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ENGINEERING DATA TRANSMITTAL

1. EDT 820524

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The Hanford Defined Waste (HDW) Model estimates the chemical and radionuclide compositions of waste types present in the 200 Area underground tanks based on ORIGEN2, process flowsheets, and historical data. The Revision 5.0 update is focused on improvement of the radionuclide predictions.

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K. M Bowen	R2-12	H			
P.J. Certa	R2-12	X			
K. L. Hennesay	R1-10	H			
B. A. Higley (5)	R2-12	H			
T. M. Horner	S5-08	X			
N. L. Hulse	R2-12	X			
M. E. Johnson	H6-19	X			
A. J. Knepp	H6-03	X			
N. W. Kirch	R2-58	H			
S. M. Mackay	R2-58	H			
F. M. Mann	E6-35	X			
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D. M. Nguyen	R2-12	X			
D. E. Place	R2-12	H			
J. H. Rasmussen	R2-12	X			
D. A. Reynolds	S7-90	X			
L. M. Saski	S7-90	X			
D. J. Washenfelder	H6-03	X			
DMJMH+N					
J. Reddick	H0-05	H			
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W. Liou	H6-60	H			
R. W. Lober	H6-60	X			
C. S. Louie	H6-60	X			
Pacific Northwest National Laboratory					
C. T. Kincaid	K9-33	H			
Technical Resources International, Inc.					
R. A. Corbin	B1-41	H			
B. C. Simpson	B1-41	H			

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Abstract: Documents the changes made to the Hanford Defined Waste Model encommpassed by Revision 5.0 including: updated ORIGEN2 fuel activity estimates, improved chemical process simulation, and correction of identified errors. The Model is a spreadsheet-based engineering estimate of the chemical & radionuclide composition of the wastes contained in the single-shell and double-shell tanks; based on process flowsheets, and reactor, separation plant and tank farm records.

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EXECUTIVE SUMMARY

This report documents the improvements made to the Hanford Defined Waste (HDW) Model encompassed by Revision 5.0. New information generated since Revision 4.0 of the HDW Model has reduced the conservatism in some important areas. Specifically, the HDW Model has been updated to account for partitioning of tritium to cribs via evaporator condensates, ^{14}C and ^{129}I to the atmosphere, and ^{99}Tc with the uranium product shipped off-site. The opportunity has been taken, in this revision, to incorporate new *Oak Ridge Isotope Generation* (ORIGEN2) fuel activity estimates and to improve chemical process models.

The Hanford Defined Waste (HDW) Model is a spreadsheet-based engineering estimate of the chemical and radionuclide contents of the single-shell and double-shell tanks. The calculation is based on process knowledge, which includes, but is not limited to, reactor fuel irradiation records, separation plant dissolver charging records, separation plant and tank farm process flowsheets, and tank farm waste receipt and transfer records. The calculation is made using Microsoft® Excel[1] 2002 software.

The changes made in this revision are in three main areas:

- Updated ORIGEN2 Fuel Activity Estimates,
- Improved Chemical Process Simulation, and
- General Error Correction.

The changes to the HDW Model have reduced the estimated tank waste inventories of many radionuclides and, in particular, most of the key soluble radionuclides. Estimates of activation product inventories increased because of a more comprehensive description of fuel and cladding impurities. Correction of outdated half-lives reduced the inventory of ^{79}Se and ^{126}Sn. Accounting for process losses reduced the tank inventory of ^{3}H, ^{14}C, ^{99}Tc, and ^{129}I. Table ES-1 compares the current estimate with the previous version of the HDW Model.

[1] Microsoft® Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

Table ES-1. Change in HDW Model Predicted Tank Waste Radionuclide Inventories (All values are reported as of January 1, 2001). (3 Sheets)

Radionuclide	HDW Model Rev. 4.0 (Ci)	HDW Model Rev. 5.0 (Ci)	Change in Estimated Tank Waste Inventory (Percent)	Primary Reason for Change
^{3}H	4.83E+04	9.52E+03	-80%	Modeling of process losses
^{14}C	4.80E+03	8.51E+02	-82%	Modeling of process losses
^{59}Ni	9.34E+02	1.32E+03	+41%	Corrected material balance error
^{63}Ni	8.73E+04	1.26E+05	+44%	Corrected material balance error
^{60}Co	4.90E+03	1.60E+04	+226%	Postulated 1 ppm ^{59}Co fuel impurity. See Section 7.1
^{79}Se	7.73E+02	7.70E+01	-90%	Half-life change
^{90}Sr	5.21E+07	5.04E+07	-3%	---
^{90}Y	5.21E+07	5.04E+07	-3%	---
^{93}Zr	3.63E+03	4.64E+03	+28%	Corrected material balance error
^{93m}Nb	2.97E−03	3.66E+03	+23%	Corrected material balance error
^{99}Tc	3.26E+04	2.51E+04	-23%	Modeling of process losses
^{106}Ru	8.48E+02	1.06E+03	+24%	Corrected material balance error and half-life change
^{113m}Cd	1.21E+04	5.72E+03	-53%	Fission product yield change
^{125}Sb	3.61E+04	1.90E+04	-47%	Fission product yield change
^{126}Sn	1.19E+03	3.21E+02	-73%	Half-life change
^{129}I	6.30E+01	3.18E+01	-50%	Fission product yield change and modeling of process losses
^{134}Cs	8.39E+03	8.40E+03	0%	---
^{137}Cs	4.01E+07	3.92E+07	-2%	---
^{137m}Ba	3.79E+07	3.70E+07	-2%	---
^{151}Sm	2.61E+06	3.22E+06	+23%	Corrected material balance error
^{152}Eu	1.03E+03	1.07E+03	+3%	---
^{154}Eu	8.38E+04	9.17E+04	+9%	---
^{155}Eu	5.13E+04	5.12E+04	0%	---
^{226}Ra	6.29E-02	9.14E-03	-85%	Stopped in-growth at date of U separation

Table ES-1. Change in HDW Model Predicted Tank Waste Radionuclide Inventories (All values are reported as of January 1, 2001). (3 Sheets)

Radionuclide	HDW Model Rev. 4.0 (Ci)	HDW Model Rev. 5.0 (Ci)	Change in Estimated Tank Waste Inventory (Percent)	Primary Reason for Change
^{228}Ra	3.96E+01	3.04E+00	-92%	Stopped in-growth at date of Th separation
^{227}Ac	1.01E+02	4.62E+00	-95%	Thorium cross-section change
^{231}Pa	1.56E+02	7.09E+00	-95%	Thorium cross-section change
^{229}Th	1.81E+00	1.41E+00	-22%	DKPRO modeling of separations by fuel record
^{232}Th	4.36E+00	2.80E+00	-36%	DKPRO modeling of separations by fuel record
^{232}U	2.42E+02	7.45E+00	-97%	Thorium cross sections were adjusted to known ^{233}U production and ^{232}U impurity levels
^{233}U	9.94E+02	4.49E+02	-55%	Thorium cross sections were adjusted to known ^{233}U production and ^{232}U impurity levels
^{234}U	8.50E+02	3.22E+02	-62%	Improved information on metal waste sluicing
^{235}U	3.66E+01	1.38E+01	-62%	Improved information on metal waste sluicing
^{236}U	1.61E+01	8.25E+00	-49%	Improved information on metal waste sluicing
^{238}U	9.06E+02	3.04E+02	-66%	Improved information on metal waste sluicing
^{237}Np	1.41E+02	1.27E+02	-10%	Single-pass reactor cross-section change
^{238}Pu	1.96E+03	1.97E+03	+1%	---
^{239}Pu	4.69E+04	3.23E+04	-31%	DKPRO modeling of separations by fuel record
^{240}Pu	9.86E+03	7.96E+03	-19%	Single-pass reactor cross-section change and DKPRO modeling of separations by fuel record
^{241}Pu	1.19E+05	1.27E+05	+7%	DKPRO modeling of separations by fuel record
^{242}Pu	7.90E-01	7.92E-01	0%	---

Table ES-1. Change in HDW Model Predicted Tank Waste Radionuclide Inventories (All values are reported as of January 1, 2001). (3 Sheets)

Radionuclide	HDW Model Rev. 4.0 (Ci)	HDW Model Rev. 5.0 (Ci)	Change in Estimated Tank Waste Inventory (Percent)	Primary Reason for Change
^{241}Am	7.07E+04	8.24E+04	+17%	In-growth due to decay date change
^{243}Am	9.33E+00	4.22E+01	+352%	Incorrect entry of fuel activity in HDW Model Rev. 4.0
^{242}Cm	7.44E+01	7.32E+01	-2%	---
^{243}Cm	8.43E+00	7.74E+00	-8%	---
^{244}Cm	1.85E+02	1.91E+02	+3%	---

In addition to the overall changes in inventory, other improvements to the model resulted in redistribution of radionuclide inventories between waste streams:

- Radionuclide inventories of the Bismuth Phosphate first cycle, second cycle and 224 wastes were substantially reduced due to a better understanding of the Bismuth Phosphate process chemistry.
- Improved modeling of the irradiated fuel and separation plant processing resulted in ^{3}H, ^{14}C, ^{59}Ni, and ^{63}Ni, inventories being shifted from high-level waste streams to cladding waste streams.
- The fraction of uranium reporting to sludge layers increased because of more realistic solubility modeling.
- The inventory of ^{233}U was decreased based on benchmarking thorium irradiation to production data.
- Plutonium and uranium losses were reconciled to plant records.
- Americium-241 to ^{241}Pu ratios were made consistent and reasonable, especially for cladding waste streams.
- Corrections to the input quantity and disposition of lead and mercury chemicals were made.
- The saltcake waste types were normalized to the measured saltcake densities to resolve a model sensitivity to water imbalances across the various evaporators. This resulted in reducing liquid waste concentrations to more realistic values.

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LIST OF GENERAL TERMS

BBI	Best-Basis Inventory
Ci	Curies
DKPRO	Computer code for radioactive decay (DK) and processing (PRO)
ft	feet
g/L	grams per liter
HLW	High-level waste
HDW	Hanford Defined Waste (Model)
kg	kilograms
kgal	kilogallons
M	molar concentration (moles per liter)
MCi	mega-Curies
MONTEBURNS	Computer code used for estimation of single pass reactor cross sections
MTU	Metric Ton Uranium
MWD	Megawatt-Day
ORIGEN2	Oak Ridge Isotope Generation code
ppm	parts per million
PRTR	Plutonium Recycle Test Reactor
PUREX	Plutonium-uranium extraction (process or plant)
REDOX	Reduction and oxidation (process or plant)
TBP	Tributyl phosphate
TLM	Tank Layer Model
TRU	Transuranic
SMM	Supernatant Mixing Model
WSTRS	Waste Status and Transaction Record Summary
μCi/g	microcuries per gram

LIST OF WASTE TYPE TERMS

This section lists the waste type definitions used for Revision 5.0 of the HDW Model. Several of the waste type definitions have been updated relative to Revision 4.0 based on new information.

BISMUTH PHOSPHATE PROCESS WASTE TYPES (1944-1956)

Waste Type	Definition
MW1	$BiPO_4$ Metal Waste (1944-1949)
MW2	$BiPO_4$ Metal Waste (1950-1956)
1C1	$BiPO_4$ First cycle decontamination waste and coating waste (1944-1949)
1C2	$BiPO_4$ First cycle decontamination waste and coating waste (1950-1956)
2C1	$BiPO_4$ Second cycle decontamination waste (1944-1949)
2C2	$BiPO_4$ Second cycle decontamination waste (1950-1956) and low activity cell 5-6 drainage waste (June 1951-1956)
224-1	Lanthanum fluoride process 224 Building waste (1944-1949)
224-2	Lanthanum fluoride process 224 Building waste (1950-1956)

URANIUM RECOVERY AND SCAVENGING WASTE TYPES (1952-1958)

TBP	Tributyl phosphate process waste (1952-1958), same as UR
PFeCN1	Ferrocyanide sludge from TBP in-plant scavenged supernatant and co-disposed TBP sludge (1954-1955)
PFeCN2	Ferrocyanide sludge from TBP in-plant scavenged supernatant and co-disposed TBP sludge (1955-1958)
TFeCN	Ferrocyanide sludge from supernatant scavenging in 244-CR Vault (1955-1958). These supernatants consisted of TBP supernatant and the commingled supernatants from other wastes stored in the same tanks
1CFeCN	Ferrocyanide sludge from in-plant scavenging of T-Plant 1C waste (without coating waste). Transferred to TY-Farm (1955-1956)

REDUCTION AND OXIDATION (REDOX) PROCESS WASTE TYPES (1952-1966)

R1	REDOX high-level waste (1952-1958)
R2	REDOX high-level waste (1959-1966)
CWR1	REDOX cladding waste, aluminum clad fuel (1952-1960)
CWR2	REDOX cladding waste, aluminum clad fuel (1961-1966)

PLUTONIUM-URANIUM EXTRACTION (PUREX) PROCESS WASTE TYPES (1956-1990)

P1	PUREX high-level waste (1956-1962)
P2	PUREX high-level waste (1963-1967)
P2'	PUREX acid waste to B-Plant (1964-1972)
P3AZ1	PUREX high-level waste to AZ-101 (1983-March 13, 1986)
P3AZ2	PUREX high-level waste to AZ-102 (March 13, 1986 to 1990)
CWP1	PUREX cladding waste, aluminum clad fuel (1956-1960)
CWP2	PUREX cladding waste, aluminum clad fuel (1961-1972)
CWZr1	PUREX (and REDOX) zirconium cladding waste, (1968-1972)
CWZr2	PUREX zirconium cladding waste (1983-1989)
OWW1	PUREX organic wash waste and non-boiling waste (1956-1962)
OWW2	PUREX organic wash waste and non-boiling waste (1963-1967)
OWW3	PUREX organic wash waste (1968-1972)
PL1	PUREX non-boiling waste (1968-1972)
PL2	PUREX organic wash waste and non-boiling waste (1983-1988)
TH1	Thoria process wastes (1966)
TH2	Thoria process wastes (1970)
PASF	PUREX Ammonia Scrubber Feed

CESIUM AND STRONTIUM RECOVERY WASTE TYPES (1961-1985)

HS	Hot Semiworks strontium purification waste (1961-1968)
AR	Water washed PUREX sludge entrained in decants of recovered sludge or the water washes of this sludge and the solids remaining after acidification (1967-1976)
B	B-Plant high-activity waste – Rare earth (RE) fission products, recovered current acid waste (CAW), solvent wash waste, and any solution containing high activity (including cask station receipts, cell drainage containing product spills) (1967-1972)
BL	B-Plant low-activity waste – 1AW solvent extraction waste stream (includes complexants added for solvent extraction), the 1CP/organic wash waste during PAS processing, and insoluble solids remaining after treatment of solids centrifuged from CAW feed (i.e., acid leached and water washed PUREX high-level waste [HLW] sludge). Cell drainage and Waste Encapsulation Storage Facility (WESF) transfers with low radionuclide content (1967-1976)

SRR	High-activity waste from B-Plant processing of PUREX acidified sludge (PAS), solids centrifuged from AR vault feed, strontium purification wastes after solvent extraction (SX), RE or ion exchange (IX) rework, and other solutions containing activity (including cask station receipts, cell drainage containing product spills, WESF returns unsuitable for rework and crude RE disposal). (1969-1985)
CSR	Supernatants from which the cesium has been removed by ion-exchange. 241-C-801 cask station (1962-1967). B-Plant Waste Fractionization (1967-1976).

OTHER PROCESS FACILITY WASTES

Z	Plutonium Finishing Plant waste (1974-1988)
DW	Decontamination wastes, primarily from T Plant operations (1967-1976)
N	N Reactor decontamination waste (1976-1990)

MISCELLANEOUS WASTES

CEM	Portland cement added to tank 241-BY-105
DE	Diatomaceous earth added to six tanks (241-BX-102, 241-SX-113, 241-TX-116, 241-TX-117, 241-TY-106, and 241-U-104)
NIT	Partial neutralization feed for evaporator campaigns (1977-1981)

SALTCAKES AND SALT SLURRIES

BT-SltCk	Saltcake from 242-B Evaporator operation (1951-1953) and the 242-T Evaporator operation (1951-1955). Formerly BSltCk and T1SltCk.
BYSltCk	Saltcake from in-tank solidification (ITS) in BY-Farm (1965-1974)
RSltCk	Saltcake from self-concentration in S- and SX-Farms (1952-1966)
T2SltCk	Saltcake from the last 242-T Evaporator campaign (1965-1976)
A1SltCk	Saltcake from the first 242-A Evaporator campaign using 241-A-102 feed tank (1977-1980)
A2SltCk	Saltcake form the second 242-Evaporator campaign using 241-AW-102 feed tank (1981-1988)
S1SltCk	Saltcake from the first 242-S Evaporator campaign using 241-S-102 feed tank (1973-1976)
S2SltCk	Saltcake from the second 242-S Evaporator campaign using 241-SY-102 feed tank (1977-1980)

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1.0 PURPOSE

This report documents the improvements made to the Hanford Defined Waste (HDW) Model encompassed by Revision 5.0. New information generated since Revision 4.0 of the HDW Model has reduced the conservatism in some important areas. Specifically, the HDW Model has been updated to account for partitioning of tritium to cribs via evaporator condensates, ^{14}C and ^{129}I to the atmosphere, and ^{99}Tc with the uranium product shipped off-site. The opportunity has been taken, in this revision, to incorporate new *Oak Ridge Isotope Generation* (ORIGEN2) fuel activity estimates and to improve chemical process models. This report resolves issues and limitation identified in a Best-Basis Inventory workshop (see Appendix F) and an evaluation of the HDW model, *Hanford Defined Waste Model Limitations and Improvements* (Harmsen et al. 1998). This report also responds to an audit finding from the Best-Basis Inventory Data Defensibility Assessment, A-03-AMTF-TANKFARM-002-O-10, "*Ensure that potential short falls in the HDW update (data limitations and assumptions) are identified and formally documented*" (Schepens 2003).

