22E+04	
AP106			3.79E+00	
AP107			3.22E+05	
AP108			3.50E-06	
AW101	3.45E+04	5.40E+04	4.49E+04	
AW102				
AW103				
AW104			5.36E+00	
AW105				
AW106				
AY101			7.55E+05	
AY102	<2.54E+03	7.13E+04	3.50E+01	
AZ101	5.86E+02	4.87E+05	1.67E+07	
AZ102			3.35E+03	
SY101			4.07E+05	
SY102			6.36E-01	
SY103			6.95E+05	

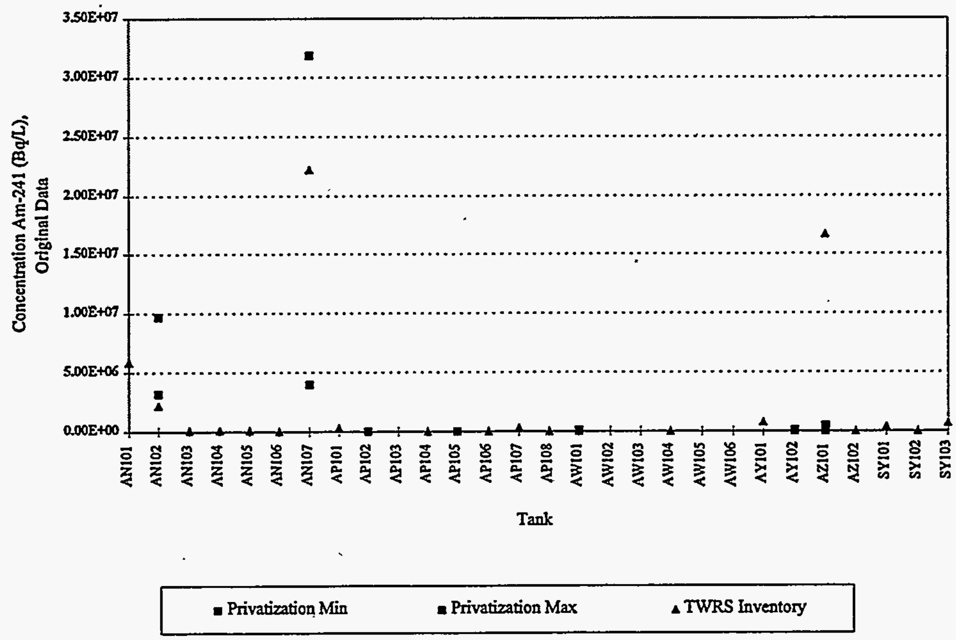

Figure D.67. ^{241}Am Concentration in Double-Shelled Tank Waste Supernatant

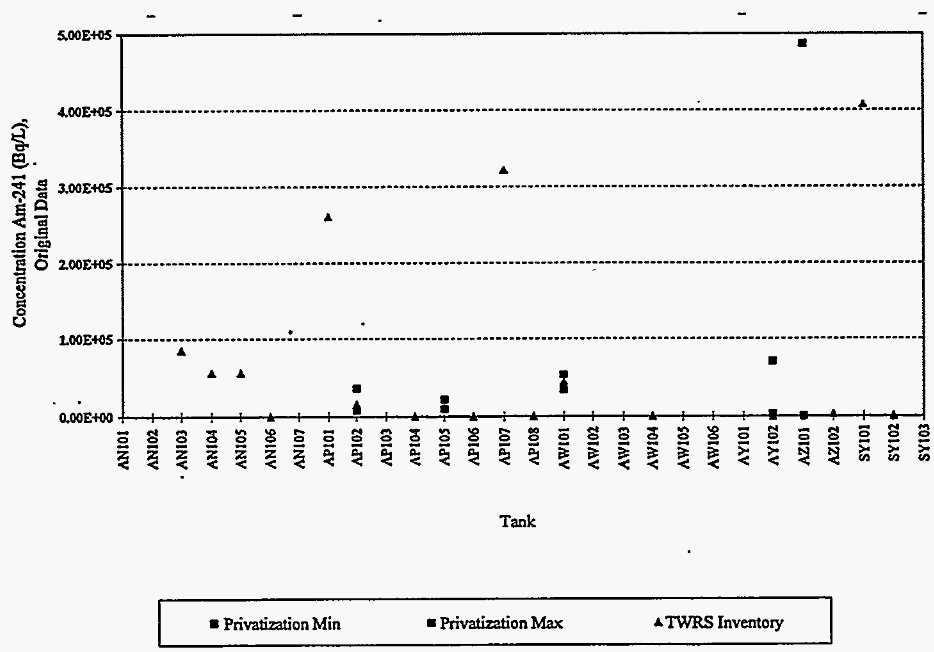

Figure D.68. ^{241}Am Concentration in Double-Shelled Tank Waste Supermatant

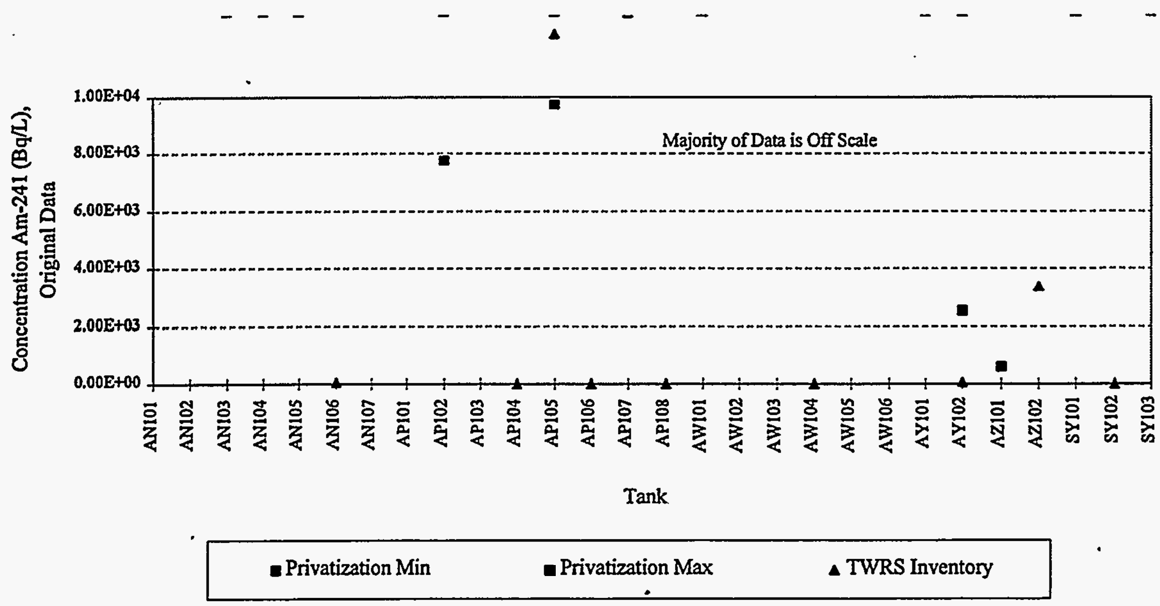

Figure D.69. ^{241}Am Concentration in Double-Shelled Tank Waste Supernatant

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Table D.40. ^{137}Cs Concentration in g/L

^{137}Cs				
	Privatization Inventory			
DST	Min	Max	TWRS Iventory	HTCE Inventory
AN101			1.14E+10	3.71E+09
AN102	9.08E+09	1.42E+10	6.97E+09	1.23E+10
AN103			1.86E+10	8.89E+09
AN104			2.04E+10	7.56E+09
AN105			1.36E+10	1.33E+10
AN106			6.78E+06	6.81E+09
AN107	7.22E+09	1.33E+10	6.74E+09	9.61E+09
AP101			4.17E+09	4.05E+08
AP102	7.23E+09	8.62E+09	6.09E+09	4.80E+09
AP103			1.69E+08	2.30E+09
AP104			1.26E+02	
AP105	7.07E+09	9.70E+09	5.21E+07	5.61E+09
AP106			2.57E+06	1.69E+09
AP107			1.39E+09	
AP108			6.26E+07	1.36E+09
AW101	1.12E+10	1.71E+10	1.22E+10	1.02E+10
AW102				3.54E+09
AW103			5.63E+08	1.11E+08
AW104			1.27E+05	1.02E+09
AW105			2.94E+07	2.04E+09
AW106				3.52E+09
AY101			4.03E+10	2.09E+09
AY102	1.18E+08	1.29E+08	4.23E+06	6.06E+08
AZ101	5.86E+10	5.88E+10	1.02E+10	7.01E+10
AZ102	3.81E+10	3.92E+10	2.28E+09	4.03E+10
SY101			4.95E+09	1.19E+10
SY102			4.18E+00	2.95E+06
SY103			6.98E+09	9.33E+09