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2.0 BACKGROUND

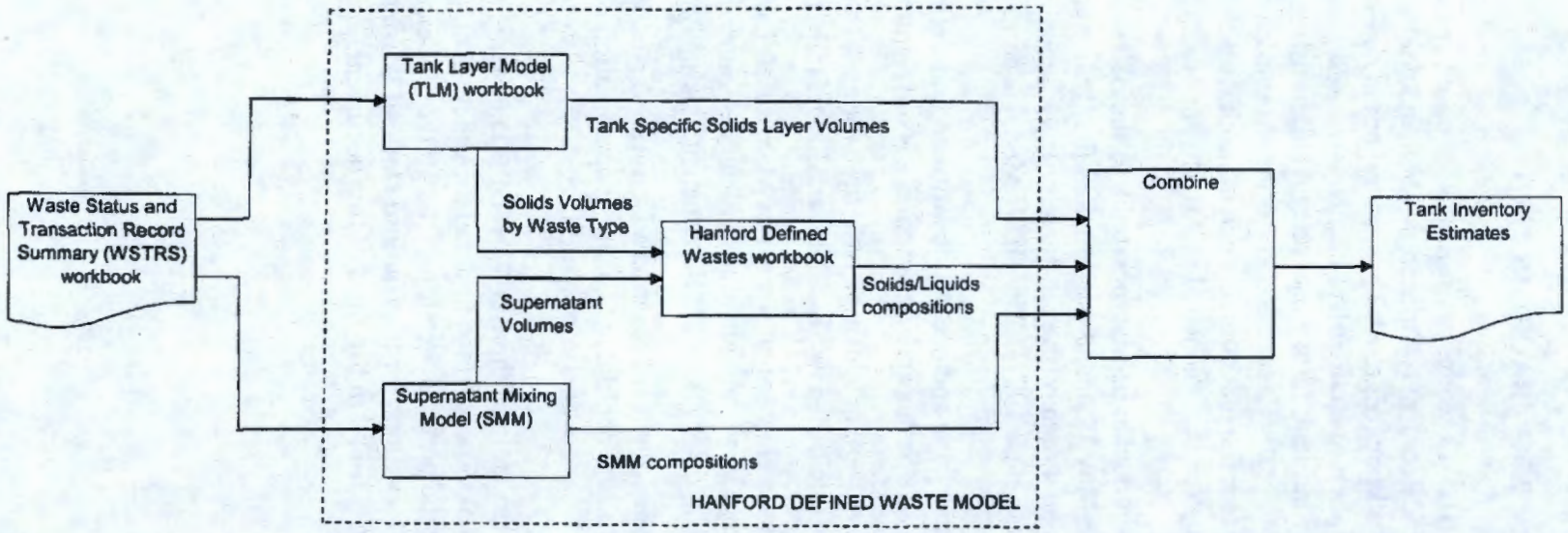
The Hanford Defined Waste (HDW) Model is a spreadsheet-based engineering estimate of the chemical and radionuclide contents of the single-shell and double-shell tanks. The calculation is based on process knowledge, which includes, but is not limited to, reactor fuel irradiation records, separation plant dissolver charging records, separation plant and tank farm process flowsheets, and tank farm waste receipt and transfer records. The calculation is made using Microsoft® Excel 2002 software. Microsoft defines a Microsoft® Excel workbook as a file that contains one or more worksheets. These definitions will be used throughout the balance of this report for clarity.

The first version of the HDW model to be incorporated into the BBI was Revision 3.0. Revision 3.0 was published in May 1996 and only tracked four radionuclides, ^{90}Sr, ^{137}Cs, uranium, and total Pu. Revision 4.0, published in January 1997, included an expanded list of 46 radionuclides (Agnew et al. 1997). The HDW Model is composed of four parts:

1. A compilation of the available and partially confirmed transaction records for all the tanks called the Waste Status and Transaction Record Summary (WSTRS);
2. A derivation of estimated solid deposition over time for each tank based on primary additions of waste called the Tank Layer Model (TLM);
3. A C++ algorithm, installed in a spreadsheet as a Microsoft® Excel macro, for estimating the effect of supernatant blending and concentration on waste composition and tank inventory with the Supernatant Mixing Model (SMM); and
4. Derived compositions for about fifty Hanford Defined Wastes, each of which has both sludge and supernatant components, using a combination of process information along with transaction information.

Figure 2-1 shows the overall structure of the HDW Model. The modeling approach for each of the functional workbooks is explained in detail in Agnew et al. (1997). The background and approach for the previous version of the HDW Model, Revision 4.0, is reproduced in Appendix E. Definitions for the Hanford Defined Wastes are provided in the "List of Waste Type Terms" found in the front of this document.

Figure 2-1. Schematic of Hanford Defined Waste Model Strategy.



3.0 BEST-BASIS INVENTORY INTERFACE WITH THE HDW MODEL

The Best-Basis Inventory (BBI) is the official database for tank waste inventory estimates at the U.S. Department of Energy (DOE) Hanford Site. Estimates are based on the "best" available information to describe in-tank waste contents. This includes sample-based information when available, process knowledge calculations, and waste type templates based on sample data, and the Hanford Defined Waste (HDW) Model waste composition estimates. The BBI process involves developing and maintaining waste tank inventory estimates comprising 24 chemical and 46 radionuclide constituents for 177 underground storage tanks. BBI waste composition and inventory data are used for safety analysis, risk assessments, and waste retrieval, treatment, and disposal planning. Frequently, sample data are limited or unavailable for most of the 46 radionuclides tracked by the BBI. The BBI is dependant upon the HDW Model to estimate these values.

The preferred basis for the BBI is sample characterization data directly from a tank. If direct sample data are not available, the inventory is estimated from analytical results for samples from tanks that contains the same waste type according to available process history data. When no sample data are available, the BBI uses estimates from the HDW Model (Field 2003). The BBI does not use individual tank inventory estimates made by the HDW Model but instead interfaces with waste type composition estimates calculated by the Hanford Defined Wastes workbook. These waste type compositions are used in the form of templates by the BBI (Higley et al. 2001).

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4.0 SCOPE OF REVISION

This update, Revision 5.0, is limited to updating the HDW Model Hanford Defined Wastes workbook because these estimates are used directly by the BBI to quantify tank contents. The balance of the HDW Model components (WSTRS, TLM, SMM, and tank estimates) was not included in the scope of Revision 5.0 because these portions of the HDW Model are not directly used by the BBI. The WSTRS, TLM, and SMM components of the HDW Model are considered legacy calculations and are not subject to verification for this revision of the HDW Model.

In addition, this revision has focused on resolving BBI user concerns regarding radionuclide inventories and their distribution. Little effort was spent on identifying and correcting problems with the chemical compositions of separation plant waste streams. Reviewing and updating of the chemical composition of separation plant waste streams was not an identified task for this revision.

The major changes made in this revision are in three major areas with nine items within these areas. These changes are described in the following sections:

- Updated Fuel Activity Estimates (Items 1-4),
- Improved Chemical Process Simulation (Items 5-8), and
- General Error Correction (Item 9).

4.1 UPDATED FUEL ACTIVITY ESTIMATES

Fuel activity estimates used in Revision 4.0 of the HDW Model were based on nuclear physics data dating from the 1980's and early 1990's. Fuel activity records estimated by the *Oak Ridge Isotope Generation* (ORIGEN2) reactor simulation code were updated to provide the best available information.

Item 1: An update of neutron capture cross sections for actinides and important activation products.

The ORIGEN2 cross sections for N Reactor fuel that were used in generating the 1996 DKPRO[2] analysis included errors in the treatment of capture to ground and excited states of the daughter nuclides. This primarily affected ^{243}Am capture to produce ^{244}Cm. This was changed in the 1996 ORIGEN2 analysis (Watrous and Wootan 1997) by changing the ^{243}Am cross section in the library. These errors were corrected with the release in 1997 of a revised ORIGEN2 cross section library. This cross section set is the current library in certified version of ORIGEN2 Version S.2 and was used in the current analysis.

Previous updating of the ORIGEN2 cross sections library had been limited to N Reactor cross sections. Separate cross sections for single pass reactors had not been generated.

[2] DKPRO is a computer code used for radioactive decay and processing calculations (Watrous et al. 2002).

Prior analysis in 1996 used N Reactor cross sections with the ^{238}U capture cross sections adjusted to match the total single pass reactor Pu production.

Models for K5E enriched and K5N natural cored fuel were selected to represent all single pass reactor fuel. Approximately 50 percent of single pass reactor production was in K reactors. The MONTEBURNS code was selected to generate cross sections as a function of geometry, composition, operating conditions, and burn-up for a single pass reactor cross section library.

Item 2: Update of half-lives and specific activities of BBI radionuclides.

The ORIGEN2 decay library contains the half lives and decay branching ratios used by both the ORIGEN2 and DKPRO to calculate the changes in inventory by decay both within and after the reactor. DKPRO calculates the radionuclide activities in a batch of fuel by interpolation on the ORIGEN2 generated inventory files as a function of fuel type and fuel exposure. The ORIGEN2 decay library in common use had not been updated since before 1980. More recent values of half-lives and branching ratios can be found in Evaluated Nuclear Data Files (ENDF/B-6), (England and Ryder 1994) evaluation files and other published references such as the *Nuclide and Isotopes, Fifteenth Edition Chart of the Nuclides* (Parrington et al. 1996). The approach taken to update the ORIGEN2 half-lives and branching ratios was to substitute the ORIGEN-S library (Hermann et al. 1998) which had been updated with ENDF/B-6 values and then update the half-lives of the 46 key BBI radionuclides to *Nuclide and Isotopes, Fifteenth Edition Chart of the Nuclides* (Parrington et al. 1996).

Item 3: Update of fission product yield values.

The ORIGEN2 cross section library includes fission product yields for eight fissionable isotopes (^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, ^{241}Pu, ^{245}Cm, and ^{249}Cf). The ORIGEN2 fission product yields in common use had not been updated since before 1980. More recent fission product yield values were available in ENDF/B-6 evaluation files (England and Ryder 1994). The ORIGEN2 fission product yields for all fission products were replaced with the ENDF/B-6 independent fission product yields corresponding to eight fissionable nuclides.

Item 4: A more detailed and comprehensive description of fuel and cladding impurities.

The prior ORIGEN2 simulation based the fuel activity estimates on four different fuel element compositions, aluminum clad single pass natural uranium, aluminum clad single pass enriched uranium, Zircaloy clad N Reactor MK-IV (0.94% enriched uranium), and Zircaloy clad N Reactor MK-1A (1.1% enriched uranium).

For the current set of ORIGEN2 simulations, an expanded set of time dependant fuel element compositions were developed. These changes included modeling three different aluminum claddings that accounted for a change in 1954 from a bronze dip to a lead dip fabrication process and a subsequent change from 1245 aluminum to X-8001 aluminum

(Kupfer et al. 1999). Different uranium compositions were used for single pass fuel and N Reactor fuel. Time-dependant information on the nitrogen and ^{236}U content of the fuel was also modeled.

A detailed discussion of the deficiencies in the previous ORIGEN2 libraries can be found in letter FDNW-RJP-98-028 (see Appendix C). Previous ORIGEN2 irradiated fuel simulations have applied the N Reactor radionuclide cross-section library to calculate source terms for the older single-pass reactors. Heeb (1991) discusses the limitations of this approach. An expanded discussion of the basis for and the results of the updated ORIGEN2 fuel activity estimates can be found in *Activity of Fuel Batches Processed Through Hanford Separation Plants, 1944 Through 1989* (Watrous et al. 2002). A discussion of the modeling approach used to implement these changes is provided in Sections 5.1 and 5.2.

4.2 IMPROVED CHEMICAL PROCESS SIMULATION

Other refinements dealt with modeling assumptions and simplifications that could either be eliminated or improved by changing how the HDW model received and manipulated the radionuclide source input.

Item 5: Separation of the fuel and cladding radionuclides into discrete components.

In the previous version of the HDW Model (Revision 4.0), the activity of the irradiated fuel was first decayed to January 1, 1994, and summed by multi-year campaign before calculating the separation of U, Pu, Np, and Th. This methodology caused problems in the estimation of daughter isotopes as well as in estimating losses of U and Pu by the separation plants. For Revision 5.0 of the HDW Model, these problems were solved by using a series of intermediate calculations. These intermediate calculations first separated the fuel into a cladding component and a uranium core component; second, decayed the separate components to the separation plant date indicated by fuel reprocessing records; third, calculated the amount of U, Pu, Np, and Th recovered and lost at the date of separation; and fourth, decayed the results to January 1, 2001. Between 1944 and 1972, the separation plant fuel reprocessing records are summarized by month. Records after 1972 are available in greater detail. Use of this procedure eliminated many of the simplifying assumptions inherent in the HDW Model. These intermediate calculations were carried out with the DKPRO code, version 3.1 (Watrous et al. 2002). The January 1, 2001 decay date was selected for consistency with the BBI decay index date. Additional discussion of the operations performed by DKPRO is found in Section 5.1.

Item 6: Incorporation of various documented process losses.

Revision 4.0 of the HDW Model (conservatively) neglects to model the loss of ^{3}H with plant process condensates and only crudely modeled tank farm evaporator condensates, ^{14}C to the atmosphere, ^{129}I to the atmosphere and solid waste, and ^{99}Tc with the uranium

product. Revision 5.0 incorporates modeling assumptions to account for these losses. Section 5.2 discusses how these losses were incorporated in the HDW Model.

Item 7: Improvements to chemical process models.

Users of the HDW Model were concerned by inaccuracies in the modeling of the Bismuth Phosphate process. As a result of this concern, new process split factors were developed for the Bismuth Phosphate plants from process flowsheets and laboratory simulation of the process. In addition, process split factors for the PUREX plants were updated to a documented source. Other improvements to the chemical process models included clarifying the various ^{90}Sr and ^{137}Cs extraction processes, and splitting the last PUREX production run into two distinct high-level waste streams. These changes are discussed in Section 5.4.

Item 8: Redefining selected physical and chemical assumptions used in describing the waste stream compositions.

Review of the Hanford Defined Wastes workbook identified several modeling assumptions in error with respect to solubility of individual radionuclides. In addition, during the workshop concerns were expressed regarding the validity of data used to derive the initial HDW Model solubility factors in October 1994. The method used by Agnew and Watkins (1994) to calculate solubility factors is basically to compute the mean of the top 25% of the available liquid concentrations for each analyte (75% trimmed mean). This methodology assumes that the top 25% of rank ordered data represents saturation for the analyte. The data set used by Agnew and Watkins was obtained from the May 1963 to October 1993 time period. For Revision 5.0, no attempt was made to alter the basic computation methodology. However, the data set on which the solubility factors are based was updated to newer analytical data (post-1989) that have improved analytical methods and Quality Assurance protocols. In addition, the data set was screened for outliers and the data for highly complexed wastes (Total Organic Carbon, liquid greater than 30 g/L) were evaluated separately to provide waste type specific estimates (Appendix C, interoffice memorandum 7G300-02-NWK-037). Additional changes to specific analytes and waste streams were made as needed to represent the results observed in tank farms. Further detail on the application of individual solubilities can be found in Section 5.3 and Appendix D.

4.3 GENERAL ERROR CORRECTION

Item 9: Correct obvious cell reference and formula errors.

During review of the Hanford Defined Wastes workbook, several modeling errors were identified. These errors included cell reference errors, and simple math and logic errors. These errors and the corrections made are summarized in Appendix B.

5.0 CHANGES MADE TO THE HANFORD DEFINED WASTE MODEL

Because of the complexity of some of the changes deemed necessary, some of the functions embedded in the HDW Model Hanford Defined Wastes workbook were determined to be more effectively carried out pre-HDW Model processing by other modeling codes or worksheets. Revision 4.0 of the HDW Model was developed using Microsoft® Excel 1997 as the software platform. Revision 5.0 of the HDW Model is calculated with Microsoft® Excel 2002 software.

5.1 FUEL ACTIVITY RECORDS

The primary radionuclide input to the HDW Model consists of a file of "pre-decayed and extracted" isotopic inventories (Fuel Activity Records) generated using the ORIGEN2 and DKPRO codes (Watrous et al. 2002). The DKPRO code solves the general problem of modeling complex nuclear waste streams using ORIGEN2 production files. The ORIGEN2 code is used to calculate initial radionuclide inventories as a function of fuel type, fuel burn-up, and reactor type, with subsequent decay and processing calculated by the DKPRO code. The most recent ORIGEN2 output includes all of the new technical information described in Section 4.1, Items 1-4.

Previous input for the HDW Model (Rev. 4.0) was generated with ORIGEN2 and DKPRO assuming no processing of the fuel, no removal of product constituents, and no splitting between fuel separations waste and cladding waste. The DKPRO code primarily performed the functions of interpolation and decay on the ORIGEN2 inventory files. The splitting between fuel separations and cladding waste streams and product recovery was performed in the HDW Model Hanford Defined Wastes workbook. This configuration contributed to problems with second order decay and loss of detail in the calculation of product recovery and in the splitting of the cladding waste stream from other process wastes.

For Revision 5.0 of the HDW Model, the DKPRO code was used to calculate the splitting of fuel separation and cladding waste streams and product recovery (Item 5 in Section 4.2). Input to the DKPRO code includes an archive file of separations processing records by fuel batch, a file of processing directives, a file of summary directives, and a set of ORIGEN2 inventory files representing unprocessed radionuclide inventories. The processing directives input to DKPRO are used to control the removal or splitting of the waste streams. Each fuel batch record contains data on fuel type, fuel tonnage, exposure, separations, reactor discharge date, separations date, and product recovery factors. For each fuel batch record DKPRO calculates the radionuclide activities in that batch of fuel by interpolation on the ORIGEN2 generated inventory files as a function of fuel type and fuel exposure (MWD/MTU) and then performs decay calculations and whatever processing instructions provided in the process directives file or the fuel records file. Output from the DKPRO code are two files (one for cladding waste and one for separations waste) of approximately 1300 Fuel Activity Records of pre-decayed

radionuclide values, each record representing the inventory associated with a batch of fuel processed by month (or shorter period) through individual separations plants, decayed to the reference decay date of January 1, 2001.

Figures 5-1 and 5-2 illustrate the data flow schematics described in this section. An expanded discussion of ORIGEN2 and DKPRO codes can be found in *Activity of Fuel Batches Processed Through Hanford Separation Plants, 1944 through 1989* (Watrous et al. 2002).

Figure 5-1. Preparation of Separate Core and Clad ORIGEN2 Files for Input to DKPRO.

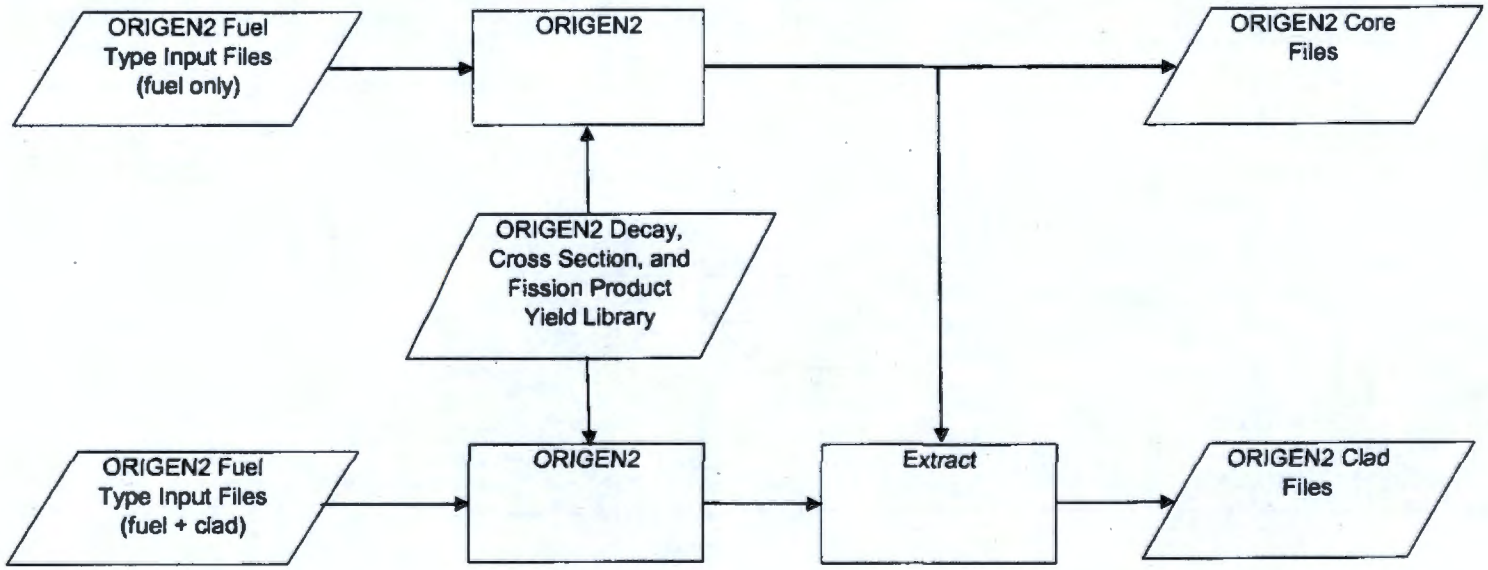
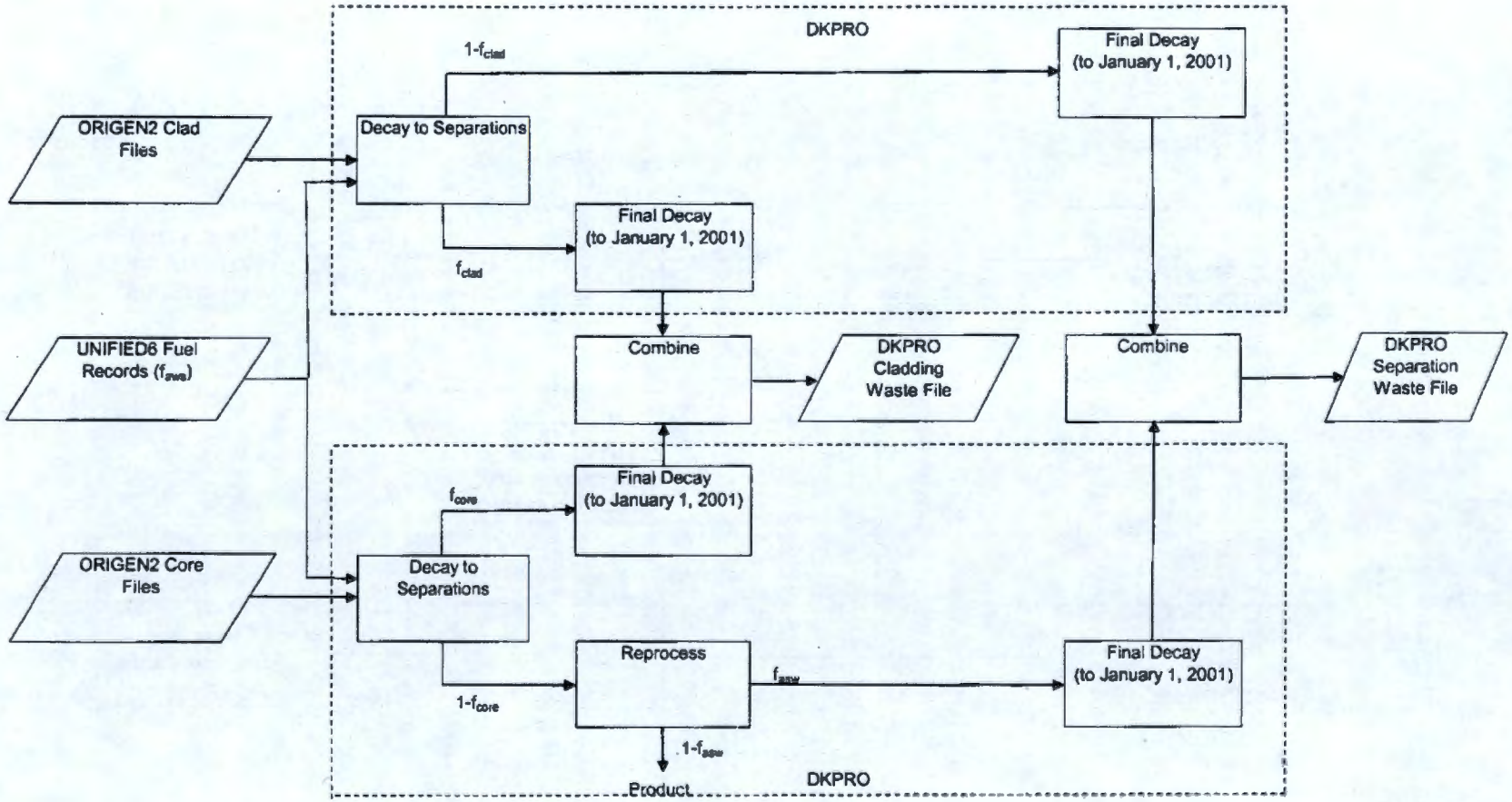


Figure 5-2. DKPRO Processing to Create Separate Cladding Waste and Separation Waste Inventories.



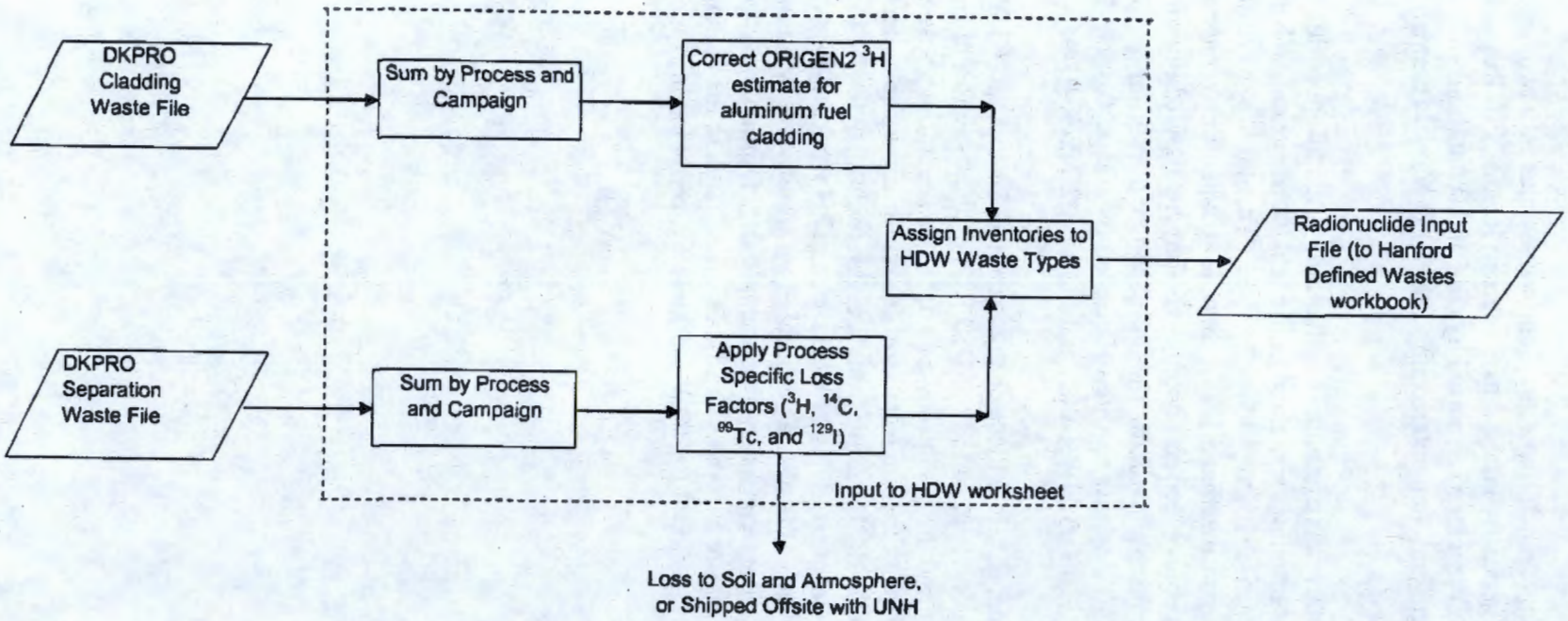
5.2 FUEL ACTIVITY DATA LOADING WORKSHEET

In general the HDW Model splits separation plant waste types into two to four campaigns per separation plant that generally lasted 4 to 6 years in length. For Revision 4.0 of the HDW Model, the DKPRO results were sorted by date and separations plant, summed by separation plant campaign, and then entered into the HDW Model Hanford Defined Wastes workbook.

For Revision 5.0, the conservative assumption that all of the radionuclides in the fuel, except for plutonium and uranium, remained in the tank farm system, is being relaxed (Section 4.2, Item 6). Several radionuclides (^{3}H, ^{14}C, ^{99}Tc, and ^{129}I) have chemical properties or processing histories that allowed them to escape or be removed from the waste. This reduction in source term is accomplished by acknowledging the behavior/property and explicitly reducing the initial source term prior to processing through the HDW model (Appendix C, interoffice memos 7G300-02-NWK-023, 7G300-02-NWK-030, 7G300-03-NWK-001, and 7G300-02-NWK-034).

A new interface worksheet to effect these changes named the Input to HDW worksheet was created. This new worksheet sorted the DKPRO results by date and separations plant and separately summed the cladding waste data and separations waste data by plant campaign. In addition, loss of tritium to the soil from in-plant waste concentration, atmospheric losses of ^{14}C and ^{129}I during from fuel dissolution, and ^{99}Tc loss with the uranium product were incorporated in this worksheet. This worksheet was also used to correct an overly conservative ORIGEN2 estimated tritium inventory for aluminum cladding waste to an inventory consistent with sample data (Appendix C, 7G300-03-NWK-012). Figure 5-3 show the data flow schematic for the Input to HDW worksheet. A printout of the Input to HDW worksheet is provided in Appendix D Supporting Information.

Figure 5-3. Input to HDW Worksheet Schematic.



5.3 SOLUBILITY WORKUP WORKBOOK AND HANFORD DEFINED WASTES WORKBOOK SOLUBILITIES WORKSHEET

For Revision 4.0 of the HDW Model, waste stream constituent solubility limits were calculated by computing the mean of the top 25% of the available liquid concentrations for each analyte (Agnew and Watkins 1994). A single solubility limit was calculated for each analyte and was applied to all waste steams. This calculation was completed outside of the HDW Model.

In Revision 5.0 of the HDW Model, more contemporary data were extracted from the Tank Waste Information Network System (TWINS) database (CH2M HILL 2002) and used to describe the solubility of the tank waste streams (Appendix C, interoffice memorandum 7G300-02-NWK-037). Instead of assuming single-point solubility for all waste streams for an analyte over a broad variety of conditions, a means to provide different, more appropriate solubility descriptions for each waste stream were developed (Section 4.2, Item 8).

For Revision 5.0, a new Solubility Workup workbook was developed and a new Solubilities worksheet was added to the Hanford Defined Wastes workbook. These changes were made to improve data traceability and to implement waste stream specific solubility factors.

The Solubility Workup workbook is used to convert solubility limits expressed as ion concentrations into molar solubility limits for the chemical compounds assumed by the HDW Model to be present in the waste. In addition, the workbook also calculates waste stream specific solubility limits for those waste streams that are complexed by organic species or that require compensation for the decay of short half-life radionuclides subsequent to solids layer formation.

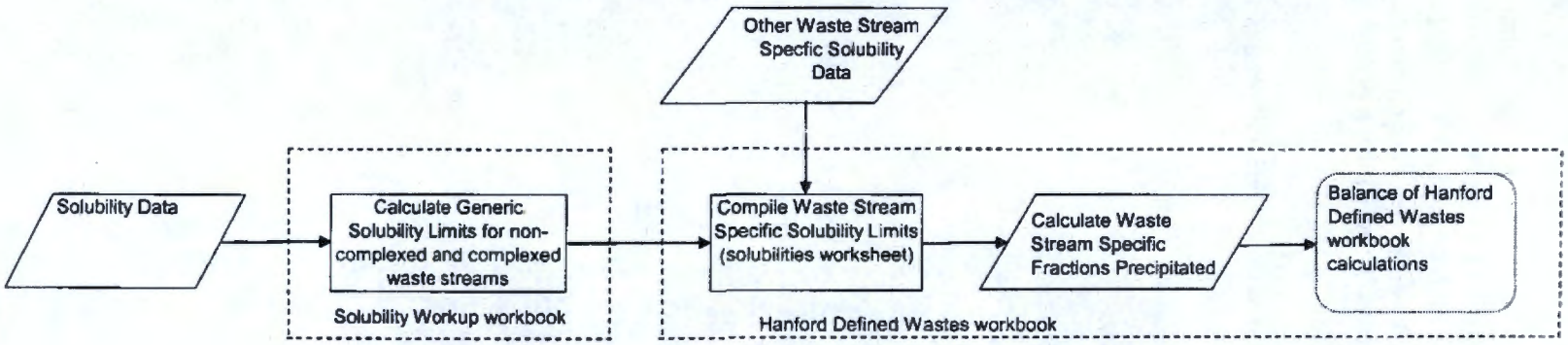
The Solubility Workup workbook interfaces with the Hanford Defined Wastes workbook through the Solubilities worksheet. Within the Solubilities worksheet, the solubility limits calculated by the Solubility Workup workbook can modified on a waste stream specific basis.

For Revision 5.0, the uranium solubility limit applied to metal waste was increased by a factor of 30 to allow for the complexing of uranium with carbonate. Revised solubility definitions in the HDW Rev. 5.0 for ^{90}Sr and ^{137}Cs in ferrocyanide waste streams (PFeCN1, PFeCN2, TFeCN, and 1CFeCN) were based on laboratory results for the ferrocyanide scavenging process (Sloat 1955a, Sloat 1955b, and Michelson 1957). The solubility of $CaCO_3$ was increased for the DW, N, and PASF waste streams to reflect the fact that these are very dilute, non-separations waste streams as opposed to the other HDW waste streams, which are of high ionic strength. The "solids fraction precipitated" for the P3AZ1 and P3AZ2 streams were adjusted to reflect tank farm surveillance information regarding the presence of solids and the unique conditions in tanks 241-AZ-101 and 241-AZ-102. These tanks are significantly warmer in temperature than other double-shell or single-shell tanks; the fraction of the sulfate precipitated varies

(11.3% for AZ-101 and 2.68% for AZ-102); the sodium concentration is relatively low (Na < 5 M); and the nitrate ion concentration is also low which precludes the formation of a nitrate-sulfate double salt. Additional details on waste stream specific solubility are provided in Appendix D.

A macro-driven subroutine within the Hanford Defined Wastes workbook applies the waste stream specific solubility factors from the Solubilities worksheet to the appropriate waste stream. Figure 5-4 shows the data flow schematic for the Solubility Workup workbook and the Solubilities worksheet. Printouts of the Solubilities worksheet and Solubility Workup workbook are provided in Appendix D.

Figure 5-4. Solubility Workup Workbook and Solubilities Worksheet Schematic.