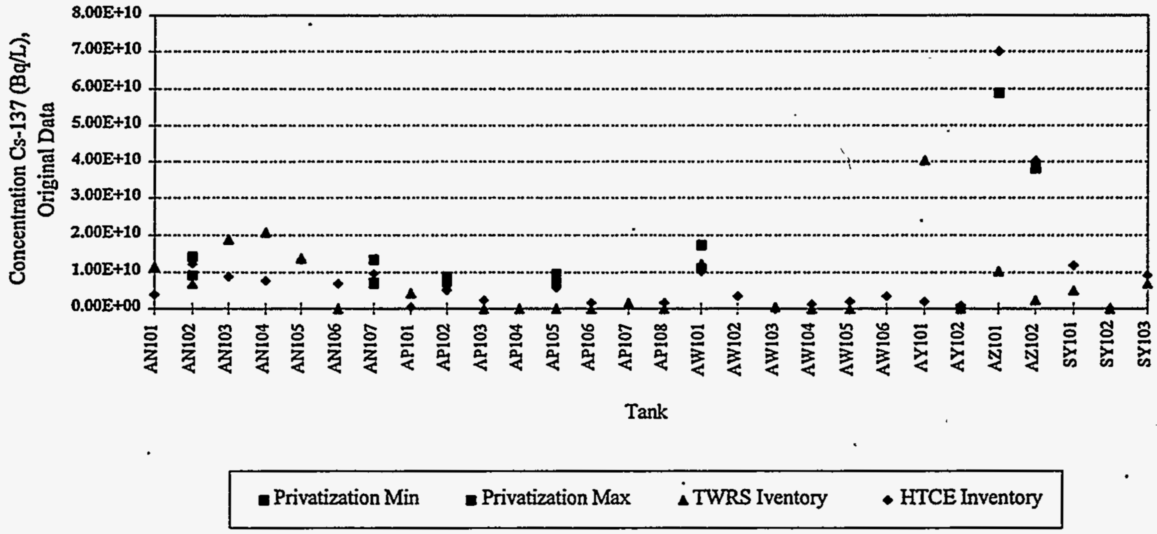

Figure D.70. ^{137}Cs Concentration in Double-Shelled Tank Waste Supernatant

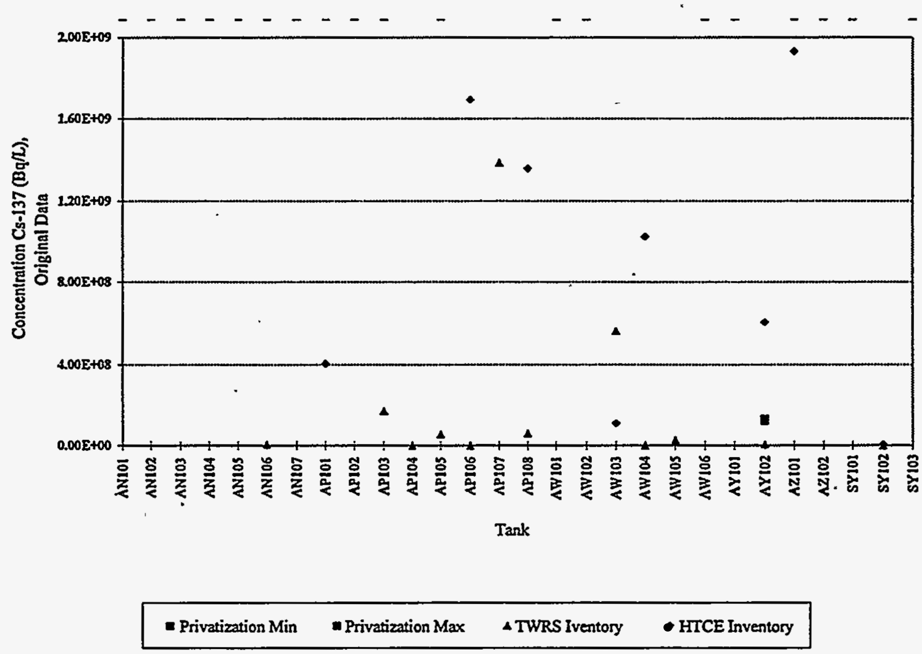

Figure D.71. ^{137}Cs Concentration in Double-Shelled Tank Waste Supernatant

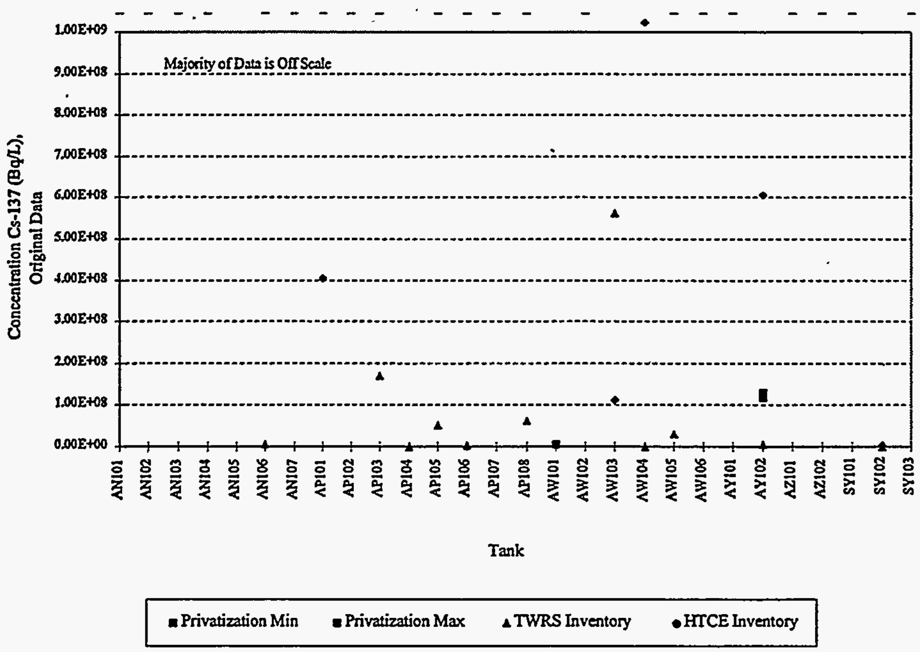

Figure D.72. ^{137}Cs Concentration in Double-Shelled Tank Waste Supernatant

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Table D.41. ^{237}Np Concentration in g/L

^{237}Np				
DST	Privatization Inventory		TWRS Inventory	HTCE Inventory
	Min	Max		
AN101			5.33E+04	
AN102				
AN103			7.48E+02	
AN104				
AN105				
AN106				
AN107	<1.85E+04	3.33E+04		
AP101				
AP102	<8.07E+03	3.70E+04		
AP103				
AP104			4.97E-03	
AP105		<1.60E+04		
AP106			8.92E+01	
AP107				
AP108			1.53E-02	
AW101		<1.13E+02		
AW102				
AW103				
AW104				
AW105				
AW106				
AY101			2.91E+03	
AY102				
AZ101		<2.62E+03	1.85E+04	
AZ102			1.66E+04	
SY101				
SY102			1.17E-04	
SY103				