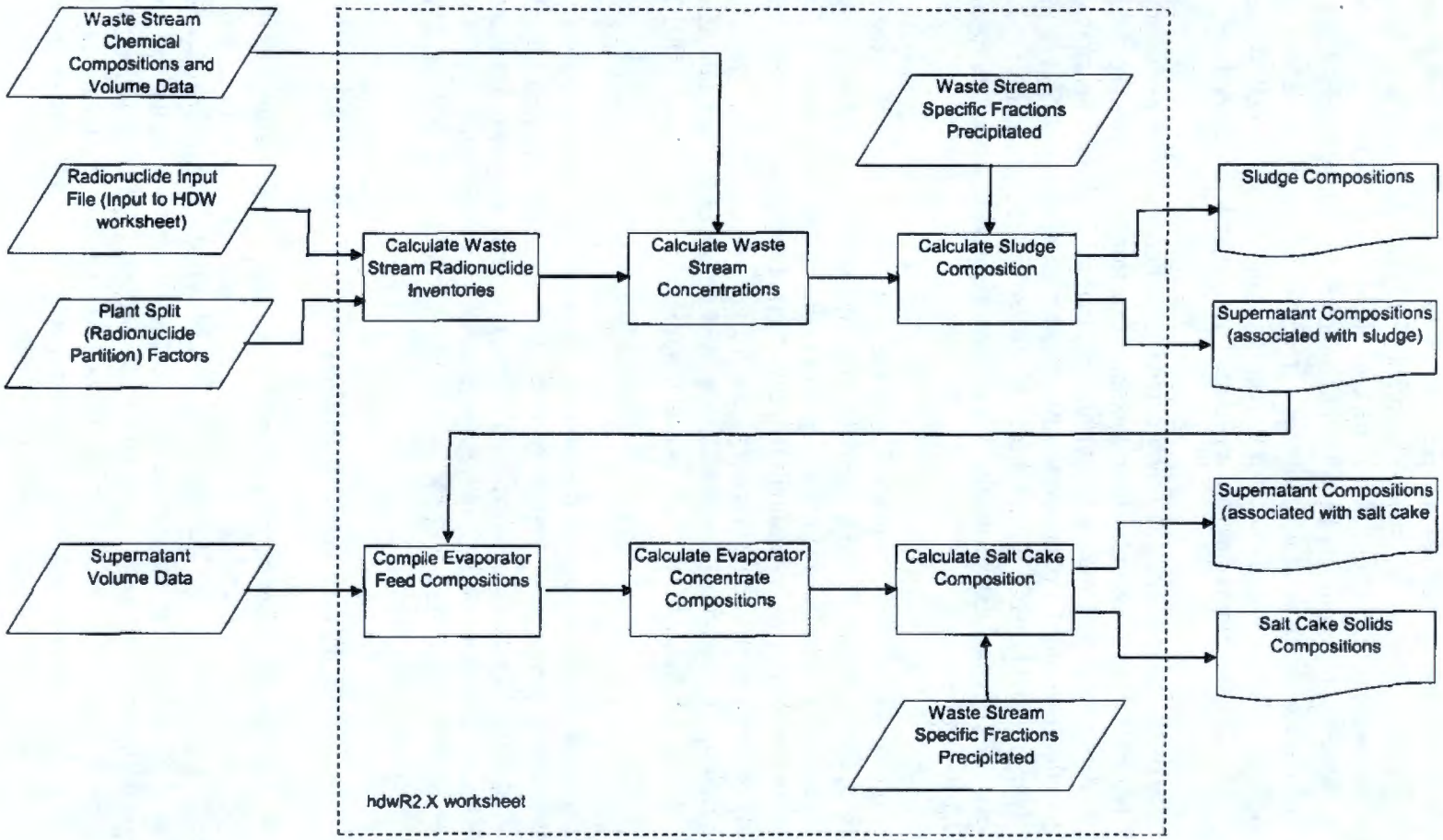


5.4 HANFORD DEFINED WASTES WORKBOOK

The functions of the Hanford Defined Wastes workbook are not significantly changed by this update to Revision 5.0. The Hanford Defined Wastes workbook is used to estimate the chemical and radionuclide concentrations for each of the HDW Model waste types. Each waste type consists of a supernatant composition and a sludge or saltcake composition. The sludge and saltcake compositions include both a precipitated solids component and an interstitial liquid component.

Figure 5-5 shows the data flow schematic for the Hanford Defined Wastes workbook hdwR2.X worksheet.

Figure 5-5. Schematic of the Hanford Defined Wastes Workbook hdwR2.X Worksheet.



5.4.1 hdwR2.X Worksheet

The hdwR2.X worksheet calculates the composition for each plant waste stream using information from process flowsheets and other plant records. Chemical compositions of waste streams are primarily defined by process flowsheets. Radionuclide concentrations of waste streams are calculated from the radionuclide inventory for the irradiated fuel processed each separations plant and a set of radionuclide partition factors specific to the process. The radionuclide inventories are copied from the Input to HDW worksheet and the radionuclide partition factors are embedded in the hdwR2.X worksheet.

Formation of sludge and saltcake is estimated by application of waste stream specific solubility limits from the Solubilities worksheet (Section 5.3) to each of the plant waste streams. A macro-driven subroutine within the Hanford Defined Wastes workbook calculates the fraction of a plant waste stream that precipitates as sludge or saltcake and enters them into the hdwR2.X worksheet. Measured saltcake densities reported by the BBI were used to benchmark saltcake densities values and correct water balance in the hdwR2.X worksheet.

In addition to estimating the composition of the wastes discharged from the Bismuth Phosphate, REDOX and PUREX irradiated fuel-plutonium production process facilities, the hdwR2.X worksheet also simulates re-processing of the waste streams from these facilities by the Tributyl phosphate (TBP) Plant (uranium recovery), Hot Semiworks, and B-Plant (cesium and strontium recovery), and various tank farm evaporators (tank waste concentration). The feed streams for these second tier processes are calculated from the waste streams discharged from the Bismuth Phosphate, REDOX, and PUREX process facilities.

Numerous changes were made to the hdwR2.X workbook that involved waste stream definition, improvements to chemical process models (Item 7, Section 4.2), incorporation of updated solubility data, and correction of cell reference and formula errors (Item 9, Section 4.3). A printout of the hdwR2.X workbook is provided in Appendix A. A record of the changes made to the hdwR2.X workbook for Revision 5.0 of the HDW Model is provided in Appendix B.

5.4.2 Changes to Waste Stream Definitions

Revision 5.0 includes a number of changes to the waste stream definitions used by the hdwR2.X worksheet. In Revision 4.0, the 224 waste stream did not account for wastes generated prior to 1952. For Revision 5.0, the 224 waste type was redefined as 224-1 and 224-2 to account for these earlier wastes. The 224-1 waste was generated from 1944 through 1949, and 224-2 waste covers the 1950 through 1956 time period. Initially, 224 waste was disposed of in 20-ft diameter unlined concrete settling tanks, 241-B-361 and 241-T-361. When these tanks were filled to capacity, the 224 waste was routed to the 241-B-200 and 241-T-200 series tanks beginning in October 1946 (Greager 1946 and Lauder 1946).

The BSltCk and T1SltCk waste types were combined into a single waste type B/T1SltCk. This change was made to facilitate development of a saltcake composition with a high total organic carbon content. Combination of the BSltCk and T1SltCk was necessary to open space in the Hanford Defined Wastes workbook without reworking the SMM model itself. Separation of saltcakes complexed by organic chemicals from other saltcakes would allow the inventory of tanks containing these wastes to be more concisely estimated. Development of a separate organic saltcake stream was not completed. This would have required renaming numerous waste transfer records within the WSTRS database, which was well beyond the scope of the update.

In Revision 4.0, several of the saltcake models (S1SltCk, S2SltCk, A1SltCk, and A2SltCk) were incomplete, and saltcake inventories were predicted by the Supernatant Mixing Model (SMM). This was a change from Revision 3 where all of the saltcakes were modeled, due to improved predictions within the tanks from individual predictions from the SMM. However, the SMM does not provide the separate liquid and solid phase data needed by the BBI. Phase-specific saltcake (S1SltCk, S2SltCk, etc.) models were completed for Revision 5.0.

The P3 waste stream (PUREX high-level waste 1983-1989) was split into P3AZ1 (PUREX high-level waste to tank 241-AZ-101, 1983 through March 13, 1986), and P3AZ2 (PUREX high-level waste to tank 241-AZ-102, March 13, 1986 through 1990). This change was made to more accurately model these two high-activity tanks. Most of the aluminum sent to tank 241-AZ-102 precipitated because of low hydroxide concentration, and the PUREX usage of ferrous sulfamate was higher during filling of this tank due to neptunium recovery operations.

5.4.3 Improvements to Chemical Process Models

The most significant changes in this area were a re-evaluation of the Bismuth Phosphate process and PUREX process split factors (Section 4.1, Item 7). The hdwR2.X worksheet uses process split factors to distribute radionuclides in the fuel to the various waste streams produced by the separations plants.

Revision 4.0 the HDW model used a simple 0.889/0.1/0.01/0.001 split to distribute the radionuclides to the MW, 1C, 2C, and 224 waste streams. This distribution is believed to be based on a statement in the *Hanford Works Technical Manual Part C* (GE 1944) which states that approximately 90% of the fission products went with the metal waste, and about 10% with the first cycle waste, second cycle and 224 waste. This statement is accurate for the fission products with half-lives of less than 65 days which dominated the waste activity during operation of the Bismuth Phosphate processes. However, for the radionuclides of interest to the BBI, this statement is not accurate. A new set of Bismuth Phosphate process split factors was developed based on a review of process flowsheets, plant test data, and a laboratory simulation of the plutonium product extraction step (Appendix C, interoffice memorandum 7G300-02-NWK-024). These new process split factors substantially reduced the activity estimated for the 1C, 2C, and 224 waste streams.

Several errors were corrected pertaining to the calculation of the TBP, PFeCN1, PFeCN2, TFeCN, and 1CFeCN streams. In Revision 4.0, the radioactivity of the TBP, PFeCN1, and PFeCN2 were based on the total fuel activity charged to the $BiPO_4$ process. For Revision 5.0, the TBP, PFeCN1, and PFeCN2 streams were linked to the $BiPO_4$ process metal waste activity to more accurately simulate metal waste sluicing. Previously, the activity of the TFeCN waste stream was based on the activity of the TBP waste sent to tank farms. For Revision 5.0, the TFeCN activity was based on the activity of the supernatants scavenged in 244-CR Vault. These supernatants consisted of TBP supernatant and the commingled supernatants from other wastes stored in the same tanks. This change more correctly aligns the calculations with actual the 244-CR Vault in-farm scavenging process. The activity of the 1CFeCN in Revision 4.0 of the model was calculated from the activity of the first cycle waste with cladding waste. For Revision 5.0, the activity of the 1CFeCN waste stream is based on the activity of the first cycle waste only, because when implemented in T-Plant, cladding waste was segregated and disposed separately from the first cycle waste scavenging process (Coppinger and Smith 1954).

Several errors in the representation of the Hot Semiworks and the B-Plant Waste Fractionization were identified in Revision 4.0 of the HDW Model. Mercury is now included in the waste stream descriptions for these processes. Several organic species, incorrectly assigned to the SRR waste, were added to the BL waste. These errors were corrected for Revision 5.0, and the corrections made are discussed in Appendix B, Change Record for Revision 5.0. Additional discussion on modeling of the Hot Semiworks waste streams is provided in Section 7.2.21.

The process split factors used in Revision 4.0 of the HDW model over-simplify the PUREX process by routing 100% of the fission products to the high-level waste stream, 0% of the fission products to low-level wastes, and 0.4% to the cladding waste. New process split factors were developed for the PUREX process based on a review of process flowsheets and other documents (Appendix C, interoffice memorandum 7G300-03-NWK-011).

5.4.4 Waste Stream Specific Solubilities

New solubility factors generated by the Solubility Workup workbook were incorporated into the Hanford Defined Wastes workbook (Section 4.2, Item 8, and Section 5.3). For Revision 5.0, the Hanford Defined Wastes workbook was modified to allow waste stream specific solubility factors to be used rather than the global solubility factors used for all waste streams in Revision 4.0. This feature allows the use of specific solubility limits for those waste streams that are complexed by organic species or that require compensation for the decay of short half-life radionuclides subsequent to solids layer formation. This feature also allows scavenging processes to be more accurately modeled. Waste stream specific exceptions to the general solubility limits are discussed in Section 5.3.

5.4.5 Cell Reference and Formula Errors

During checking of the spreadsheet, many errors relating to cell references, incorrect formulas, and macros were identified and corrected (Item 9, Section 4.3). Specific details of these changes are listed in Appendix B.

5.5 CHECKING OF THE HDW MODEL

Checking of the model was limited to the Hanford Defined Wastes workbook which includes the Input to HDW worksheet, the Solubilities worksheet, and the hdwR2.X worksheet. The WSTRS, TLM, and SMM components of the model are considered legacy calculations and are not subject to verification for this revision of the HDW Model. Appendix G summarizes the methods used to check the HDW Model.

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6.0 RESULT OF CHANGES TO THE HDW MODEL

The changes made to the HDW Model have reduced the estimated tank waste inventories of many radionuclides and, in particular, most of the key soluble radionuclides. Estimates of activation product inventories have increased due to a more comprehensive description of fuel and cladding impurities. Correction of outdated half-lives reduced the inventory of ^{79}Se and ^{126}Sn. Accounting for process losses reduced the tank inventory of ^{3}H, ^{14}C, ^{99}Tc, and ^{129}I. Table 6-1 compares the current ORIGEN2 prediction of the fuel activity (Watrous et al. 2002) with the ORIGEN2 prediction used for the previous version of the HDW Model (Watrous and Wootan 1997). Table 6-2 compares the current HDW Model tank inventory estimate with that from the previous version of the HDW Model.

Table 6-1. Comparison of 1997 and 2002 ORIGEN2 Fuel Activity Estimates (All values have been decayed to January 1, 2001). (2 Sheets)

Radionuclide	1997 ORIGEN2 Fuel Activity Estimate (Ci)	2002 ORIGEN2 Fuel Activity Estimate (Ci)	Change in Estimated Inventory (Percent)	Comment
^{3}H	1.60E+5	1.85E+5[a]	+15%	Revised Li impurity
^{14}C	4.90E+3	3.94E+3	-20%	Fuel impurity history change
^{59}Ni	1.18E+03	1.33E+3	+12%	---
^{63}Ni	1.11E+05	1.27E+05	+15%	---
^{60}Co	5.29E+03	1.61E+04	+204%	Postulated 1 ppm ^{59}Co fuel impurity. See Section 7.1
^{79}Se	1.00E+03	7.90E+01	-92%	Half-life change
^{90}Sr	8.80E+07	8.79E+07	0%	---
^{90}Y	8.80E+07	8.79E+07	0%	---
^{93}Zr	4.74E+03	4.72E+03	0%	---
^{93m}Nb	3.86E+03	3.73E+03	-3%	---
^{99}Tc	3.31E+04	3.43E+04	+3%	---
^{106}Ru	9.26E+02	1.06E+03	+14%	---
^{113m}Cd	1.61E+04	5.79E+03	-64%	Fission product yield change
^{125}Sb	3.81E+04	1.90E+04	-50%	Fission product yield change
^{126}Sn	1.53E+03	3.29E+02	-79%	Half-life change
^{129}I	6.41E+01	4.94E+01	-23%	Fission product yield change
^{134}Cs	8.45E+03	8.56E+03	+1%	---
^{137}Cs	1.02E+08	1.04E+08	+2%	---
^{137m}Ba	9.67E+07	9.83E+07	+2%	---
^{151}Sm	3.35E+06	3.30E+06	-2%	---
^{152}Eu	1.32E+03	1.07E+03	-19%	---
^{154}Eu	9.89E+04	9.19E+04	-7%	---
^{155}Eu	6.03E+04	5.14E+04	-15%	---

Table 6-1. Comparison of 1997 and 2002 ORIGEN2 Fuel Activity Estimates (All values have been decayed to January 1, 2001). (2 Sheets)

Radionuclide	1997 ORIGEN2 Fuel Activity Estimate (Ci)	2002 ORIGEN2 Fuel Activity Estimate (Ci)	Change in Estimated Inventory (Percent)	Comment
^{226}Ra	7.70E-02	1.14E-01	+48%	In-growth increase from change in reference decay date
^{228}Ra	6.67E+01	5.97E+01	-10%	---
^{227}Ac	1.25E+02	5.11E+00	-96%	Thorium cross-section change
^{231}Pa	1.91E+02	8.21E+00	-96%	Thorium cross-section change
^{229}Th	2.91E+01	2.66E+01	-9%	---
^{232}Th	6.88E+01	6.08E+01	-12%	---
^{232}U	2.82E+03	1.43E+02	-95%	Thorium cross sections were adjusted to known ^{233}U production and ^{232}U impurity levels.
^{233}U	1.17E+04	8.41E+03	-28%	Thorium cross sections were adjusted to known ^{233}U production and ^{232}U impurity levels.
^{234}U	3.56E+04	3.55E+04	0%	---
^{235}U	1.47E+03	1.47E+03	0%	---
^{236}U	1.17E+03	1.02E+03	-13%	---
^{238}U	3.29E+04	3.29E+04	0%	---
^{237}Np	2.76E+02	2.44E+02	-12%	---
^{238}Pu	1.23E+05	1.13E+05	-8%	---
^{239}Pu	3.72E+06	3.84E+06	+3%	---
^{240}Pu	6.78E+05	8.77E+05	+29%	Single-pass reactor cross-section change
^{241}Pu	7.12E+06	7.84E+06	-10%	---
^{242}Pu	4.25E+01	5.25E+01	+24%	Single-pass reactor cross-section change
^{241}Am	8.85E+05	9.98E+05	+13%	---
^{243}Am	4.19E+01	4.22E+01	+1%	---
^{242}Cm	1.06E+02	7.33E+01	-31%	Single-pass reactor cross-section change
^{243}Cm	1.16E+01	7.74E+00	-33%	Single-pass reactor cross-section change
^{244}Cm	2.40E+02	1.92E+02	-20%	Single-pass reactor cross-section change

Note:

(a) The tritium estimate shown in this table has been adjusted from the ORIGEN2 estimate to reconcile the tritium content of aluminum fuel cladding with cladding waste sample data.

Table 6-2. Change in HDW Model Predicted Tank Waste Radionuclide Inventories (All values are reported as of January 1, 2001). (3 Sheets)

Radionuclide	HDW Model Rev. 4.0 (Ci)	HDW Model Rev. 5.0 (Ci)	Change in Estimated Tank Waste Inventory (Percent)	Primary Reason for Change
^{3}H	4.83E+04	9.52E+03	-80%	Modeling of process losses
^{14}C	4.80E+03	8.51E+02	-82%	Modeling of process losses
^{59}Ni	9.34E+02	1.32E+03	+41%	Corrected material balance error
^{63}Ni	8.73E+04	1.26E+05	+44%	Corrected material balance error
^{60}Co	4.90E+03	1.60E+04	+226%	Postulated 1 ppm ^{59}Co fuel impurity. See Section 7.1
^{79}Se	7.73E+02	7.70E+01	-90%	Half-life change
^{90}Sr	5.21E+07	5.04E+07	-3%	---
^{90}Y	5.21E+07	5.04E+07	-3%	---
^{93}Zr	3.63E+03	4.64E+03	+28%	Corrected material balance error
^{93m}Nb	2.97E+03	3.66E+03	+23%	Corrected material balance error
^{99}Tc	3.26E+04	2.51E+04	-23%	Modeling of process losses
^{106}Ru	8.48E+02	1.06E+03	+24%	Corrected material balance error and half-life change
^{113m}Cd	1.21E+04	5.72E+03	-53%	Fission product yield change
^{125}Sb	3.61E+04	1.90E+04	-47%	Fission product yield change
^{126}Sn	1.19E+03	3.21E+02	-73%	Half-life change
^{129}I	6.30E+01	3.18E+01	-50%	Fission product yield change and modeling of process losses
^{134}Cs	8.39E+03	8.40E+03	0%	---
^{137}Cs	4.01E+07	3.92E+07	-2%	---
^{137m}Ba	3.79E+07	3.70E+07	-2%	---
^{151}Sm	2.61E+06	3.22E+06	+23%	Corrected material balance error
^{152}Eu	1.03E+03	1.07E+03	+3%	---
^{154}Eu	8.38E+04	9.17E+04	+9%	---
^{155}Eu	5.13E+04	5.12E+04	0%	---
^{226}Ra	6.29E-02	9.14E-03	-85%	Stopped in-growth at date of U separation

Table 6-2. Change in HDW Model Predicted Tank Waste Radionuclide Inventories (All values are reported as of January 1, 2001). (3 Sheets)

Radionuclide	HDW Model Rev. 4.0 (Ci)	HDW Model Rev. 5.0 (Ci)	Change in Estimated Tank Waste Inventory (Percent)	Primary Reason for Change
^{228}Ra	3.96E+01	3.04E+00	-92%	Stopped in-growth at date of Th separation
^{227}Ac	1.01E+02	4.62E+00	-95%	Thorium cross-section change
^{231}Pa	1.56E+02	7.09E+00	-95%	Thorium cross-section change
^{229}Th	1.81E+00	1.41E+00	-22%	DKPRO modeling of separations by fuel record
^{232}Th	4.36E+00	2.80E+00	-36%	DKPRO modeling of separations by fuel record
^{232}U	2.42E+02	7.45E+00	-97%	Thorium cross sections were adjusted to known ^{233}U production and ^{232}U impurity levels
^{233}U	9.94E+02	4.49E+02	-55%	Thorium cross sections were adjusted to known ^{233}U production and ^{232}U impurity levels
^{234}U	8.50E+02	3.22E+02	-62%	Improved information on metal waste sluicing
^{235}U	3.66E+01	1.38E+01	-62%	Improved information on metal waste sluicing
^{236}U	1.61E+01	8.25E+00	-49%	Improved information on metal waste sluicing
^{238}U	9.06E+02	3.04E+02	-66%	Improved information on metal waste sluicing
^{237}Np	1.41E+02	1.27E+02	-10%	Single-pass reactor cross-section change
^{238}Pu	1.96E+03	1.97E+03	+1%	---
^{239}Pu	4.69E+04	3.23E+04	-31%	DKPRO modeling of separations by fuel record
^{240}Pu	9.86E+03	7.96E+03	-19%	Single-pass reactor cross-section change and DKPRO modeling of separations by fuel record
^{241}Pu	1.19E+05	1.27E+05	+7%	DKPRO modeling of separations by fuel record
^{242}Pu	7.90E-01	7.92E-01	0%	---

Table 6-2. Change in HDW Model Predicted Tank Waste Radionuclide Inventories (All values are reported as of January 1, 2001). (3 Sheets)

Radionuclide	HDW Model Rev. 4.0 (Ci)	HDW Model Rev. 5.0 (Ci)	Change in Estimated Tank Waste Inventory (Percent)	Primary Reason for Change
^{241}Am	7.07E+04	8.24E+04	+17%	In-growth due to decay date change
^{243}Am	9.33E+00	4.22E+01	+352%	Incorrect entry of fuel activity in HDW Model Rev. 4.0
^{242}Cm	7.44E+01	7.32E+01	-2%	---
^{243}Cm	8.43E+00	7.74E+00	-8%	---
^{244}Cm	1.85E+02	1.91E+02	+3%	---

In addition to the overall changes in the tank waste inventory, other changes to the model resulted in redistribution of radionuclide inventories between waste streams:

- Radionuclide inventories of the Bismuth Phosphate first cycle, second cycle, and 224 wastes were substantially reduced due to a better understanding of the Bismuth Phosphate process chemistry.
- Improved modeling of the irradiated fuel and separation plant head-end processing resulted in ^{3}H, ^{14}C, ^{59}Ni, and ^{63}Ni inventories being shifted from high-level waste streams to cladding waste streams.
- The fraction of uranium reporting to sludge layers increased because of more realistic solubility modeling.
- The inventory of ^{233}U was decreased based on benchmarking thorium irradiation to production data.
- Plutonium and uranium losses were reconciled to plant records.
- Americium-241 to ^{241}Pu ratios were made consistent and reasonable, especially for cladding waste streams.
- Corrections of the input quantities and disposition of lead and mercury chemicals were made.
- The saltcake waste types were normalized to the measured saltcake densities to resolve a model sensitivity to water imbalances across the various evaporators. This resulted in reducing liquid waste concentrations to more realistic values.

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7.0 LIMITATIONS OF THE HANFORD DEFINED WASTE MODEL

The Best-Basis Inventory Data Defensibility Assessment included audit finding A-03-AMTF-TANKFARM-002-O-10, "*Ensure that potential shortfalls in the HDW update (data limitations and assumptions) are identified and documented,*" (Schepens 2003).

Additionally, Section 5.6.3.1 of the *Recommendation 93-5 Implementation Plan* lists milestones for addressing Defense Nuclear Facility Safety Board concerns regarding tank characterization and safety. Milestone 5.6.3.1.i includes a requirement to issue a report addressing "Updates to the Tank Contents Model or Define Limitations to the Model." A report in response to this milestone was issued in 1998 by Harmsen et al. Section 7.1 reviews the findings of the Harmsen et al. (1998) study and the corrective action taken in Revision 5.0 of the HDW Model. Limitations of the HDW Model identified subsequent to the Harmsen et al. (1998) report are discussed in Section 7.2.

7.1 HDW MODEL LIMITATIONS AND IMPROVEMENTS REPORT

Harmsen et al. (1998) identified limitations and simplifications used in the HDW model, as well numerous modeling assumptions used for undefined or vaguely defined processes that affected both global inventory estimates and individual tank inventory estimates. These limitations and the changes made in Revision 5.0 of the HDW Model are summarized in Tables 7-1 and 7-2.

Table 7-1. Limitations Affecting Global Inventory Estimates. (2 Sheets)

Limitation Affecting Global Inventory Estimates	HDW Model Improvement for Revision 5.0
Many of the ORIGEN2 modeling parameters have not been updated since before 1980	ORIGEN2 nuclear data libraries were updated to ENDF/B-6 (England and Ryder 1994). Half-lives and specific activities were updated to the 15th Edition of the Chart of the Nuclides (Parrington et al. 1996).
Improve modeling of single-pass reactors	Single-pass reactor specific cross section data was developed for the ORIGEN2 libraries using the MONTEBURNS code (Watrous et al. 2002).
Improve fuel impurity history	Additional fuel composition data were incorporated into the ORIGEN2 calculations (Watrous et al. 2002).

Table 7-1. Limitations Affecting Global Inventory Estimates. (2 Sheets)

Limitation Affecting Global Inventory Estimates	HDW Model Improvement for Revision 5.0
The inventory of activation products (^{14}C, ^{60}Co, ^{59}Ni, ^{63}Ni, etc.) is uncertain due to poorly characterized impurity levels.	Three activation products, ^{3}H, ^{14}C, and ^{60}Co retain a high degree of uncertainty regarding their overall production amount. Tritium is formed from activation of lithium impurities and ^{14}C is formed from activation of nitrogen impurities. Measurements of the lithium and nitrogen content of aluminum cladding are not available. The lithium and nitrogen content of the aluminum cladding was indirectly inferred from tank sample data. The absence of data on ^{59}Co impurities in the fuel was not resolved, and a nominal amount (1 ppm) was included for future scaling if impurity data becomes available.
Losses of radionuclides (^{3}H, ^{14}C, ^{99}Tc, and ^{129}I) to atmosphere, process condensate, and product streams are (conservatively) neglected.	Assumptions to estimate the loss of ^{3}H, ^{14}C, ^{99}Tc, and ^{129}I were developed and implemented in Revision 5.0 of the HDW Model.
Adding decay correction calculations to the model for ^{233}U and ^{238}Pu.	This problem was corrected by re-configuration of the DKPRO code.
The U, Pu, and Np decay daughters are significantly over predicted as a result of the HDW Model performing process separations after the decay to January 1, 1994, rather than before at the time of fuel separation.	This problem was corrected by re-configuration of the DKPRO code to calculate the decay up to the separation date, compute the separation, and decay the remaining U, Pu, and Np to January 1, 2001.
Adding a new radionuclide to the model – activation product ^{36}Cl.	Nominal amounts (1 ppm) of chlorine and cobalt were added to the fuel compositions in ORIGEN2 calculations to allow tracking and scaling of activation products ^{36}Cl and ^{60}Co if information on actual impurity levels for these elements in the fuel is developed. ^{36}Cl is not currently tracked by the HDW Model or the BBI.
Correcting the apparent error in the model's prediction (under prediction) of ^{243}Am.	This problem was corrected by re-configuration of the DKPRO code to calculate the cladding and separation inventories separately. (Incorrect values for ^{243}Am were entered into the HDW Model Rev. 4.0.)
For the extracted product elements (U, Pu, Th, and Np) the model has used loss factors containing uncertainties which cannot be characterized.	The global product extraction factors were replaced with monthly (or shorter) fuel batch specific extraction factors. These factors are based on accountability records.

Table 7-2. Limitations Affecting Individual Tank Estimates.

Limitations Affecting Individual Tank Estimates	HDW Model Improvement for Revision 5.0
Updating the model with improved solubility parameters	New solubility factors were derived using newer analytical data (post-1989) from the Tank Characterization database that have improved analytical methods and Quality Assurance protocols. These solubility descriptions provide more appropriate chemical concentrations for the various waste streams.
Updating the model with improved radionuclide split factors	New radionuclide split factors were developed for the Bismuth Phosphate process and the PUREX process
Updating the model with adjusted solids carryover factors for cascaded tanks.	No changes were made to the model
Waste Transaction Database (WSTRS) Errors - Approximately 40% of the WSTRS transactions have not been verified. Waste transactions that have occurred since January 1, 1994 are not included in the WSTRS database.	Update of the WSTRS file was beyond the scope of this update (Revision 5.0) of the HDW Model.
Waste Averaging – Averaging of fuel batch activity over several years introduces uncertainty because over several years of fuel exposures were increased significantly and separation plant flowsheets were improved to significantly reduce the volume of waste generated per MTU. The error occurs because the HDW Model assumes a constant average waste type for the period.	Averaging of fuel batch activity and separation plant flowsheet was not changed by Revision 5.0.
Verification/updating model tank layering profiles (TLM model) based on core sample profiles from tanks that have been core sampled.	Updating of the tank layer model (TLM) to match core sample profiles is outside the scope of this revision. The BBI protocols allow for the core profile tank layer assessments in calculation of BBI tank specific estimates (Field 2003)
Modifying the HDW model to generate tank specific estimates that more closely match sample results for key radionuclides.	The BBI does not utilize HDW model tank specific estimates. Model features such as the SMM and TLM that contribute to tank specific estimates have not been modified. In addition, matching model results to tank-specific sample results is not useful without understanding and quantifying the uncertainties inherent in both data sets, and having a metric that can legitimately quantify these comparisons.

7.2 THE LIMITATIONS OF THE HANFORD DEFINED WASTE MODEL

This section discusses HDW Model limitations and uncertainties that were not identified by Harmsen et al. (1998). In general, the HDW Model tends to over simplify the actual behavior of waste in the tanks. Many of the limitations discussed in the following paragraphs relate to tank chemistry and operation phenomena that are beyond the capabilities of the HDW Model.

7.2.1 Return of ^{99}Tc with Recycled Uranium

Fuel activity estimates by ORIGEN2 did not consider the return of ^{99}Tc with recycled uranium. Recycled uranium contained about 3 ppm ^{99}Tc (Appendix C, interoffice memorandum 7G300-03-NWK-001). The recycle of ^{99}Tc was considered in estimating the amount of ^{99}Tc shipped off-site with recovered uranium but the activation of the recycled ^{99}Tc to ^{100}Tc and subsequent decay to stable ^{100}Ru was not modeled by ORIGEN2.

7.2.2 Estimation of Radium Content of Irradiated Fuel

^{226}Ra is formed by decay from ^{238}U and is naturally present in uranium ore. ^{228}Ra is formed by decay from ^{232}Th and is naturally present in thorium. Assumptions used by ORIGEN2 underestimate the radium inventory in the irradiated fuel and tank waste. ORIGEN2 modeling of the reactor fuel assumed that uranium and thorium targets were free of radium at the time of irradiation. The quantity of ^{226}Ra initially present as an impurity in the uranium metal is not known. The radium content of the fuel is a function of the radium content of uranium at the time it was separated by an enrichment plant or by a smelting process plus the in-growth of radium that has occurred since the metal refining date. The lead time between enrichment/smelting and irradiation is unknown. The radium impurity content of enriched uranium and natural uranium (from the smelter) are likely to be different. During fuel fabrication, natural uranium was often blended with enriched uranium. The true ^{228}Ra content of thorium is unknown for similar reasons.

7.2.3 PRTR and Shippingport Fuel Records

The fuel record files used in ORIGEN2/DKPRO modeling do not include the fuel activity for 6 MTU of Plutonium Recycle Test Reactor (PRTR) fuel and 11 MTU of Shippingport fuel used in reprocessing demonstrations at the Hanford Site. However, these fuel inventories account for less than 0.02% of the total irradiated uranium reprocessed at the Hanford Site and are not believed to practically impact the overall tank farm inventories.

7.2.4 New Waste Streams

The 224 waste stream did not account for waste generated prior to 1952. For Revision 5.0, the 224 waste type was redefined as 224-1 and 224-2 to account for these

earlier wastes. The P3 waste stream was split into a P3AZ1 and P3AZ2 streams to more accurately estimate the radionuclide concentrations of the 241-AZ-101 and 241-AZ-102 tanks. These tanks are of particular interest because of their high fission product inventories. Development of a separate organic saltcake stream to more accurately estimate the composition of saltcakes with a high total organic carbon content was considered, but was not completed. This would have required renaming numerous waste transfer records within the WSTRS database.

7.2.5 Chemical Composition of Waste Streams

Significant errors with respect to modeling the lead and mercury constituents of separation plant waste streams were corrected for Revision 5.0. However, as noted in Section 4.0, review and update of the chemical constituents of separation plant waste streams was not an identified task for this revision. Several of the waste stream chemical compositions do not readily reconcile with flowsheets documents or other records. For example, the HDW Model indicates that the aluminum in the cladding waste streams varied from 20 to 49 kg Al/MTU fuel. However, fuel fabrication drawings indicate that the variation in aluminum based on the fuel element design was only 30 to 44 kg Al/MTU fuel.

7.2.6 Solubility

The methodology of Agnew and Watkins (1994) was employed to determine solubility limits for each species. This methodology assumes that the top 25% of rank-ordered tank waste liquid sample data represents saturation for the analyte. This assumption is not always valid because (1) tank waste solutions may not be saturated in the analyte of interest, and (2) saturation is affected by the presence of other species in solution, sometimes quite strongly. Additionally, changes in chemical equilibrium conditions as a function of time and subsequent waste management operations (e.g., evaporation, CO_2 absorption, radiolysis, etc.) can also impact the data interpretation and application in the HDW Model.

The chemical calcium and strontium levels from untreated raw water used by the Bismuth Phosphate process facilities and/or impurities in essential chemicals were apparently sufficient to cause the precipitation of strontium sulfate from the dissolved metal solutions during the extraction step as evidenced by high ^{90}Sr and chemical strontium levels in samples taken from first-cycle sludge. The HDW Model does not fully account for this lack of water demineralization in early processing.

7.2.7 pH Control and Criteria

During the initial years of tank farm operation, the waste pH was not controlled to the same criteria that are in place today. Schneider (1951) states that the Bismuth Phosphate process wastes, with the exception of the alkaline coating waste were buffered to a pH of 7. The uranium recovery process manual (GE 1951a) reports that wastes were neutralized to a pH of greater that 9.5. The desired pH for in-farm ferrocyanide

scavenging was 9.5 but in practice ranged from 8.4 to 12.2 (Sloat 1955b). Abrams (1956) states that for in-plant scavenging, the desired pH was 9.0, but in practice ranged from 8.0 to 10.0. REDOX wastes were adjusted to a pH of 13; the specification was based on keeping the large quantities of aluminum salts present in the neutralized wastes in soluble form (GE, 1951b). The current minimum allowed hydroxide concentration is 0.01 M, (pH $\geq$ 12) [Fowler 2002]; however, the hydroxide concentration is frequently much higher. Therefore, solubility limits derived from current tank waste conditions may not accurately reflect the conditions under which sludges were formed during the early years at the Hanford Site. The HDW Model does not account for the variation in pH over time.

7.2.8 Sludge/Saltcake Void Fraction

The sludge/saltcake void fraction determines the amount of interstitial liquid within each waste sludge or saltcake and, therefore, concentrations of specific chemicals and radionuclides. The void fraction is calculated from the specific volume of the species precipitated, and the settled volume percent solids. Volume percent solids is the ratio of the accumulated sludge (or saltcake) volume divided by the volume of waste discharged to the tanks. In general, there are significant uncertainties in the volumes of accumulated sludge (or saltcake), in the volumes of wastes discharged to the tanks, and in identification of the precipitated chemical compounds. These factors result in an uncertainty that is in addition to the uncertainty in the solubility.

7.2.9 Solids Entrainment

The HDW Model does not account for solids entrainment that may have occurred during supernatant transfers. This limitation is most evident in reconciling saltcake samples with model results. Many saltcake samples exhibit relatively high concentrations of insoluble metals such as iron, manganese, and transuranic waste. The presence of these species in saltcake samples is partially attributed to entrained solids could also be from degrading complexants which would allow chelated metals to precipitate with time.