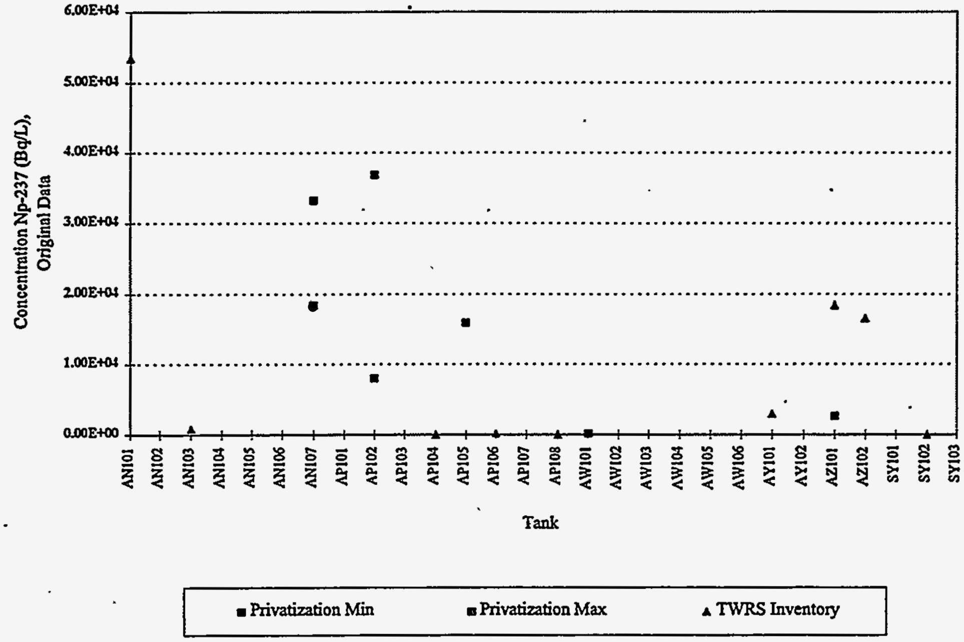

Figure D.73. ^{237}Np Concentration in Double-Shelled Tank Waste Supernatant

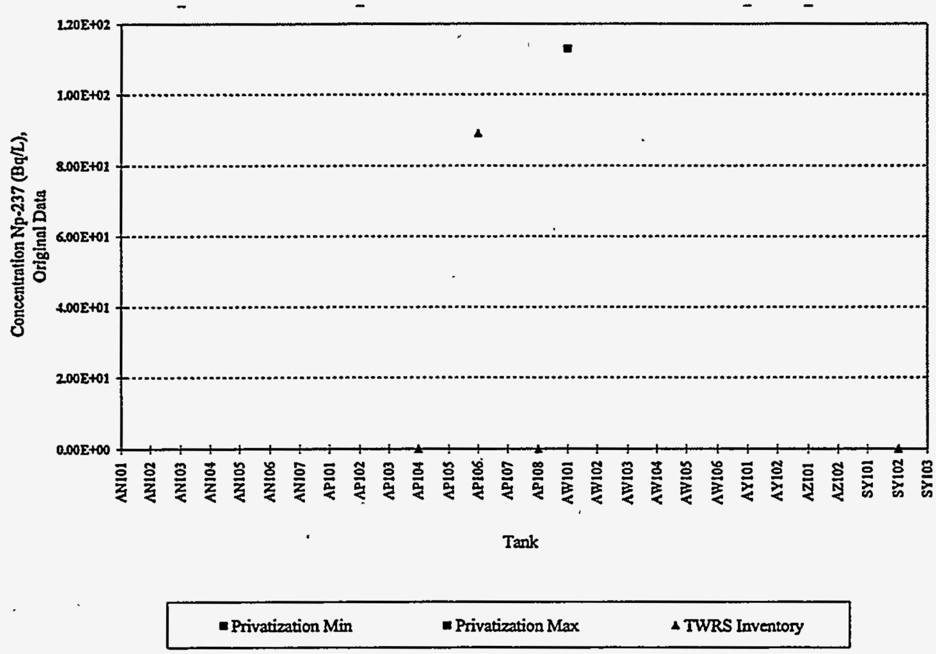

Figure D.74. ^{237}Np Concentration in Double-Shelled Tank Waste Supernatant

Table D.42. ^{238}Pu Concentration in g/L

^{238}Pu				
	Privatization Inventory			
DST	**Min**	**Max**	**TWRS Inventory**	**HTCE Inventory**
AN101				1.04E+06
AN102				3.67E+06
AN103				3.74E+06
AN104				2.61E+06
AN105				4.52E+06
AN106				1.98E+06
AN107				2.53E+06
AP101				2.56E+05
AP102	<3.11E+03	<7.68E+03		1.39E+06
AP103				4.60E+05
AP104				
AP105		<1.75E+04		3.53E+06
AP106				1.18E+06
AP107				
AP108				4.91E+05
AW101				4.82E+06
AW102				2.08E+06
AW103				8.74E+05
AW104				1.59E+05
AW105				1.52E+06
AW106				2.11E+06
AY101				9.29E+05
AY102				4.39E+05
AZ101		<2.87E+03		9.14E+05
AZ102				4.96E+05
SY101				3.98E+06
SY102				1.66E+05
SY103				2.95E+06

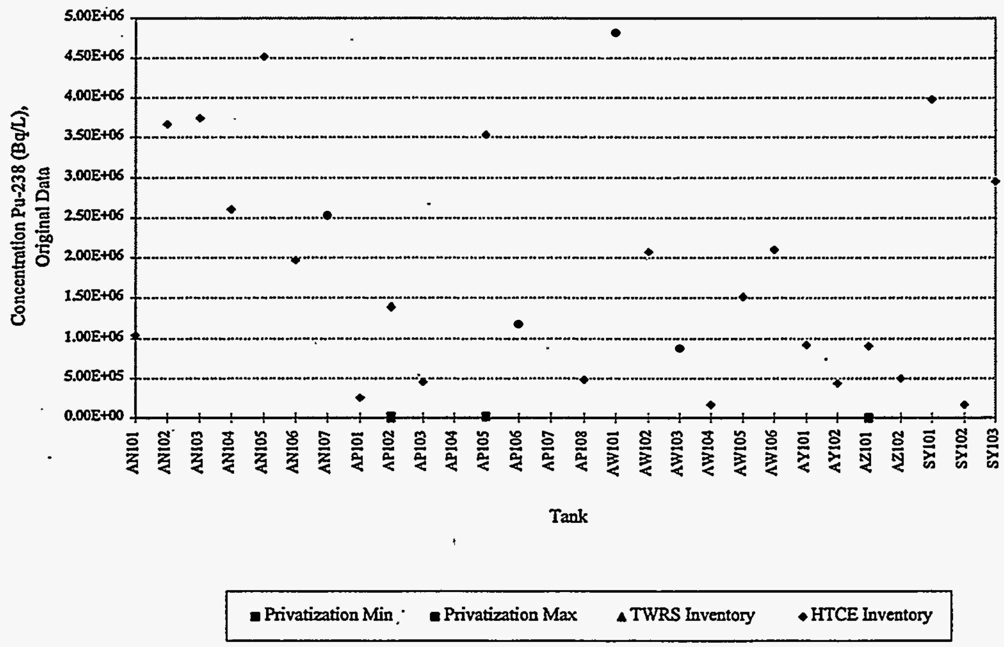

Figure D.75. ^{238}Pu Concentration in Double-Shelled Tank Waste Supernatant

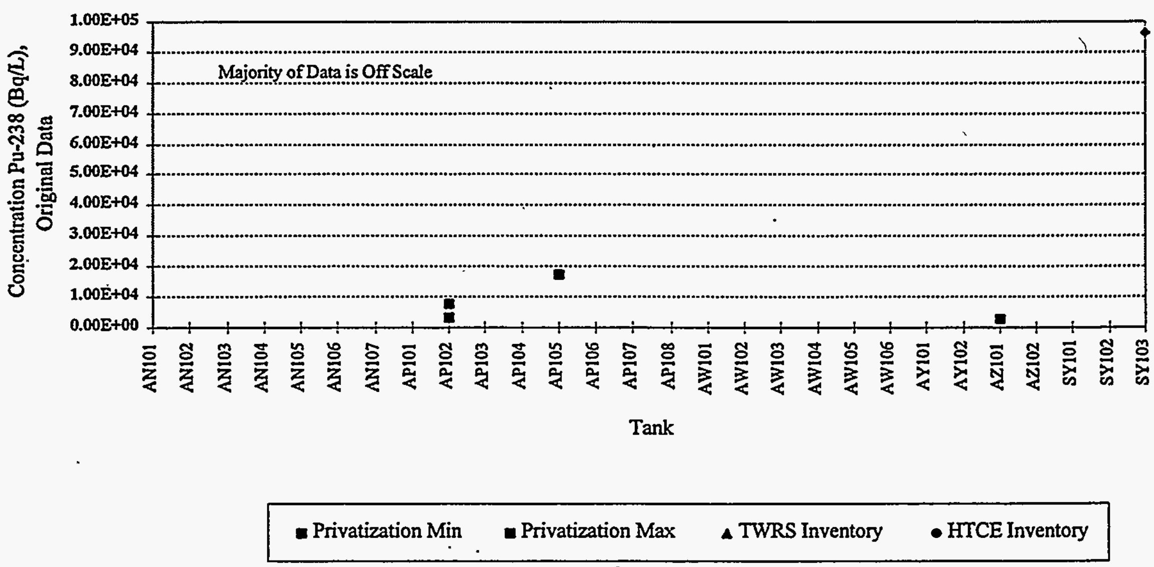

Figure D.76. ^{238}Pu Concentration in Double-Shelled Tank Waste Supernatant

Table D.43. $^{239/240}Pu$ Concentration in g/L

	$^{239/240}Pu$			
	Privatization Inventory			
DST	Min	Max	TWRS Inventory	HTCE Inventory
AN101			9.23E+05	
AN102	5.11E+05	2.60E+06	2.16E+06	
AN103			7.11E+04	
AN104			3.11E+05	
AN105			3.11E+05	
AN106			1.54E+00	
AN107	1.22E+06	4.51E+06	9.61E+05	
AP101			8.32E+04	
AP102	<2.44E+03	<2.77E+03		
AP103				
AP104			2.87E-02	
AP105	4.44E+03	6.70E+03	3.91E+03	
AP106			1.31E+02	
AP107			1.03E+05	
AP108				
AW101	1.65E+04	5.37E+04	3.44E+04	
AW102				
AW103				
AW104			7.36E-01	
AW105				
AW106				
AY101			4.96E+05	
AY102	<4.51E+02	1.85E+03	1.76E+03	
AZ101			2.66E+03	
AZ102			5.62E+04	
SY101			4.47E+04	
SY102			3.12E-02	
SY103			9.65E+04	

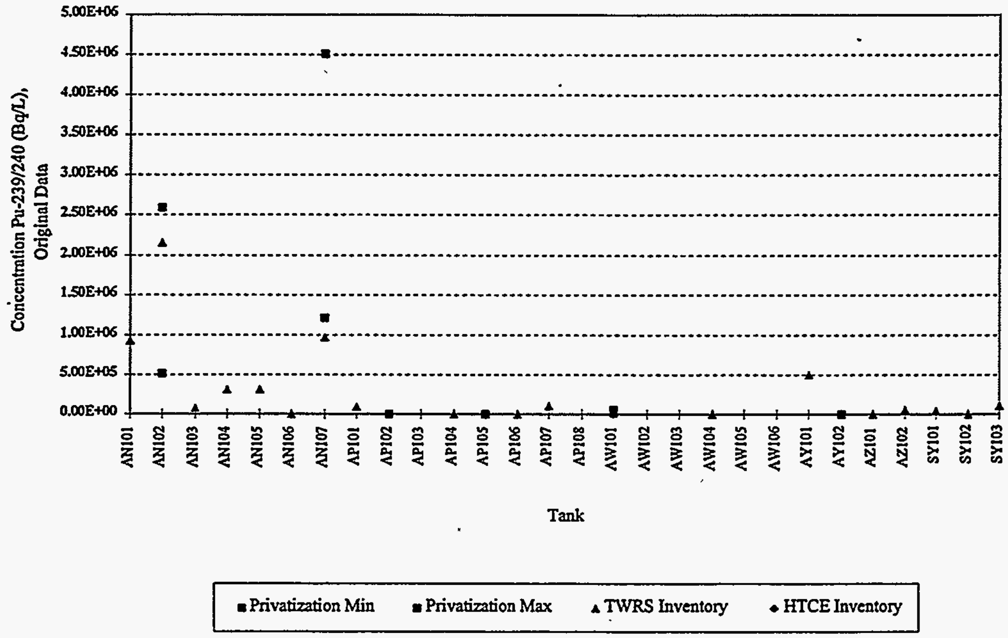

Figure D.77. $^{239/240}$Pu Concentration in Double-Shelled Tank Waste Supernatant

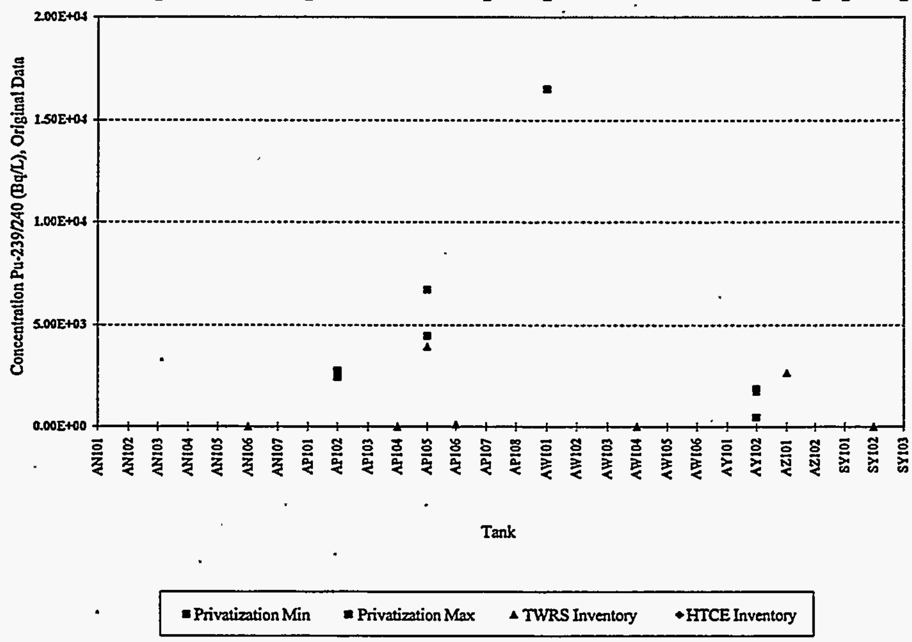

Figure D.78. $^{239/240}$Pu Concentration in Double-Shelled Tank Waste Supernatant

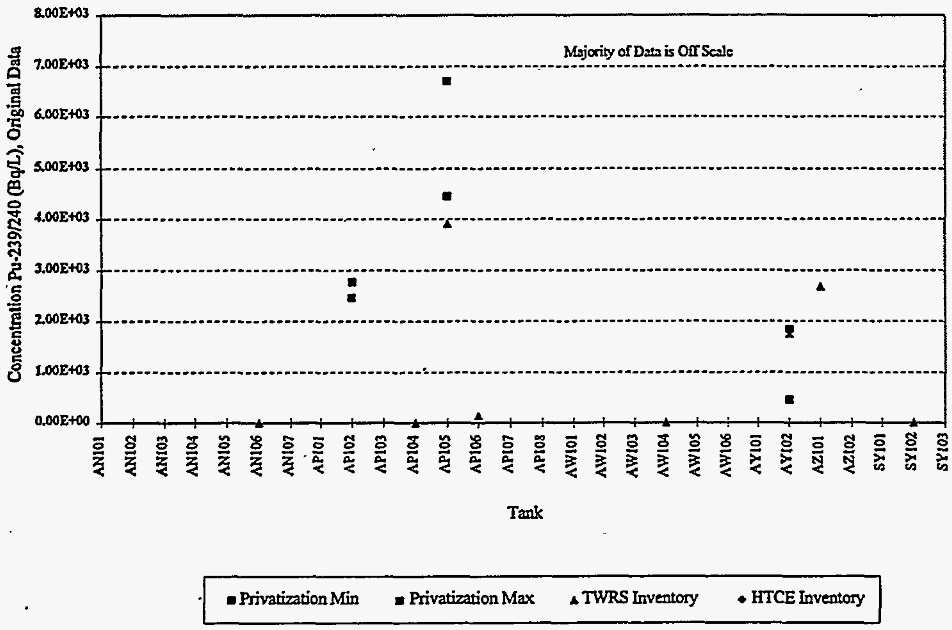

Figure D.79. $^{239/240}$Pu Concentration in Double-Shelled Tank Waste Supernatant

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Table D.44. ^{90}Sr Concentration in g/L

DST	^{90}Sr Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			1.43E+09	1.60E+09
AN102	1.55E+09	3.62E+09	2.10E+09	5.64E+09
AN103			3.15E+08	4.75E+09
AN104			2.61E+08	3.68E+09
AN105			8.56E+07	6.07E+09
AN106			7.20E+04	2.83E+09
AN107	3.35E+09	4.79E+09	2.35E+09	3.56E+09
AP101			1.16E+09	3.13E+08
AP102	2.05E+07	6.22E+07	3.77E+07	2.00E+09
AP103			6.63E+04	4.94E+08
AP104			1.52E-01	
AP105	6.41E+06	9.22E+06	5.63E+07	4.36E+09
AP106			1.07E+03	1.42E+09
AP107			1.50E+09	
AP108			1.99E+03	6.11E+08
AW101	3.42E+07	2.83E+08	2.67E+07	6.07E+09
AW102				2.68E+09
AW103			5.91E+03	9.37E+07
AW104			1.13E+02	8.85E+08
AW105				1.51E+09
AW106				2.69E+09
AY101			7.83E+07	2.00E+09
AY102	7.74E+06	8.54E+06	1.22E+05	4.95E+08
AZ101	4.37E+07	4.55E+07	4.09E+09	1.08E+09
AZ102	5.40E+07	8.88E+07	2.72E+06	5.70E+08
SY101			1.56E+08	5.87E+09
SY102			1.95E-01	1.60E+06
SY103			5.39E+08	4.34E+09