7.2.10 Degradation of Organic Chemicals

Organic chemicals were used as complexants and solvents during processing of the wastes. Waste chemistry and radiation have caused many of these chemicals to degrade. Strong complexants degrade to weaker complexants (i.e., oxalate) causing complexed species to come out of solution; thus, the presence of some analytes attributed to entrainment could be the result of complexant destruction. The HDW Model does not account for organic degradation.

7.2.11 Ferrocyanide Degradation

Over time some of the nickel ferrocyanide used to scavenge cesium from waste solutions has degraded, which may release cesium back into solution (Lilga et al. 1996). Ferrocyanide degradation is not accounted for by the HDW Model. Specifically the

HDW Model predictions are unreliable because the $NiFe(CN)_6^-$ is assumed to be completely insoluble and stable. This is contrary to known behavior cited by Lilga et al. (1996).

7.2.12 Radiolysis of Nitrate

The HDW model includes equations to estimate the radiolysis of nitrate to nitrite to ammonia as a function of the time-dependant integrated radiation dose. The methodology is described in the HDW model Rev. 4.0 documentation (Agnew et al. 1997). However, the radionuclides considered include only ^{90}Sr and ^{137}Cs, ignoring short-lived radionuclides such as ^{144}Ce, ^{106}Ru, etc. that could have initially contributed substantially to the total radiation dose. The conversion of nitrate to nitrite ion is referenced to controlled experiments; however, the conversion of nitrite to ammonia is based loosely on ammonia data from one Hanford Site tank (241-SY-101). Additionally, this model does not include volatilization of ammonia. Thus, the model erroneously predicts that all of the ammonia produced within a waste is retained. It is known that ammonia is evolved from basic tank waste solutions as evidenced by fugitive ammonia emissions for Hanford Site tank wastes and ammonium nitrate deposits on tank ventilation filters (particulate formed from gaseous ammonia and NO_X). The predicted HDW model ammonia concentrations are unreliable and should be used with extreme caution.

7.2.13 Carbon Dioxide Absorption

Tank waste when exposed to air absorbs CO_2 which reacts with NaOH to form Na_2CO_3 and H_2O. This reaction reduces the pH of the waste which can change the solubility of the waste constituents. Although CO_2 absorption occurs in all tanks, the process was accelerated in the atmospheric pressure evaporators and in tanks with air-lift circulators. Carbon dioxide absorption is not modeled by the HDW Model. This phenomenon can affect aluminum chemistry.

7.2.14 Aluminum Chemistry

Aluminum is present in the tank waste in multiple chemical compounds that include sodium aluminate, aluminum hydroxide, and cancrinite. The solubility of aluminum is pH sensitive, and the reaction kinetics can be slow. In addition, multiple forms of aluminum hydroxide can be precipitated from a saturated sodium aluminate solution (Meacham 2003). These forms have varying solubility, and physical/chemical properties. Small changes in hydroxide concentration can cause aluminum to precipitate. These changes can be caused by CO_2 absorption or by mixing with other wastes. The most prevalent form of precipitated aluminum hydroxide in the tanks is thought to be gibbsite. Although gibbsite precipitation can be reversed by increasing the hydroxide content of the waste (a matter of a few hours at 100°C), exposure of gibbsite to temperatures common in the boiling waste tanks transforms gibbsite to boehmite, which takes considerably longer digest times to dissolve. Boehmite is not readily re-dissolved in hydroxide. The complexities of aluminum chemistry are not accounted for by the HDW

Model, but are often observed in tank waste samples. Additionally, the slow depletion of hydroxide and mixing of liquid wastes make it difficult to ascertain where aluminum precipitates, resulting in considerable uncertainties in the saltcake aluminum concentrations. Numerous other species are also known to be present (dawsonite, boehmite, amorphous, etc.).

7.2.15 Chromium Chemistry

Chromium is generally found in only two oxidation states in the waste, Cr^{+3} which is insoluble in the sludge and Cr^{+6} or chromate (CrO_4^{+2}) which is highly soluble in supernatant and interstitial liquid. Lambert and Meacham (2003) determined from examination of wash-leach data that Cr^{+6} could be reduced to Cr^{+3} by radiolytically produced hydrogen gas. Evaporator concentrates were apparently exposed to strongly reducing conditions caused by hydrogen generated by radiolysis of water and organic chemicals in the waste. This phenomenon is only important to waste retrieval, when saltcakes are re-dissolved, and this feature is neglected by the HDW Model.

7.2.16 Self-Concentration of Wastes

The HDW Model does not specifically simulate the self-concentration of boiling waste tanks or the redeployment of small plant evaporators to concentrate tank wastes. In August 1953, condensates from S-Farm were diverted to cribs rather than refluxed to the tanks. This practice of self-concentration was used in conjunction with the boiling waste tanks in S, SX, A, and AX Farms (Anderson 1990). The REDOX D-12 waste concentrator was used from January 1970 to March 1972 to evaporate 11.6 million gallons of customer and tank waste. A steam coil in tank 241-AX-101 was used to boil off approximately 1.8 million gallons of PUREX organic wash waste in 1967 (Uebelacker 1967). The HDW Model accounts for this boil-off in the saltcake models and not in conjunction with the affected waste type. The HDW Model waste streams, with the exception of saltcakes, represent wastes in unconcentrated form. This approach could skew the liquid-solid distribution of chemical and radionuclide species in the self-boiling waste streams.

7.2.17 Evaporator Feed Tanks

The HDW Model assumes that the saltcake composition of an evaporator feed tank to be identical to the saltcake found in the corresponding evaporator receiver tanks. Sample data indicates that for those feed tanks with an identifiable layer of saltcake, the saltcake composition of evaporator feed tanks are noticeably different from the saltcake composition of the corresponding receiver tanks. Specifically, tank 241-TX-118 was the feed tank for the T2SltCk campaign; tank 241-S-102 was the feed tank for the S1SltCk campaign; and tanks 241-BY-101, 241-BY-102, and 241-BY-112 were equipped with in-tank heaters for the BYSltCk campaign. These tanks usually exhibit higher PO_4 concentrations than the corresponding saltcake receiver tanks. In addition, the evaporator feed tanks contain higher concentrations of insoluble metals from collection of entrained solids.

7.2.18 Averaging of B and T1 Saltcake

For Revision 5.0 of the HDW Model, B and T1 saltcake waste streams were combined to facilitate development of a separate a saltcake with a high organic content. This change increased the variation of the B and T saltcake compositions by a small amount. Although modeling of B and T1 saltcake would be improved by separate modeling, accurate modeling would require separation of B- and T-Plant Bismuth Phosphate processes waste streams because B-Plant shut down four years before T-Plant and fuel irradiation was not constant during this time period. Additional discussion regarding the combining of B and T1 saltcake waste streams can be found in Appendix D.

7.2.19 Rare Earth Precipitation of PUREX Zirflex Waste

The PUREX process used a rare earth precipitation process to reduce the transuranic (TRU) levels in the Zirflex decladding wastes from March 6, 1985 until plant shutdown. The DKPRO Model incorrectly applies the rare earth precipitation process to all Zircaloy fuel resulting in under estimation of the actinides present in CWZr1 by the HDW Model.

7.2.20 Special Isotope Processing

In addition to the B-Plant Waste Fractionization processes used to recovery and encapsulate ^{90}Sr and ^{137}Cs, various special processing campaigns were run at the Hot Semiworks, PUREX, and B-Plant to recover ^{90}Sr, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{99}Tc, and ^{241}Am. Lead carrier precipitation was used in PUREX and B-Plant (1961-1968) to recover ^{90}Sr for purification at the Hot Semiworks. A total of 3.35 MCi ^{90}Sr was recovered by this process. During the same time period (1961-1968), the PUREX cask station and the 241-C-801 cask station were used to recover 2.07 MCi ^{137}Cs (Appendix C, interoffice memorandum 7G240-03-BAH-001). The impact of the ^{144}Ce and ^{147}Pm recovery on the tank inventory is negligible (Appendix C, interoffice memo 7G400-03-SMM-003). Americium-241 recovery at REDOX recovered 2.7 MCi, less than 4% of the tank wastes ^{241}Am inventory (Boldt and Ritter 1969). Monthly reports indicate that less than 30 Ci of ^{99}Tc was recovered for test and development purposes (Reas 1964a and 1964b, and Walling 1964). In general, these minor special processes are either incompletely modeled or are neglected by the HDW Model. All radionuclide values were decayed to January 1, 2001 for the preceding discussion.

7.2.21 Hot Semiworks Processes

The initial mission for the Hot Semiworks was to pilot plant the TBP, REDOX, and PUREX processes. The REDOX testing involved only unirradiated uranium and resulted in no transfers to the underground storage tanks. The PUREX flowsheet testing included the dissolution and solvent extraction processing of irradiated fuel elements. Waste from these development tests were transferred to the 241-C-200 series tanks (1952-1957). The Hot Semiworks was modified in 1961 to demonstrate the B-Plant Fission Product Recovery flowsheet and to support strontium recovery. The Hot Semiworks was

renamed the Strontium Semiworks in 1961 and was operated until 1967 to separate strontium from various waste solutions. Waste from the strontium recovery mission was transferred to the tanks 241-C-107, 241-C-108, 241-C-109, 241-C-111, and 241-C-112 where it was stored with other wastes (Johnson 2003). The HDW model erroneously assumed that the wastes transferred to the C-200 series tanks were produced under the B-Plant strontium recovery flowsheets and, therefore, predicts high lead and low uranium and plutonium concentrations for the residual wastes in tanks 241-C-201 through C-204 (GE 1965).

Prior to cesium and strontium recovery by the B-Plant Waste Fractionization process, cesium and strontium were recovered by a series of processes in PUREX, B-Plant, Hot Semiworks, and 241-C-801 cask station. In general, the PUREX plant (1961-1962) and then B-Plant (1963-1967) recovered a crude strontium product from the PUREX HLW stream using lead sulfate carrier precipitation followed by a strontium rare earth separation (Boldt 1964, Caudill et al. 1961). The crude strontium product was shipped to the Hot Semiworks facility where the strontium was purified by solvent extraction using di-(2-ethyl-hexyl) phosphoric acid (D2EHPA) (HAPO 1963). Cesium was recovered in the 241-C-801 Cask Station. Shipping casks filled with cesium selective ion-exchange media were placed in the 241-C-801 cask station. Cesium-bearing supernatant from one 241-C Farm tank was transferred through the cask to another 241-C Farm tank. Cesium loaded casks were shipped offsite for elution. Each of these processes produced a unique waste stream; a strontium-depleted PUREX HLW, a strontium purification waste, and a cesium-depleted supernatant. For Revision 4.0, the HDW Model simplifies these three processes into a single waste type, HS waste. For Revision 5.0, the 241-C-801 Cask Station cesium recovery process was included in the B-Plant cesium recovery process simulation, but the strontium-depleted PUREX waste and the strontium purification waste were not separated.

7.2.22 In-Farm Supernatant Scavenging

In-Farm supernatant scavenging was used to treat TBP supernatant and other supernatants stored in the same tanks. The HDW Model simulates this process as the TFeCN waste type. The HDW Model assumes that both cesium and strontium were scavenged from TBP supernatant. In actual practice, three different methods were employed to scavenge supernatants; nickel ferrocyanide scavenging only, both nickel ferrocyanide and calcium phosphate scavenging, and calcium phosphate scavenging only. These processes were applied on a tank-by-tank basis depending on the ^{137}Cs and ^{90}Sr concentrations measured in the supernatant. This resulted in a two order of magnitude range in the ^{137}Cs and ^{90}Sr concentration of the scavenged supernatant (Sloat 1955b). The impact on the scavenged solids is not reported but could exhibit similar variability. Modeling at the detail level described by Sloat is beyond the current capability of the HDW Model.

7.2.23 Metal Waste Modeling

During metal waste recovery operations, the general practice was to sluice with metal waste supernatant. When a tank was close to empty, water was often used as the final sluicing media (Rodenhizer 1987). The impact of sluicing with water on the metal waste sludge composition is not modeled, but is not thought to be a significant impact to the BBI because 94% of the uranium was recovered, and little metal waste remains in the tanks.

7.2.24 Mass Balances

The HDW Model does not maintain mass balances throughout the waste stream or tank inventory calculations. Frequently, waste stream chemical compositions are calculated independently rather than from the waste streams of which they are dependant. In addition, the method used to calculate waste volumes is independent from waste stream compositions. The HDW Model approximates a mass balance through a waste volume accountability process. This calculation method can lead to over or under estimation of the total site chemical inventory. Radionuclides are not subject to this problem since the inputs were made based on the fuel content (Curies) rather than as a concentration.

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8.0 CONCLUSIONS

This update of HDW Model achieved the objectives outlined in Section 4.0, Scope of Revision, and resolves issues identified by Harmsen et al. (1998) and by BBI users. Outdated ORIGEN2 estimates have been replaced with new fuel activity predictions. Bases for significant reductions in the tank waste estimate for ^{3}H, ^{14}C, ^{99}Tc, and ^{129}I were established. The simulation of chemical processes was improved. Documentation of the model was expanded. The new sludge and saltcake waste concentration estimates predicted by Revision 5.0 of the HDW Model are reported in Appendix A, pages A-70 through A-79. The new supernatant waste concentration estimates are reported in Appendix A, pages A-80 through A-89. Appendix G summarizes the methods used to check the HDW Model.

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APPENDIX A

HANFORD DEFINED WASTES WORKBOOK

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A.0 HANFORD DEFINED WASTES WORKBOOK

The following pages are a printout of the hdwR2.X worksheet. Certain intermediate calculations and blank rows have been deleted for clarity.

Worksheet contents:

	Page
Campaign Information	A-5 – A-9
Chemicals in [mol/L]	A-10 – A-14
Chemicals in [Ci]	A-15 – A-19
Species Total Concentration (mol/L)	A-20 – A-24
Species Total Concentration (Ci/L)	A-25 – A-29
Predicted Sludge Species (mol/L)	A-30 – A-34
Predicted Sludge Species (Ci/L)	A-35 – A-39
Predicted Supernatant Species (mol/L)	A-40 – A-44
Predicted Supernatant Species (Ci/L)	A-45 – A-49
Predicted Solids Concentration in Layer (mol/L)	A-50 – A-54
Solids Volumes (cc/L)	A-55 – A-59
Solids Fraction Precipitated	A-60 – A-69
Predicted Sludge Concentration (μg/g)	A-70 – A-74
Predicted Sludge Concentration (μCi/g)	A-75 – A-79
Predicted Supernatant Concentration (μg/g)	A-80 – A-84
Predicted Supernatant Concentration (μCi/g)	A-85 – A-89
Supernatant Volumes to Evaporator (kgal)	A-90 – A-94
Radionuclide Partition Fractions	A-95 – A-99

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Campaign Information. (Sheet 1)

Campaign Information	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
st. date	1944	1950	1944	1950	1944	1950	1944	1950	1952	1954
en. date	1949	1956	1949	1956	1949	1956	1949	1956	1958	1955
short tons fuel	3,653	4,943	3,653	4,943	3,653	4,943	3,653	4,943		
kgal waste input									35,574	
volume factor									0.65	0.37
kgal waste out	15,325	20,551	11,767	16,531	8,962	19,689	12,964	17,543	23,090	13,179
gal/ton	4,195	4,158	3,221	3,344	2,453	3,983	3,549	3,549	6,608	total waste rate
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
void frac.	2.70E-01	1.45E-01	5.74E-01	5.99E-01	4.76E-01	5.26E-01	7.26E-01	7.89E-01	4.45E-01	2.34E-01
supernatant density	1.10E+00	1.10E+00	1.13E+00	1.13E+00	1.10E+00	1.07E+00	1.09E+00	1.09E+00	1.21E+00	1.21E+00
solids density	1.80E+00	1.85E+00	1.41E+00	1.38E+00	1.45E+00	1.42E+00	1.48E+00	1.39E+00	1.78E+00	1.59E+00
H-3 (Ci) loss									3.98E+02	2.27E+02
residual totals										
H-3 (Ci)	3.71E+00	6.02E+00	1.09E+01	1.95E+01	1.15E-04	2.92E-03	1.12E-07	1.85E-05	6.56E+00	1.98E+00
C-14 (Ci)	1.75E-01	1.23E+00	3.59E-01	2.58E-01	7.94E-03	9.20E-03	2.49E-04	7.64E-04	2.54E-01	7.67E-02
Sr-90 (Ci)	8.83E+04	2.42E+05	1.02E+03	1.25E+03	7.52E+00	9.79E+00	4.00E-02	1.38E-01	6.29E+05	2.80E+05
Tc-99 (Ci)	2.20E+00	2.68E+00	5.77E-01	6.46E-01	4.24E-03	4.99E-03	2.25E-05	7.02E-05	4.00E+00	1.21E+00
I-129 (Ci)	9.72E-04	3.06E-03	2.84E-04	5.64E-03	1.88E-06	0.00E+00	9.98E-09	0.00E+00	5.12E-03	1.55E-03
Cs-137 (Ci)	4.48E+03	6.14E+03	1.18E+03	1.46E+03	8.64E+00	1.14E+01	4.59E-02	1.61E-01	1.23E+04	3.61E+05
U-Total (Ci)	3.76E+02	5.13E+02	8.90E+00	5.10E+00	7.62E-03	5.48E-03	8.90E-06	1.69E-05	1.81E+01	6.74E+00
U-Total (kg)	5.54E+05	7.55E+05	1.31E+04	7.51E+03	1.12E+01	8.06E+00	1.31E-02	2.49E-02	2.66E+04	9.91E+03
Pu-Total (Ci)	1.46E+00	2.38E+01	7.31E+02	9.57E+02	6.55E+01	1.38E+02	3.40E+00	2.07E+02	4.20E+00	1.27E+00
Pu-Total (kg)	7.83E-02	1.39E-01	5.68E-01	4.62E-01	2.50E-01	2.70E-01	6.76E-02	1.35E-01	1.18E-01	6.79E-02
kgal solids	1,839	2,466	1,612	2,363	609	669	234	410	647	403
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
uncertainty			2.60E+00	1.10E+00	2.00E+00	1.00E+00				
kgal solids left	313	423	1,732	1,407	762	822	234	410	636	359
				531	kgal lost to B and T1					

Campaign Information. (Sheet 2)