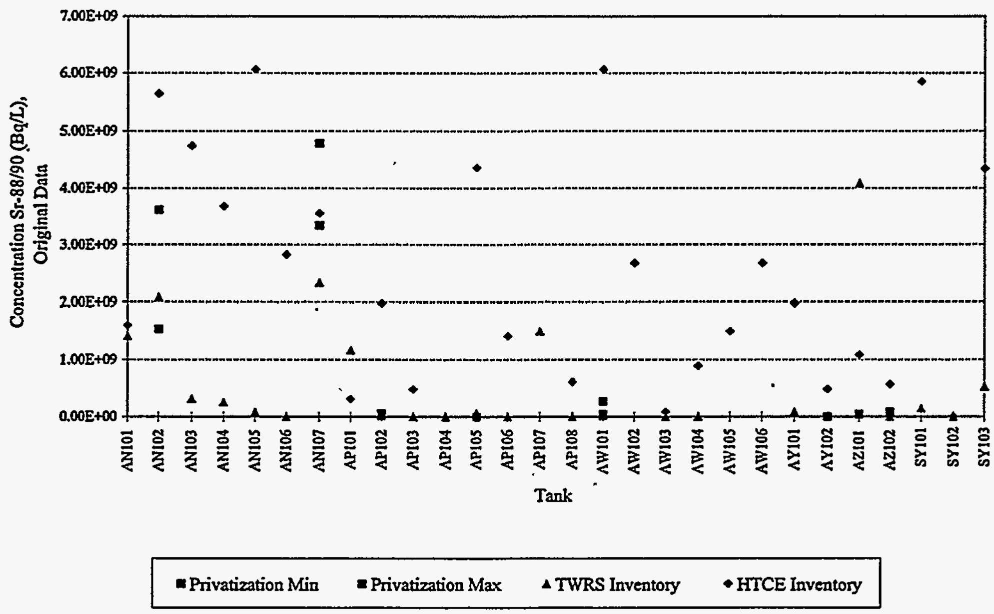

Figure D.80. ^{90}Sr Concentration in Double-Shelled Tank Waste Supernatant

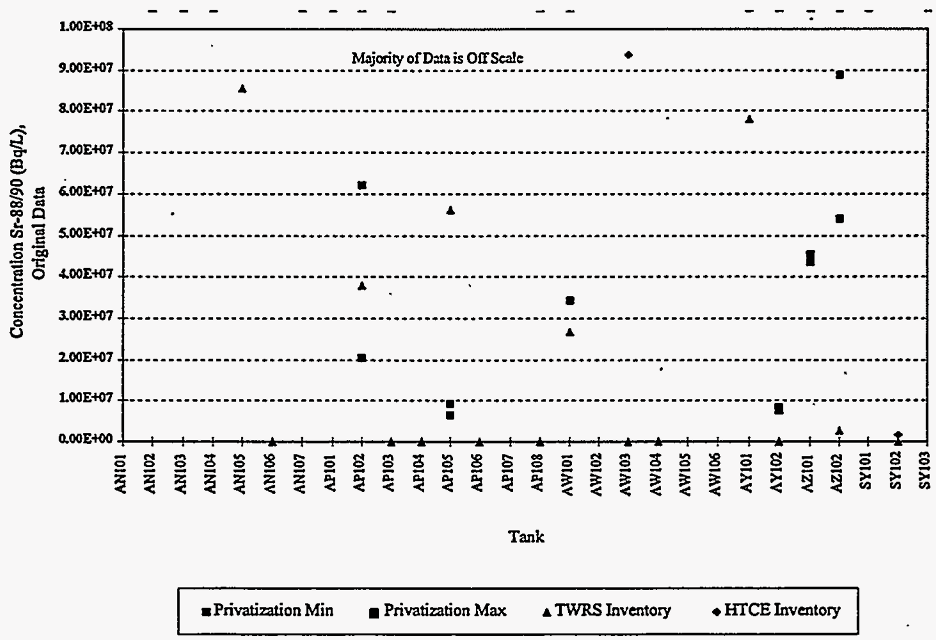

Figure D.81. ^{90}Sr Concentration in Double-Shelled Tank Waste Supernatant

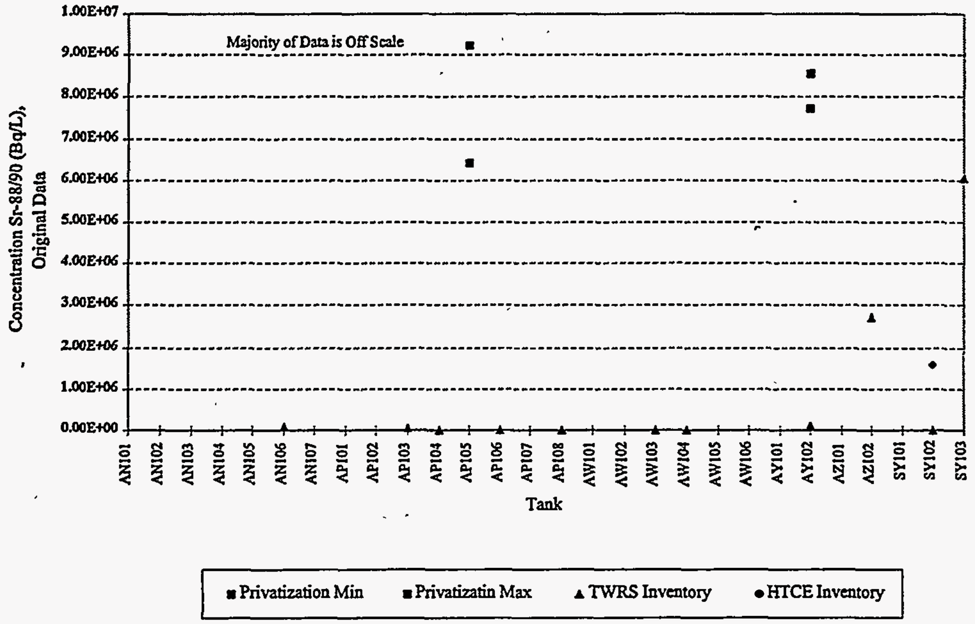

Figure D.82. ^{90}Sr Concentration in Double-Shelled Tank Waste Supernatant

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Table D.45. ^{99}Tc Concentration in g/L

DST	^{99}Tc Privatization Inventory Min	Privatization Inventory Max	TWRS Inventory	HTCE Inventory
AN101			3.55E+06	
AN102			1.14E+07	
AN103			6.36E+06	
AN104			4.90E+06	
AN105			4.90E+06	
AN106			3.52E+03	
AN107			1.10E+07	
AP101			4.37E+06	
AP102	4.70E+05	3.77E+06	3.21E+06	
AP103			4.05E+04	
AP104			2.79E-03	
AP105	2.07E+06	3.18E+06	1.31E+05	
AP106			1.36E+02	
AP107			3.45E+06	
AP108			7.54E+03	
AW101	4.74E+06	1.63E+07	5.64E+06	
AW102				
AW103			8.53E+05	
AW104			8.66E+01	
AW105			3.77E+03	
AW106				
AY101			1.36E+07	
AY102			3.10E+03	
AZ101	1.20E+07	1.42E+07	2.44E+06	
AZ102			4.73E+05	
SY101			1.30E+07	
SY102				
SY103			1.59E+07	

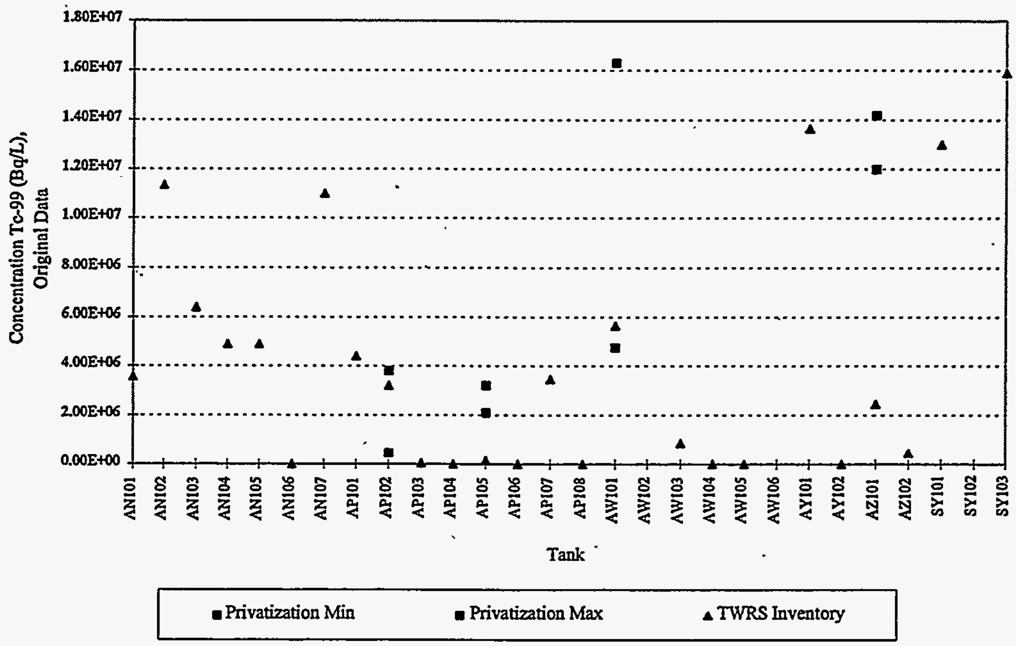

Figure D.83. ^{90}Tc Concentration in Double-Shelled Tank Waste Supernatant

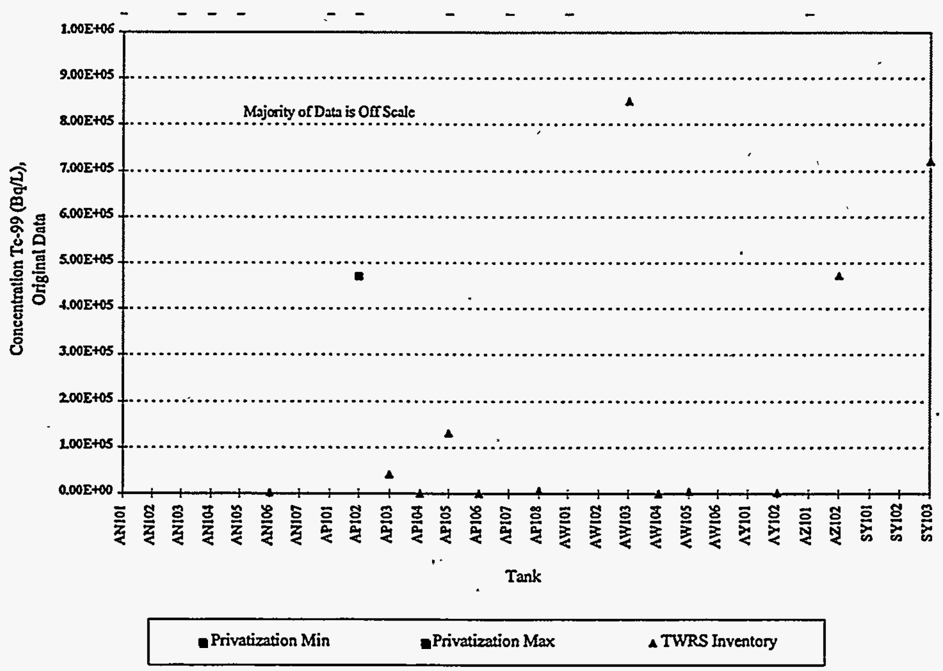

Figure D.84. ^{90}Tc Concentration in Double-Shelled Tank Waste Supernatant

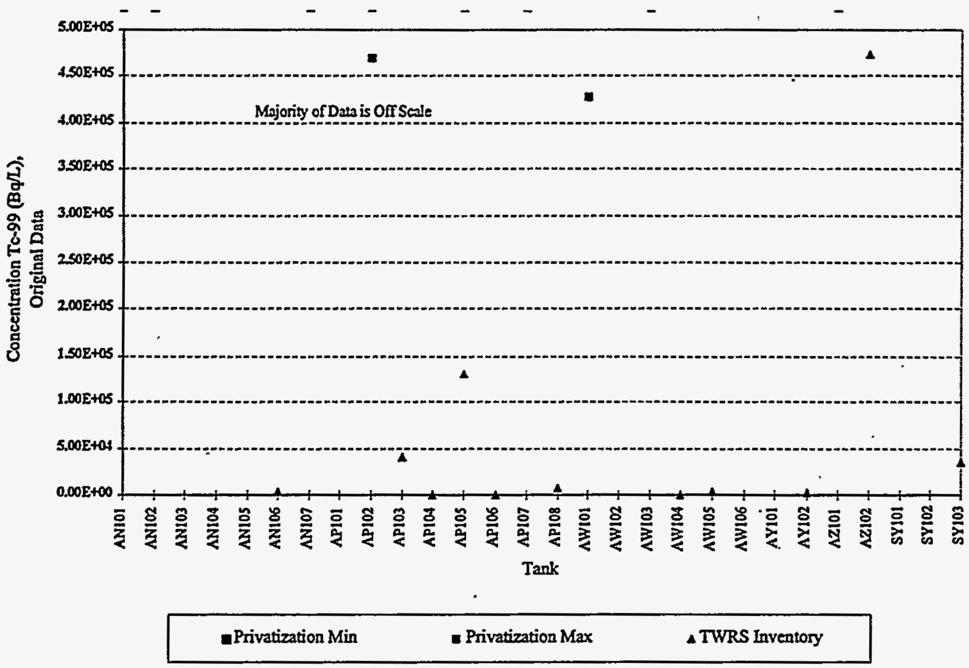

Figure D.85. ^{90}Tc Concentration in Double-Shelled Tank Waste Supernatant

Appendix E

Calculation of Process Limits

Appendix E

Calculation of Process Limits

The calculation of process limits used for the evaluation of the RFP limits in Section 4.0 are presented in this appendix. Tables E.1-2 summarize the calculation of the process limits considered for the evaluation. Information such as RFP limit, selected process limit (in bold), technical basis for process limit, and source citation is provided in the tables. The tables also refer to the equation used to calculate the process limit. The equations along with sample calculations are shown following the tables.

Table E.1. Calculation of Chemical Analyte Process Limits Used to Evaluate RFP Limits

Analyte	Waste Envelope	Component limits (mol/mol Na)		Process Limit Basis					Compound molecular Weight per Mole of Metal (g/mol)	wt% Na_2O in glass	equation for conversion to RFP units
		RFP limit	Process Limit	Limit	Units	Compound basis	Constraint	Source			
Al	A/C	1.9E-01	**4.7E-01**	12	wt% in glass	Al_2O_3	melter/glass	Shade 1995	50.98	15.5	A
	B	1.9E-01	**1.2E+00**	12	wt% in glass	Al_2O_3	melter/glass	Shade 1995	50.98	6.2	A
Ba	A/C	1.0E-04	**2.6E-01**	20	wt% in glass	BaO	melter/glass	Kalia(a)	153.34	15.5	A
	B	1.0E-04	**6.5E-01**	20	wt% in glass	BaO	melter/glass	Kalia(a)	153.34	6.2	A
	A/C	1.0E-04	2.9E-03	100	mg/L	Ba	RCRA metal	40 CFR 261	137.34	15.5	B
	B	1.0E-04	7.3E-03	100	mg/L	Ba	RCRA metal	40 CFR 261	137.34	6.2	B
Ca	A/C	4.0E-02	**4.3E-01**	12	wt% in glass	CaO	melter/glass	Shade 1995	56.08	15.5	A
	B	4.0E-02	**1.1E+00**	12	wt% in glass	CaO	melter/glass	Shade 1995	56.08	6.2	A
	A/C	4.0E-02	3.6E-02	1	wt% in glass	CaO	melter/glass	Lambert 1994	56.08	15.5	A
	B	4.0E-02	8.9E-02	1	wt% in glass	CaO	melter/glass	Lambert 1994	56.08	6.2	A
Cd	A/C	4.0E-03	**3.9E-02**	2.5	wt% in glass	CdO	melter/glass	Shade 1995	128.4	15.5	A
	B	4.0E-03	**9.7E-02**	2.5	wt% in glass	CdO	melter/glass	Shade 1995	128.4	6.2	A
	A/C	4.0E-03	3.6E-05	1	mg/L	Cd	RCRA metal	40 CFR 261	112.4	20.0	B
	B	4.0E-03	8.9E-05	1	mg/L	Cd	RCRA metal	40 CFR 261	112.4	6.2	B

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Analyte	Waste Envelope	Component limits (mol/mol Na)		Process Limit Basis					Compound molecular Weight per Mole of Metal (g/mol)	wt% Na_2O in glass	equation for conversion to RFP units
		RFP limit	Process Limit	Limit	Units	Compound basis	Constraint	Source			
Cl	A/C	3.7E-02	**2.8E-02**	0.5	wt% in glass	Cl	melter/glass	Li 1995	35.5	15.5	A
	B	8.9E-02	**7.0E-02**	0.5	wt% in glass	Cl	melter/glass	Li 1995	35.5	6.2	A
	A/C	3.7E-02	4.2E-03	0.003	g Cl/g waste oxide	Cl	melter offgas	Kalia[a]	35.5	15.5	C
	B	8.9E-02	1.1E-02	0.003	g Cl/g waste oxide	Cl	melter offgas	Kalia[a]	35.5	6.2	C
	A/C	3.7E-02	5.6E-02	1	wt% in glass	Cl	melter/glass	Shade 1995	35.5	15.5	A
	B	8.9E-02	1.4E-01	1	wt% in glass	Cl	melter/glass	Shade 1995	35.5	6.2	A
Cr	A/C	6.9E-03	**1.3E-02**	0.5	wt% in glass	Cr_2O_3	melter/glass	Shade 1995	76	15.5	A
	B	2.0E-02	**3.3E-02**	0.5	wt% in glass	Cr_2O_3	melter/glass	Shade 1995	76	6.2	A
	A/C	6.9E-03	3.9E-04	5	mg/L	Cr	RCRA metal	40 CFR 261	52	15.5	B
	B	2.0E-02	9.6E-04	5	mg/L	Cr	RCRA metal	40 CFR 261	52	6.2	B
F	A/C	9.1E-02	**1.8E-01**	1.7	wt% in glass	F	melter/glass	Shade 1995	19	15.5	A
	B	2.0E-01	**4.5E-01**	1.7	wt% in glass	F	melter/glass	Shade 1995	19	6.2	A
Fe	A/C	1.0E-02	**3.0E-01**	12	wt% in glass	Fe_2O_3	melter/glass	Shade 1995	79.85	15.5	A
	B	1.0E-02	**7.5E-01**	12	wt% in glass	Fe_2O_3	melter/glass	Shade 1995	79.85	6.2	A