Campaign Information	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
st. date	1955	1955	1955	1952	1959	1952	1961	1956	1963	1968
en. date	1958	1958	1958	1958	1967	1960	1967	1962	1967	1976
short tons fuel			1,311	11,905	9,554	13,660	7,799	30,236	27,016	16,449
kgal waste input										
volume factor	0.58	0.31								
kgal waste out	20,537	11,110	3,818	25,067	10,690	2,975	1,752	26,502	9,454	1,233
gal/ton				2,106	1,119	218	225	877	350	75
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
void frac.	2.29E-01	9.16E-01	8.51E-01	6.86E-01	6.40E-01	6.90E-01	7.50E-01	7.59E-01	5.47E-01	5.56E-01
supernatant density	1.21E+00	1.19E+00	1.06E+00	1.26E+00	1.25E+00	1.16E+00	1.08E+00	1.03E+00	1.05E+00	1.18E+00
solids density	1.58E+00	1.32E+00	1.40E+00	1.72E+00	1.79E+00	1.60E+00	1.46E+00	1.38E+00	1.51E+00	1.79E+00
H-3 (Ci) loss	3.54E+02									
residual totals										
H-3 (Ci)	2.36E+00	2.44E+00	9.35E-02	8.65E+01	7.65E+01	9.72E+01	4.04E+01	4.46E-02	1.98E+00	6.18E-02
C-14 (Ci)	9.16E-02	8.50E-02	1.06E-01	4.72E+00	4.76E-01	1.07E+00	2.74E-01	2.81E-02	5.00E-01	5.94E-04
Sr-90 (Ci)	3.71E+05	2.19E+04	4.64E+03	6.10E+06	5.73E+06	4.16E+02	1.62E+02	1.62E+05	4.73E+06	3.07E+01
Tc-99 (Ci)	1.44E+00	1.12E+00	6.09E-02	8.30E+01	3.85E+01	1.96E-01	6.27E-02	8.62E-01	2.84E+01	1.06E-02
I-129 (Ci)	1.85E-03	2.47E-03	5.87E-04	1.33E-01	5.96E-02	2.76E-04	8.82E-05	5.14E-05	1.71E-03	0.00E+00
Cs-137 (Ci)	4.39E+05	9.98E+04	5.77E+03	2.35E+05	1.31E+05	4.90E+02	1.88E+02	3.26E+03	1.22E+05	3.61E+01
U-Total (Ci)	8.20E+00	7.98E-03	2.40E+00	3.78E+01	5.96E+00	6.73E+00	4.71E+00	6.51E-02	2.67E+00	6.64E+01
U-Total (kg)	1.21E+04	1.17E+01	3.53E+03	5.55E+04	7.07E+03	9.65E+03	5.59E+03	9.57E+01	3.83E+03	8.52E+03
Pu-Total (Ci)	1.51E+00	1.81E+00	3.20E+02	4.23E+03	1.79E+03	6.84E+02	6.70E+02	3.96E+01	1.36E+03	6.83E+03
Pu-Total (kg)	8.27E-02	2.43E-02	3.90E-02	3.95E-01	6.62E-02	7.91E-02	1.67E-02	1.31E-03	2.66E-02	4.59E-03
kgal solids	719	156	115	1,128	321	241	51	583	369	27
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
uncertainty				3.00E+00	1.30E+00	1.40E+00	5.00E-01	1.70E+00	3.00E+00	
kgal solids left	437	112	119	1,206	202	241	51	4	81	14

Campaign Information. (Sheet 3)

Campaign Information	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
st. date	1956	1961	1965	1956	1963	1968	1974	1961	1966	1970
en. date	1960	1972	1972	1962	1967	1972	1988	1968	1966	1970
short tons fuel	18,141	54,583	1,954	30,236	27,016	16,449			191	390
kgal waste input										
volume factor										
kgal waste out	6,276	21,651	2,285	4,543	11,053	8,094	3,302	1,003	443	912
gal/ton	346	397	1,170	150	409	492	1,442 to SY-102, 1,823 to TX-118, 37 to TX-101		2,319	2,338
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
void frac.	8.22E-01	7.49E-01	8.55E-01	7.40E-01	7.14E-01	7.39E-01	5.23E-01	9.42E-01	8.43E-01	8.43E-01
supernatant density	1.10E+00	1.07E+00	1.03E+00	1.03E+00	1.06E+00	1.08E+00	1.18E+00	1.08E+00	1.19E+00	1.19E+00
solids density	1.35E+00	1.43E+00	1.30E+00	1.64E+00	1.56E+00	1.42E+00	1.76E+00	1.30E+00	1.32E+00	1.32E+00
H-3 (Ci) loss										
residual totals										
H-3 (Ci)	1.90E+02	2.85E+02	2.11E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-02	2.23E-02	1.43E-01
C-14 (Ci)	1.79E+00	1.82E+00	4.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.06E-03	9.29E-06	1.98E-05
Sr-90 (Ci)	7.25E+02	9.13E+02	4.16E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E+03	1.62E+04	3.80E+04
Tc-99 (Ci)	3.24E-01	3.41E-01	1.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-01	1.79E-01	3.80E-01
I-129 (Ci)	3.89E-01	2.96E-01	2.09E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-05	1.69E-05	3.59E-05
Cs-137 (Ci)	8.60E+02	1.07E+03	4.59E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.39E+02	8.53E+02	1.95E+03
U-Total (Ci)	8.06E+00	1.11E+02	1.66E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E+00	1.11E+02	2.26E+02
U-Total (kg)	1.19E+04	3.21E+04	1.93E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.40E+03	1.16E+01	2.37E+01
Pu-Total (Ci)	1.07E+03	4.06E+03	9.63E+02	0.00E+00	0.00E+00	0.00E+00	4.73E+04	9.12E+02	3.38E-06	7.37E-06
Pu-Total (kg)	1.20E-01	1.96E-01	1.31E-02	0.00E+00	0.00E+00	0.00E+00	2.69E-02	4.63E-03	2.37E-10	5.17E-10
kgal solids	508	628	240	50	122	89	82	12	26	53
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
uncertainty	1.40E+00	5.00E-01	1.00E+00							
kgal solids left	366	598	40				82	12	26	53

Campaign Information. (Sheet 4)

Campaign Information	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
st. date	1967	1967	1967	1969	1962	1967	1951	1952	1965	1965
en. date	1976	1972	1976	1976	1976	1976	1955	1965	1976	1974
short tons fuel		16,449								
kgal waste input	7,826			801	25,638	5,737	30,230	14,213	47,414	43,037
volume factor				4.19	1.03		0.58	0.47	0.27	0.18
kgal waste out	5,796	11,536	14,425	3,355	26,371	12,438	17,630	6,748	12,714	7,637
gal/ton		701								
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00	1.00E+00	7.96E+00	1.30E+01	4.30E+01	5.40E+01
void frac.	8.22E-01	4.80E-01	6.98E-01	7.81E-01	8.88E-01	8.77E-01	5.08E-01	8.62E-01	7.75E-01	7.08E-01
supernatant density	1.07E+00	1.02E+00	1.09E+00	1.15E+00	1.19E+00	1.01E+00	1.26E+00	1.50E+00	1.48E+00	1.51E+00
solids density	1.34E+00	1.74E+00	1.50E+00	1.51E+00	1.31E+00	1.12E+00	1.70E+00	1.64E+00	1.63E+00	1.72E+00
H-3 (Ci) loss					2.28E+03		2.62E+02	2.59E+03	6.30E+03	1.25E+04
residual totals										
H-3 (Ci)	5.48E+00	6.84E-01	4.44E-01	2.28E+00	4.64E-01	0.00E+00	1.31E+01	2.13E+02	6.00E+02	8.55E+02
C-14 (Ci)	9.95E-01	4.29E-02	3.23E-02	2.07E-01	8.90E-02	0.00E+00	7.66E-01	8.28E+00	7.90E+01	1.01E+02
Sr-90 (Ci)	6.75E+06	9.78E+05	1.95E+04	5.42E+06	9.47E+03	0.00E+00	6.15E+03	9.00E+04	8.73E+05	5.77E+05
Tc-99 (Ci)	3.73E+01	3.05E+00	2.13E+00	1.23E+01	3.38E+00	0.00E+00	8.87E+00	2.88E+02	2.32E+03	2.18E+03
I-129 (Ci)	1.98E-02	1.88E-04	1.31E-04	7.53E-04	1.99E-03	0.00E+00	1.23E-02	4.44E-01	2.54E+00	1.60E+01
Cs-137 (Ci)	1.50E+05	8.67E+02	0.00E+00	5.62E+04	3.53E+02	0.00E+00	2.58E+04	8.57E+05	4.27E+06	1.81E+06
U-Total (Ci)	3.88E+00	2.79E+00	2.25E+00	1.28E+01	1.28E-01	0.00E+00	4.33E+00	9.09E-01	7.63E+00	3.15E+01
U-Total (kg)	4.72E+03	3.42E+03	3.15E+03	1.83E+04	1.03E+02	0.00E+00	6.38E+03	9.75E+02	4.11E+03	4.43E+03
Pu-Total (Ci)	1.86E+03	7.28E+03	2.14E+03	9.33E+03	5.41E+01	0.00E+00	5.31E+02	3.94E+02	1.86E+03	2.50E+03
Pu-Total (kg)	5.45E-02	7.55E-03	3.86E-02	3.31E-02	2.30E-03	0.00E+00	4.60E-01	2.89E-01	1.79E+00	1.35E+00
kgal solids	180	58	144	87	264		1,403	880	5,467	4,126
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00		4.64E+00		1.15E+01	9.59E+00
uncertainty										
kgal solids left	166	23	100	101	7		1,403	880	5,467	4,126

Campaign Information. (Sheet 5)

Campaign Information	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
st. date	1973	1977	1977	1981	1982	1986	1983	1983
en. date	1976	1980	1980	1989	1986	1990	1988	1988
short tons fuel					2,743	1,545	4,302	4,302
kgal waste input	39,219	9,826	11,788	34,739				
volume factor	0.40	0.82	0.58	0.30				
kgal waste out	15,819	8,076	6,888	10,439	993	959	11,499	5,555
gal/ton					362	621	4,192	2,025
vol% solids	3.61E+01	2.80E+01	1.89E+01	2.09E+01	4.43E+00	7.61E+00	2.00E+00	1.05E+01
void frac.	8.28E-01	9.03E-01	8.34E-01	8.18E-01	7.28E-01	8.37E-01	8.50E-01	8.48E-01
supernatant density	1.56E+00	1.58E+00	1.59E+00	1.54E+00	1.17E+00	1.11E+00	1.04E+00	1.03E+00
solids density	1.67E+00	1.64E+00	1.67E+00	1.65E+00	1.56E+00	1.38E+00	1.28E+00	1.31E+00
H-3 (Ci) loss	3.13E+03	2.44E+02	7.23E+02	2.88E+03				
residual totals								
H-3 (Ci)	5.06E+02	2.24E+02	1.25E+02	1.66E+02	7.09E+01	8.44E+01	6.54E-01	2.97E+02
C-14 (Ci)	1.19E+02	5.35E+01	3.53E+01	6.71E+01	2.21E-01	2.33E-01	4.36E-03	3.59E+00
Sr-90 (Ci)	1.12E+06	4.18E+04	2.97E+05	1.45E+06	5.51E+06	3.20E+06	4.54E+01	3.19E+03
Tc-99 (Ci)	3.72E+03	1.64E+03	1.02E+03	1.26E+03	3.22E+01	3.52E+01	1.11E-02	1.03E+01
I-129 (Ci)	3.53E+00	1.61E+00	1.05E+00	1.48E+00	2.86E-03	3.08E-03	1.09E-02	6.85E-02
Cs-137 (Ci)	4.55E+06	2.22E+06	1.30E+06	1.63E+06	2.06E+05	2.34E+05	5.16E+01	4.83E+04
U-Total (Ci)	3.88E+00	5.77E-01	2.07E+00	3.25E+00	7.88E+00	4.41E+00	1.78E+01	2.21E+01
U-Total (kg)	3.03E+03	4.03E+02	7.15E+02	2.30E+03	8.96E+03	4.99E+03	2.02E+04	2.51E+04
Pu-Total (Ci)	1.45E+03	1.90E+02	4.01E+02	2.72E+03	2.92E+04	1.46E+04	2.03E+04	8.82E+03
Pu-Total (kg)	1.88E+00	7.41E-01	4.27E-01	7.16E-01	1.44E-02	2.39E-02	6.30E-02	1.91E-01
kgal solids	5,715	2,259	1,303	2,182	44	73	230	583
vol% solids	1.46E+01	2.30E+01	1.11E+01	6.28E+00	4.43E+00	7.61E+00	2.00E+00	1.05E+01
uncertainty					1.00E+00	1.00E+00	6.00E-01	2.00E+00
kgal solids left	5,715	2,259	1,303	2,182	44	73	192	583

Chemicals in [mol/L] (Sheet 1)

chemicals in mol/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
HNO3	1.00E-01	1.00E-01	1.55E+00	1.54E+00	1.15E+00	7.08E-01	1.06E+00	1.06E+00	3.00E+00	3.00E+00
NaAlO2			8.20E-02	6.20E-02						
Al(NO3)3										
Fe(HSO4)2			3.40E-02	3.40E-02	2.40E-02	1.48E-02			3.00E-02	1.40E-02
Fe(NO3)3	1.60E-02	1.60E-02	1.60E-02	1.60E-02	1.60E-02	1.60E-02	1.60E-02	1.60E-02	1.60E-02	1.60E-02
NaCrO4	3.20E-03	3.20E-03	6.50E-03	6.50E-03	4.20E-03	5.79E-03	6.80E-03	6.80E-03	3.20E-03	3.20E-03
BiPO4	2.86E-04	2.86E-04	1.20E-02	1.20E-02	1.00E-02	6.16E-03	6.00E-03	6.00E-03	1.80E-04	1.80E-04
ZrO(OH)2			3.20E-04	3.20E-04						
NiSO4	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	6.60E-03
NaOH	1.41E-01	1.41E-01	1.90E+00	1.90E+00	1.31E+00	8.56E-01	1.25E+00	1.25E+00	3.15E+00	3.31E+00
NaNO2			5.80E-02	4.40E-02						
Na2CO3	6.00E-01	7.00E-01	1.82E-02	1.82E-02	1.82E-02	1.81E-02	1.82E-02	1.82E-02	2.00E-01	1.84E-02
Na3PO4	1.80E-01	1.80E-01	2.77E-01	2.77E-01	2.00E-01	1.23E-01	3.20E-02	3.20E-02	1.30E-01	1.30E-01
Na2SO4	2.10E-01	2.10E-01					1.40E-03	1.40E-03	8.00E-02	1.50E-01
Na2SiO3	4.00E-03	4.00E-03	2.90E-02	2.20E-02	3.70E-02	2.28E-02				
Na2SiF6			3.10E-02	3.10E-02						3.50E-02
NaF					2.20E-01	1.36E-01	2.70E-01	2.70E-01		
NaCl	3.25E-03	3.25E-03	4.37E-02	4.37E-02	3.00E-02	1.97E-02	2.88E-02	2.88E-02	9.55E-02	7.62E-02
Na2S										
La(NO3)3							3.80E-03	3.80E-03		
Hg(NO3)2		5.13E-05		1.17E-05					1.74E-05	1.74E-05
KNO3	7.06E-04	7.06E-04	9.50E-03	9.50E-03	6.53E-03	4.28E-03	2.26E-01	2.26E-01	1.58E-02	1.66E-02
Ca(NO3)2	1.80E-02	1.80E-02	1.82E-02	1.82E-02	1.82E-02	1.81E-02	1.82E-02	1.82E-02	1.84E-02	1.84E-02
KMnO4							5.10E-03	5.10E-03		
Sr(NO3)2	2.84E-06	5.19E-06	6.54E-08	9.41E-08	1.35E-09	1.50E-09	1.58E-11	2.86E-11	2.48E-06	2.48E-06
PbSO4										
H3C6H5O7										
H4EDTA										
H3HEDTA										
Hglycolate										
Hacetate										
H2oxalate							4.60E-02	4.60E-02		
Na4Fe(CN)6										5.00E-03
NH3			1.10E-01	8.00E-02						

Chemicals in [mol/L] (Sheet 2)

chemicals in mol/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
HNO3	3.00E+00		5.00E-01	2.80E+00	2.50E+00	8.00E-01	8.00E-01	2.80E-01	5.50E-01	2.70E+00
NaAlO2			0.00E+00	1.13E+00	1.13E+00	2.00E+00	7.80E-01			
Al(NO3)3										
Fe(HSO4)2	1.40E-02		1.88E-03	7.50E-03	1.30E-02			1.98E-02	7.74E-02	2.60E-02
Fe(NO3)3	1.60E-02			4.00E-02	4.00E-02	1.52E-02	1.52E-02	4.00E-02	4.00E-02	4.00E-02
NaCrO4	3.20E-03		2.00E-03	1.13E-01	1.13E-01	3.04E-03	3.04E-03	8.00E-03	8.00E-03	8.00E-03
BiPO4	1.80E-04		1.40E-02							
ZrO(OH)2			4.00E-03							
NiSO4	6.60E-03	1.16E-02	1.16E-02	4.00E-03	4.00E-03	1.52E-03	1.52E-03	4.00E-03	4.00E-03	4.00E-03
NaOH	3.31E+00		8.40E-01	4.10E+00	4.00E+00	4.59E-01	6.99E-01	6.28E-01	1.13E+00	2.94E+00
NaNO2			1.70E-01			1.40E+00	2.80E-01	1.00E-02	1.00E-02	1.00E-02
Na2CO3	1.84E-02		2.18E-02	1.85E-02	1.85E-02	1.81E-02	1.81E-02	1.81E-02	1.81E-02	1.84E-02
Na3PO4	1.30E-01		7.06E-02							9.60E-02
Na2SO4	1.50E-01									
Na2SiO3				1.47E-02	4.24E-02	3.00E-02		4.69E-02	9.21E-02	
Na2SiF6	3.50E-02		3.80E-02							
NaF										
NaCl	7.62E-02		1.93E-02	9.43E-02	9.20E-02	1.05E-02	1.61E-02	1.44E-02	2.59E-02	6.77E-02
Na2S		6.00E-03	6.00E-03							
La(NO3)3										
Hg(NO3)2	1.74E-05		1.83E-05	9.21E-06	1.60E-05			2.60E-05	2.60E-05	
KNO3	1.66E-02		4.20E-03	2.05E-02	2.00E-02	2.29E-03	3.49E-03	3.14E-03	5.64E-03	1.47E-02
Ca(NO3)2	1.84E-02	2.00E-02	2.00E-02	1.85E-02	1.85E-02	1.81E-02	1.81E-02	1.81E-02	1.81E-02	1.84E-02
KMnO4				5.87E-03						
Sr(NO3)2	4.00E-03	4.42E-07	8.61E-08	1.39E-05	5.04E-05	1.43E-07	2.47E-07	4.99E-05	1.26E-04	2.16E-07
PbSO4						7.67E-03	4.55E-03	1.12E-04	9.44E-04	
H3C6H5O7										
H4EDTA										
H3HEDTA										
Hglycolate										
Hacetate										
H2oxalate										
Na4Fe(CN)6	2.50E-03	5.00E-03	5.00E-03							
NH3										