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Analyte	Waste Envelope	Component limits (mol/mol Na)		Process Limit Basis					Compound molecular Weight per Mole of Metal (g/mol)	wt% Na_2O in glass	equation for conversion to RFP units
		RFP limit	Process Limit	Limit	Units	Compound basis	Constraint	Source			
Hg	A/C	1.4E-05	**1.9E-05**	20	ppm oxide in glass	HgO	melter/glass	Shade[(a)]	216.59	15.5	D
	B	1.4E-05	**4.6E-05**	20	ppm oxide in glass	HgO	melter/glass	Shade[(a)]	216.59	6.2	D
	A/C	1.4E-05	9.2E-05	100	ppm oxide in glass	HgO	melter/glass	Shade[(a)]	216.59	15.5	D
	B	1.4E-05	2.3E-04	100	ppm oxide in glass	HgO	melter/glass	Shade[(a)]	216.59	6.2	D
	A/C	1.4E-05	4.0E-06	0.2	mg/L	Hg	RCRA metal	40 CFR 261	200.59	15.5	B
	B	1.4E-05	1.0E-05	0.2	mg/L	Hg	RCRA metal	40 CFR 261	200.59	6.2	B
K	A/C	1.8E-01	**1.4E-01**	0.13	mole/ mole Na	K	OK for Cs IX	Kurath 1994	39.1	N/A	E
	B	1.8E-01	**1.4E-01**	0.13	mole/ mole Na	K	OK for Cs IX	Kurath 1994	39.1	N/A	E
	A/C	1.8E-01	8.5E-01	20	wt% in glass	K_2O	melter/glass	Shade 1995	47.1	15.5	A
	B	1.8E-01	2.1E+00	20	wt% in glass	K_2O	melter/glass	Shade 1995	47.1	6.2	A
La	A/C	8.3E-05	**1.8E-02**	1.5	wt% in glass	La_2O_3	melter/glass	Lambert 1994	162.91	15.5	A
	B	8.3E-05	**4.6E-02**	1.5	wt% in glass	La_2O_3	melter/glass	Lambert 1994	162.91	6.2	A
	A/C	8.3E-05	2.5E-02	2	wt% in glass	La_2O_3	melter/glass	Shade 1995	162.91	15.5	A
	B	8.3E-05	6.1E-02	2	wt% in glass	La_2O_3	melter/glass	Shade 1995	162.91	6.2	A
Ni	A/C	3.0E-03	**5.4E-02**	2	wt% in glass	NiO	melter/glass	Shade 1995	74.71	15.5	A
	B	3.0E-03	**1.3E-01**	2	wt% in glass	NiO	melter/glass	Shade 1995	74.71	6.2	A

(a) Shade JW. 1995. E-mail message to K. D. Wiemers dated 9/28/95.

Analyte	Waste Envelope	Component limits (mol/mol Na)		Process Limit Basis					Compound molecular Weight per Mole of Metal (g/mol)	wt% Na_2O in glass	equation for conversion to RFP units
		RFP limit	Process Limit	Limit	Units	Compound basis	Constraint	Source			
NO_2^-	A/C	3.8E-01	**1.0E+00**	3	molarity (3 M Na min)	NO_2^-	OK for Tc IX	Roberts 1962	46	N/A	F
	B	3.8E-01	**1.0E+00**	3	molarity (3 M Na min)	NO_2^-	OK for Tc IX	Roberts 1962	46	N/A	F
	A/C	3.8E-01	2.9E-01	36	wt% waste oxides	NO_3^-	HWVP ref feed max	Kalia[(a)]	62	15.5	G
	B	3.8E-01	7.3E-01	36	wt% waste oxides	NO_3^-	HWVP ref feed max	Kalia[(a)]	62	6.2	G
NO_3^-	A/C	8.0E-01	**1.0E+00**	3	molarity (3 M Na min)	NO_3^-	OK for Tc IX	Roberts 1962	62	N/A	F
	B	8.0E-01	**1.0E+00**	3	molarity (3 M Na min)	NO_3^-	OK for Tc IX	Roberts 1962	62	N/A	F
	A/C	8.0E-01	2.9E-01	36	wt% waste oxides	NO_3^-	HWVP ref feed max	Kalia[(a)]	62	15.5	G
	B	8.0E-01	7.3E-01	36	wt% waste oxides	NO_3^-	HWVP ref feed max	Kalia[(a)]	62	6.2	G
OH	A/C	7.0E-01	**6.8E-01**	3.4	molarity in 5 M Na	OH	OK for Cs IX	Kurath 1994	17	N/A	F
	B	7.0E-01	**6.8E-01**	3.4	molarity in 5 M Na	OH	OK for Cs IX	Kurath 1994	17	N/A	F
	A/C	7.0E-01	4.5E-01	3	molarity in 6.7 M Na	OH	OK for Tc IX	Roberts 1962	17	20.0	F
	B	7.0E-01	4.5E-01	3	molarity in 6.7 M Na	OH	OK for Tc IX	Roberts 1962	17	20.0	F

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package*. WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Analyte	Waste Envelope	Component limits (mol/mol Na)		Process Limit Basis					Compound molecular Weight per Mole of Metal (g/mol)	wt% Na_2O in glass	equation for conversion to RFP units
		RFP limit	Process Limit	Limit	Units	Compound basis	Constraint	Source			
Pb	A/C	6.8E-04	**1.8E-02**	2	wt% in glass	PbO	melter/glass	Shade[a]	223.19	15.5	A
	B	6.8E-04	**4.5E-02**	2	wt% in glass	PbO	melter/glass	Shade[a]	223.19	6.2	A
	A/C	6.8E-04	9.7E-05	5	mg/L	Pb	RCRA metal	40 CFR 261	207.19	15.5	B
	B	6.8E-04	2.4E-04	5	mg/L	Pb	RCRA metal	40 CFR 261	207.19	6.2	B
PO_4^{-3}	A/C	3.8E-02	**8.5E-02**	3	wt% in glass	P_2O_5	melter/glass	Shade 1995	70.97	15.5	A
	B	1.3E-01	**2.1E-01**	3	wt% in glass	P_2O_5	melter/glass	Shade 1995	70.97	6.2	A
SO_4^{-2}	A	9.7E-03	**1.9E-02**	1	wt% in glass	SO_3	melter/glass	Shade 1995	80.064	15.5	A
	B	7.0E-02	**6.3E-02**	1	wt% in glass	SO_3	melter/glass	Shade 1995	80.064	6.2	A
	C	2.0E-02	**1.9E-02**	1	wt% in glass	SO_3	melter/glass	Shade 1995	80.064	15.5	A
	A	9.7E-03	9.7E-03	0.5	wt% in glass	SO_3	melter/glass	Li 1995	80.064	15.5	A
	B	7.0E-02	3.1E-02	0.5	wt% in glass	SO_3	melter/glass	Li 1995	80.064	6.2	A
	C	2.0E-02	9.7E-03	0.5	wt% in glass	SO_3	melter/glass	Li 1995	80.064	15.5	A
TIC	A/C	3.0E-01	**5.0E-01**	1	molarity (2 M Na min)	CO_3^{-2}	OK for Tc IX	Roberts 1962	60	N/A	F
	B	3.0E-01	**5.0E-01**	1	molarity (2 M Na min)	CO_3^{-2}	OK for Tc IX	Roberts 1962	60	N/A	F
	A/C	3.0E-01	2.5E-01	30	wt% waste oxides	CO_3^{-2}	HWVP ref feed max	Kalia[b]	60	15.5	G
	B	3.0E-01	6.3E-01	30	wt% waste oxides	CO_3^{-2}	HWVP ref feed max	Kalia[b]	60	6.2	G

(a) Shade JW. 1995. E-mail message to K. D. Wiemers dated 9/28/95.
(b) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Analyte	Waste Envelope	Component limits (mol/mol Na)		Process Limit Basis					Compound molecular Weight per Mole of Metal (g/mol)	wt% Na_2O in glass	equation for conversion to RFP units
		RFP limit	Process Limit	Limit	Units	Compound basis	Constraint	Source			
TOC	A	6.0E-02	**6.0E-02**	10	g/L (14 M Na max)	C	evap. gel formation	Le 1995	12	N/A	H
	B	6.0E-02	**6.0E-02**	10	g/L (14 M Na max)	C	evap. gel formation	Le 1995	12	N/A	H
	C	5.0E-01	6.0E-02	10	g/L (14 M Na max)	C	evap. gel formation	Le 1995	12	N/A	H
	A	6.0E-02	3.8E-01	46	g/L (10 M Na expt)	C	OK for Cs IX	Kurath 1994	12	N/A	H
	B	6.0E-02	3.8E-01	46	g/L (10 M Na expt)	C	OK for Cs IX	Kurath 1994	12	N/A	H
	C	5.0E-01	**3.8E-01**	46	g/L (10 M Na expt)	C	OK for Cs IX	Kurath 1994	12	N/A	H
	A	6.0E-02	4.6E-01	11	wt% waste oxides	C	HWVP ref feed max	Kalia[a]	12	15.5	G
	B	6.0E-02	1.2E+00	11	wt% waste oxides	C	HWVP ref feed max	Kalia[a]	12	6.2	G
	C	5.0E-01	4.6E-01	11	wt% waste oxides	C	HWVP ref feed max	Kalia[a]	12	15.5	G
U	A/C	1.2E-03	**5.9E-02**	8	wt% in glass	UO_2	melter/glass	Lambert 1994	270.04	20.0	A
	B	1.2E-03	1.5E-01	8	wt% in glass	UO_2	melter/glass	Lambert 1994	270.04	20.0	A

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Table E.2. Calculation of Radionuclide Process Limits Used to Evaluate RFP Limits

Radionuclide	Envelope	Limit (Bq/mole Na)		Glass Specification		Pretreatment DF (McKee 1995)	wt% Na_2O in glass	Source	equation for conversion to RFP units
		RFP	Process	Limit	Units				
TRU	A	4.8E+05	**3.7E+06**	100	nCi/g	5	15.5	McKee 1995	I
	B	4.8E+05	**9.3E+06**	100	nCi/g	5	6.2	McKee 1995	I
	C	3.0E+06	**3.7E+06**	100	nCi/g	5	15.5	McKee 1995	I
^{137}Cs	A/C	4.3E+09	**8.9E+09**	3	Ci/m^3	1000	15.5	McKee 1995	J
	B	6.0E+10	**2.2E+10**	3	Ci/m^3	1000	6.2	McKee 1995	J
^{90}Sr	A	4.4E+07	**5.9E+07**	20	Ci/m^3	1	15.5	McKee 1995	J
	B	4.4E+07	**1.5E+08**	20	Ci/m^3	1	6.2	McKee 1995	J
	C	8.0E+08	**5.9E+08**	20	Ci/m^3	10	15.5	McKee 1995	J
^{99}Tc	A/C	7.1E+06	**8.9E+06**	0.3	Ci/m^3	10	15.5	McKee 1995	J
	B	7.1E+06	**2.2E+07**	0.3	Ci/m^3	10	6.2	McKee 1995	J
	A/C	7.1E+06	4.4E+06	0.3	Ci/m^3	5	15.5	McKee 1995	J
	B	7.1E+06	1.1E+07	0.3	Ci/m^3	5	6.2	McKee 1995	J

Equations

Equation A: Conversion from [wt% oxide in LAW glass] to [mol analyte / mol Na]

Example: Aluminum - Envelope A/C

$$\left(\frac{12\,g\,Al_2O_3}{100\,g\,glass}\right) * \left(\frac{100\,g\,glass}{15.5\,g\,Na_2O}\right) * \left(\frac{62\,g\,Na_2O}{2\,mol\,Na}\right) * \left(\frac{mol\,Al}{50.98\,g\,Al_2O_3}\right) = 0.47\,\frac{mol\,Al}{mol\,Na}$$

Equation B: Conversion of RCRA [mg / L] to [mol analyte / mol Na]

This calculation assumes all of analyte leaches from LAW glass, that the leachate is 20x the weight of the glass (SW-846, Method 1311) and the density of the leachate is 1 g/mL.

Example: Barium - Envelope A/C

$$\left(\frac{100\,mg\,Ba}{L\,leachate}\right) * \left(\frac{1\,g\,Ba}{1000\,mg\,Ba}\right) * \left(\frac{1\,L\,leachate}{1000\,g\,leachate}\right) * \left(\frac{20\,g\,leachate}{1\,g\,glass}\right) * \left(\frac{100\,g\,glass}{15.5\,g\,Na_2O}\right) * \left(\frac{62\,g\,Na_2O}{2\,mol\,Na}\right) * \left(\frac{mol\,Ba}{137.34\,g\,Ba}\right) = 2.9\,E{-03}\,\frac{mol\,Ba}{mol\,Na}$$

Equation C: Conversion from [g analyte / g waste oxide] to [mol analyte / mol Na]

Assumption: 25 wt% total waste oxide loading in glass[(a)]
Example: Chloride - Envelope A/C

$$\left(\frac{0.003\,g\,Cl}{g\,waste\,oxide}\right) * \left(\frac{25\,g\,waste\,oxide}{100\,g\,glass}\right) * \left(\frac{100\,g\,glass}{15.5\,g\,Na_2O}\right) * \left(\frac{62\,g\,Na_2O}{2\,mol\,Na}\right) * \left(\frac{mol\,Cl}{35.5\,g\,Cl}\right) = 4.2E{-}03\,\frac{mol\,Cl}{mol\,Na}$$

Equation D: Conversion from [ppm oxide in glass] to [mol analyte / mol Na]

Example: Mercury (Hg) - Envelope A/C

$$\left(\frac{20\,g\,HgO}{10^6\,g\,glass}\right) * \left(\frac{100\,g\,glass}{15.5\,g\,Na_2O}\right) * \left(\frac{1\,mol\,Hg}{216.59\,g\,HgO}\right) * \left(\frac{62\,g\,Na_2O}{2\,mol\,Na}\right) = 1.9\,E{-}05\,\frac{mol\,Hg}{mol\,Na}$$

Equation E: No conversion necessary. Units are already mol analyte / mol Na

Example: Potassium (K) - Envelope A/B/C

Equation F: Divide analyte molarity (in column labeled 'limits') by sodium molarity (in column labeled 'units')

Example: NO_2 - Envelope A/B/C

$$3\,M\,NO_2\left[\frac{mol\,NO_2}{L\,Soln}\right] \Big/ \; 3\,M\,Na\left[\frac{mol\,Na}{L\,Soln}\right] = 1\,\frac{mol\,NO_2}{mol\,Na}$$

(a) Kalia J. 1992. *Hanford Waste Vitrification Plant Technical Data Package.* WHC-SD-HWV-DP-001, Rev. 6, Westinghouse Hanford Company, Richland, Washington.

Equation G: Conversion from [wt% total waste oxide] to [mol analyte / mol Na]

Assumption: 25 wt% total waste oxide loading in glass

Example: TOC - Envelope C

$$\left(\frac{11\,g\,TOC}{100\,g\,waste\ oxide}\right) * \left(\frac{25\,g\,waste\ oxide}{100\,g\,glass}\right) * \left(\frac{100\,g\,glass}{15.5\,g\,Na_2O}\right) * \left(\frac{62\,g\,Na_2O}{2\ mol\,Na}\right) * \left(\frac{mol\,TOC}{12.0\,g\,TOC}\right) = 0.46\ \frac{mol\,TOC}{mol\,Na}$$

Equation H: Convert analyte concentration (g/L) to molarity and divide by sodium molarity (in column labeled 'units')

Example: TOC - Envelope C

$$\left(\frac{46\,g\,TOC}{L\,Soln}\right) * \left(\frac{1\ mol\,TOC}{12\,g\,TOC}\right) \Big/ \ 10\,M\,Na\left[\frac{mol\,Na}{L\,Soln}\right] = 0.38\ \frac{mol\,TOC}{mol\,Na}$$

Equation I: Conversion RFP glass specification from [nCi / g glass] to [Bq / mol Na]

The decontamination factor used in the calculation is in the column 'pretreatment DF' for radionuclides.
DF = amount of analyte in waste feed / amount of analyte in waste after pretreatment.

Example: TRU - Envelope C

$$\left(\frac{100\,nCi}{g\,glass}\right) * 5\,DF\left(\frac{n\,Ci\ (supernate)}{n\,Ci\ (glass)}\right) * \left(\frac{1E\text{-}09\ Ci}{n\,Ci}\right) * \left(\frac{3.7\,E{+}10\,Bq}{Ci}\right) * \left(\frac{100\,g\,glass}{15.5\,g\,Na_2O}\right) * \left(\frac{62\,g\,Na_2O}{2\ mol\,Na}\right) = 3.7\,E{+}06\ \frac{Bq}{mol\,Na}$$

Equation J: Conversion RFP glass specification [Ci/M_3] to [mol analyte / mol Na]

The decontamination factor used in the calculation is in the column 'pretreatment DF' for radionuclides.
DF = amount of analyte in waste feed / amount of analyte in waste after pretreatment.

Example: Tc-99 - Envelope A

$$\left(\frac{0.3\ Ci(glass)}{m^3\ glass}\right) * 10\ DF\left[\frac{Ci\ (supernate)}{Ci\ (glass)}\right] * \left(\frac{m^3\ glass}{2500\ Kg\ glass}\right) * \left(\frac{Kg\ glass}{1000\ g\ glass}\right) * \left(\frac{100\ g\ glass}{15.5\ g\ Na_2O}\right) * \left(\frac{62\ g\ Na_2O}{2\ gmol\ Na}\right) * \left(\frac{3.7\ E10\ Bq}{Ci}\right) = 8.9\ E{+}06\ \frac{Bq}{gmol\ Na}$$

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