Chemicals in [mol/L] (Sheet 3)

chemicals in mol/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
HNO3	6.00E-01	6.00E-01	1.00E-02	7.30E-02	2.20E-01	7.82E-01	2.40E+00	8.60E-01	2.57E+00	2.57E+00
NaAlO2	1.20E+00	7.80E-01					5.00E-01		3.40E-01	3.40E-01
Al(NO3)3										
Fe(HSO4)2							7.00E-04	3.00E-02	2.50E-02	2.50E-02
Fe(NO3)3	1.52E-02	1.52E-02	1.52E-02	4.00E-02	4.00E-02	4.00E-02	4.00E-02	4.00E-02	4.00E-02	4.00E-02
NaCrO4	3.04E-03	3.04E-03	3.04E-03	8.00E-03	8.00E-03	8.00E-03	9.40E-03	8.00E-03	8.00E-03	8.00E-03
BiPO4										
ZrO(OH)2			1.00E-01							
NiSO4	1.52E-03	1.52E-03	1.52E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03
NaOH	2.99E-01	4.99E-01	2.49E-01	2.00E-01	3.00E-01	9.28E-01	2.53E+00	2.14E+00	2.76E+00	2.76E+00
NaNO2	7.80E-01	2.80E-01	7.00E-03	1.00E-02	1.00E-02	1.00E-02	1.40E-02	1.00E-02	1.00E-02	1.00E-02
Na2CO3	1.80E-02	1.81E-02	1.80E-02	2.20E-01	4.00E-01	3.04E-01	2.00E-01	4.90E-03	1.83E-02	1.83E-02
Na3PO4							1.40E-04		9.00E-02	9.00E-02
Na2SO4							1.40E-03			
Na2SiO3	2.00E-02									
Na2SiF6										
NaF			7.70E-01						1.20E-01	1.20E-01
NaCl	6.87E-03	1.15E-02	5.72E-03	4.60E-03	6.90E-03	2.13E-02	8.91E-02	4.92E-02	6.34E-02	6.34E-02
Na2S										
La(NO3)3										
Hg(NO3)2								7.55E-05		
KNO3	1.49E-03	2.49E-03	2.21E-01	1.00E-03	1.50E-03	4.64E-03	1.26E-02	8.87E-02	2.78E-02	2.78E-02
Ca(NO3)2	1.80E-02	1.81E-02	1.80E-02	1.80E-02	1.80E-02	1.81E-02	1.83E-02	4.90E-03	1.83E-02	1.83E-02
KMnO4					1.20E-02	8.82E-04				
Sr(NO3)2	1.31E-07	1.12E-07	1.07E-06	1.06E-07	3.95E-08	7.13E-09		2.04E-05	2.51E-06	2.79E-06
PbSO4	7.23E-03	5.17E-03						3.40E-03		
H3C6H5O7								4.00E-02		
H4EDTA								8.00E-02		
H3HEDTA										
Hglycolate										
Hacetate								5.10E-01		
H2oxalate										
Na4Fe(CN)6										
NH3			7.70E-01							

Chemicals in [mol/L] (Sheet 4)

chemicals in mol/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
HNO3				6.00E-01						
NaAlO2										
Al(NO3)3		8.30E-02	2.80E-01							
Fe(HSO4)2		7.00E-03	1.70E-02	4.10E-02						
Fe(NO3)3	4.00E-02					4.00E-02				
NaCrO4	8.00E-03	2.00E-03	2.00E-07	0.00E+00		8.00E-03				
BiPO4										
ZrO(OH)2										
NiSO4	4.00E-03	2.00E-03	1.00E-02	0.00E+00		4.00E-03				
NaOH	5.00E-02	5.52E-01	3.00E+00	2.71E+00	2.00E-01	1.38E-01				
NaNO2		1.00E-02	1.00E-02	1.00E-02	1.00E-02	2.40E-02				
Na2CO3	1.81E-03	1.01E-02	2.70E-01	2.50E-01	2.00E-05	1.10E-02				
Na3PO4	2.00E-02		1.00E-02							
Na2SO4	2.00E-02			2.00E-02						
Na2SiO3	8.00E-02	4.00E-02	5.00E-02	8.00E-02						
Na2SiF6										
NaF										
NaCl	1.15E-03	1.27E-02	6.91E-02	6.24E-02	4.60E-03	3.17E-03				
Na2S										
La(NO3)3										
Hg(NO3)2	2.58E-05	7.49E-06	1.11E-05	1.37E-04						
KNO3	2.50E-04	2.76E-03	1.50E-02	1.36E-02	1.00E-03	6.90E-04				
Ca(NO3)2	1.81E-03	1.01E-02	1.04E-02	1.23E-02	2.40E-05	1.80E-02				
KMnO4										
Sr(NO3)2	7.02E-05	1.23E-05	1.54E-05	7.77E-05						
PbSO4		1.06E-03								
H3C6H5O7		1.00E-02	1.50E-02		2.50E-02					
H4EDTA			1.50E-01							
H3HEDTA			3.00E-01		4.00E-05					
Hglycolate			3.00E-01							
Hacetate										
H2oxalate										
Na4Fe(CN)6										
NH3										

Chemicals in [mol/L] (Sheet 5)

chemicals in mol/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
HNO3					2.28E+00	1.28E+00	1.00E-01	1.00E-02
NaAlO2					4.25E-01	2.48E-01		
Al(NO3)3								
Fe(HSO4)2					5.62E-02	5.67E-02		
Fe(NO3)3					3.95E-02	6.71E-02	4.00E-02	4.00E-02
NaCrO4					1.13E-02	1.92E-02	8.00E-03	
BiPO4								
ZrO(OH)2								1.00E-01
NiSO4					5.30E-03	8.96E-03	4.00E-03	
NaOH					3.13E+00	1.81E+00	2.00E-01	2.00E-01
NaNO2					1.59E-01	9.02E-02	1.00E-02	7.00E-03
Na2CO3	0.00E+00				1.34E-02	7.79E-03	1.20E-01	1.80E-02
Na3PO4							6.95E-02	
Na2SO4					8.92E-03	4.85E-03		
Na2SiO3								
Na2SiF6								
NaF					5.18E-02	3.18E-02		7.70E-01
NaCl					3.70E-02	2.16E-02	4.60E-03	4.60E-03
Na2S								
La(NO3)3								
Hg(NO3)2								
KNO3					8.05E-03	4.69E-03	1.00E-03	2.21E-01
Ca(NO3)2					1.34E-02	7.79E-03	1.80E-02	1.80E-02
KMnO4							6.00E-03	
Sr(NO3)2					2.43E-04	1.46E-04	1.21E-08	2.77E-07
PbSO4								
H3C6H5O7								
H4EDTA								
H3HEDTA								
Hglycolate								
Hacetate								
H2oxalate								
Na4Fe(CN)6								
NH3								7.70E-01

Chemicals in [Ci] (Sheet 1)

chemicals in Ci	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3 (Ci)	6.15E+02	1.82E+03	7.36E+02	2.17E+03	6.15E+02	1.82E+03	6.15E+02	1.82E+03	9.25E+02	5.28E+02
C-14 (Ci)	1.89E+01	4.12E+01	2.10E+01	4.59E+01	1.89E+01	4.12E+01	1.89E+01	4.12E+01	2.04E+01	1.17E+01
Ni-59 (Ci)	4.95E+00	1.08E+01	5.26E+00	1.14E+01	4.95E+00	1.08E+01	4.95E+00	1.08E+01	5.34E+00	3.05E+00
Ni-63 (Ci)	4.22E+02	9.51E+02	4.98E+02	1.09E+03	4.22E+02	9.51E+02	4.22E+02	9.51E+02	4.66E+02	2.66E+02
Co-60 (Ci)	8.97E+00	3.78E+01	1.27E+01	5.37E+01	8.97E+00	3.78E+01	8.97E+00	3.78E+01	1.59E+01	9.07E+00
Se-79 (Ci)	8.45E-01	1.87E+00	8.46E-01	1.87E+00	8.45E-01	1.87E+00	8.45E-01	1.87E+00	9.22E-01	5.26E-01
Sr-90 (Ci)	6.56E+05	1.61E+06	6.57E+05	1.61E+06	6.56E+05	1.61E+06	6.56E+05	1.61E+06	8.50E+05	4.85E+05
Y-90 (Ci)	6.56E+05	1.61E+06	6.57E+05	1.61E+06	6.56E+05	1.61E+06	6.56E+05	1.61E+06	8.50E+05	4.85E+05
Zr-93 (Ci)	5.16E+01	1.13E+02	5.17E+01	1.13E+02	5.16E+01	1.13E+02	5.16E+01	1.13E+02	2.48E-01	1.41E-01
Nb-93m (Ci)	4.65E+01	9.90E+01	4.65E+01	9.91E+01	4.65E+01	9.90E+01	4.65E+01	9.90E+01	2.19E-01	1.25E-01
Tc-99 (Ci)	3.69E+02	8.18E+02	3.70E+02	8.19E+02	3.69E+02	8.18E+02	3.69E+02	8.18E+02	4.46E+02	2.55E+02
Ru-106 (Ci)	2.02E-09	1.79E-07	2.02E-09	1.79E-07	2.02E-09	1.79E-07	2.02E-09	1.79E-07	2.73E-10	1.56E-10
Cd-113m (Ci)	1.99E+01	6.16E+01	2.15E+01	6.61E+01	1.99E+01	6.16E+01	1.99E+01	6.16E+01	2.77E+01	1.58E+01
Sb-125 (Ci)	2.60E-01	2.16E+00	2.91E-01	2.28E+00	2.60E-01	2.16E+00	2.60E-01	2.16E+00	8.23E-01	4.70E-01
Sn-126 (Ci)	3.05E+00	7.20E+00	3.05E+00	7.20E+00	3.05E+00	7.20E+00	3.05E+00	7.20E+00	3.48E+00	1.99E+00
I-129 (Ci)	1.64E-01	1.04E+00	1.64E-01	1.04E+00	1.64E-01	1.04E+00	1.64E-01	1.04E+00	4.12E-01	2.35E-01
Cs-134 (Ci)	1.01E-03	2.23E-02	1.01E-03	2.23E-02	1.01E-03	2.23E-02	1.01E-03	2.23E-02	8.76E-03	5.00E-03
Cs-137 (Ci)	7.53E+05	1.87E+06	7.54E+05	1.87E+06	7.53E+05	1.87E+06	7.53E+05	1.87E+06	9.86E+05	5.63E+05
Ba-137m (Ci)	7.11E+05	1.77E+06	7.12E+05	1.77E+06	7.11E+05	1.77E+06	7.11E+05	1.77E+06	9.32E+05	5.32E+05
Sm-151 (Ci)	3.79E+04	8.14E+04	3.79E+04	8.15E+04	3.79E+04	8.14E+04	3.79E+04	8.14E+04	3.42E+04	1.95E+04
Eu-152 (Ci)	4.69E-01	3.89E+00	4.70E-01	3.89E+00	4.69E-01	3.89E+00	4.69E-01	3.89E+00	1.25E+00	7.13E-01
Eu-154 (Ci)	4.54E+01	2.86E+02	4.55E+01	2.86E+02	4.54E+01	2.86E+02	4.54E+01	2.86E+02	9.49E+01	5.41E+01
Eu-155 (Ci)	3.69E+01	1.57E+02	3.69E+01	1.57E+02	3.69E+01	1.57E+02	3.69E+01	1.57E+02	5.55E+01	3.17E+01
Ra-226 (Ci)	6.21E-03	6.74E-03	6.21E-03	6.75E-03	6.21E-03	6.74E-03	6.21E-03	6.74E-03	4.40E-03	2.51E-03
Ra-228 (Ci)	2.08E-08	3.98E-08	2.08E-08	3.98E-08	2.08E-08	3.98E-08	2.08E-08	3.98E-08	2.06E-08	1.17E-08
Ac-227 (Ci)	2.90E-02	3.23E-02	2.91E-02	3.23E-02	2.90E-02	3.23E-02	2.90E-02	3.23E-02	2.13E-02	1.22E-02
Pa-231 (Ci)	5.57E-02	6.60E-02	5.58E-02	6.61E-02	5.57E-02	6.60E-02	5.57E-02	6.60E-02	1.83E-04	1.05E-04
Th-229 (Ci)	2.94E-06	5.63E-06	2.94E-06	5.63E-06	2.94E-06	5.63E-06	2.94E-06	5.63E-06	9.82E-07	5.61E-07
Th-232 (Ci)	2.46E-08	4.79E-08	2.46E-08	4.80E-08	2.46E-08	4.79E-08	2.46E-08	4.79E-08	8.32E-09	4.75E-09
U-232 (Ci)	9.50E-03	2.23E-02	9.51E-03	2.24E-02	9.50E-03	2.23E-02	9.50E-03	2.23E-02	1.21E-02	6.92E-03
U-233 (Ci)	8.41E-04	1.75E-03	8.42E-04	1.76E-03	8.41E-04	1.75E-03	8.41E-04	1.75E-03	9.88E-04	5.64E-04
U-234 (Ci)	1.09E+03	1.47E+03	1.09E+03	1.47E+03	1.09E+03	1.47E+03	1.09E+03	1.47E+03	9.72E+02	5.55E+02
U-235 (Ci)	4.90E+01	6.49E+01	4.91E+01	6.49E+01	4.90E+01	6.49E+01	4.90E+01	6.49E+01	4.34E+01	2.48E+01
U-236 (Ci)	9.28E+00	1.99E+01	9.29E+00	1.99E+01	9.28E+00	1.99E+01	9.28E+00	1.99E+01	1.11E+01	6.35E+00
U-238 (Ci)	1.11E+03	1.50E+03	1.11E+03	1.50E+03	1.11E+03	1.50E+03	1.11E+03	1.50E+03	9.91E+02	5.65E+02
U-Total (mols)	1.39E+07	1.88E+07	1.39E+07	1.88E+07	1.39E+07	1.88E+07	1.39E+07	1.88E+07	1.25E+07	7.12E+06
Np-237 (Ci)	2.25E+00	5.08E+00	2.26E+00	5.09E+00	2.25E+00	5.08E+00	2.25E+00	5.08E+00	2.55E+00	1.45E+00
Pu-238 (Ci)	4.85E+00	2.65E+01	5.03E+00	2.74E+01	4.85E+00	2.65E+01	4.85E+00	2.65E+01	1.82E+00	1.04E+00
Pu-239 (Ci)	1.40E+03	2.99E+03	1.45E+03	3.09E+03	1.40E+03	2.99E+03	1.40E+03	2.99E+03	2.55E+02	1.45E+02
Pu-240 (Ci)	9.46E+01	3.78E+02	9.81E+01	3.92E+02	9.46E+01	3.78E+02	9.46E+01	3.78E+02	2.75E+01	1.57E+01
Pu-241 (Ci)	9.16E+01	8.31E+02	9.49E+01	8.62E+02	9.16E+01	8.31E+02	9.16E+01	8.31E+02	5.36E+01	3.06E+01
Pu-242 (Ci)	4.28E-04	6.04E-03	4.44E-04	6.27E-03	4.28E-04	6.04E-03	4.28E-04	6.04E-03	3.76E-04	2.15E-04
Pu-Total (kg)	2.30E+01	4.98E+01	2.39E+01	5.16E+01	2.30E+01	4.98E+01	2.30E+01	4.98E+01	4.23E+00	2.41E+00
Am-241 (Ci)	4.89E+01	3.56E+02	5.01E+01	3.66E+02	4.89E+01	3.56E+02	4.89E+01	3.56E+02	1.41E+02	8.04E+01
Am-243 (Ci)	2.11E-03	5.52E-02	2.11E-03	5.52E-02	2.11E-03	5.52E-02	2.11E-03	5.52E-02	1.99E-02	1.14E-02
Cm-242 (Ci)	3.70E-03	9.50E-02	3.70E-03	9.51E-02	3.70E-03	9.50E-02	3.70E-03	9.50E-02	3.43E-02	1.96E-02
Cm-243 (Ci)	2.19E-05	1.15E-03	2.19E-05	1.15E-03	2.19E-05	1.15E-03	2.19E-05	1.15E-03	4.06E-04	2.32E-04
Cm-244 (Ci)	5.13E-04	2.70E-02	5.13E-04	2.70E-02	5.13E-04	2.70E-02	5.13E-04	2.70E-02	9.54E-03	5.45E-03

Chemicals in [Ci] (Sheet 2)

chemicals in Ci	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3 (Ci)	8.23E+02	2.64E+02	3.56E+02	2.58E+03	6.26E+03	1.70E+03	1.84E+03	3.93E+02	4.21E+02	9.06E+02
C-14 (Ci)	1.82E+01	9.18E+00	3.97E+01	1.41E+02	3.90E+01	1.86E+01	1.25E+01	2.51E+02	1.08E+02	5.76E+01
Ni-59 (Ci)	4.75E+00	3.97E+00	1.87E+00	3.70E+01	3.80E+01	2.24E+01	9.13E+01	1.35E+02	1.05E+02	6.53E+01
Ni-63 (Ci)	4.15E+02	3.70E+02	1.68E+02	3.34E+03	3.60E+03	2.18E+03	8.74E+03	1.25E+04	1.01E+04	6.30E+03
Co-60 (Ci)	1.41E+01	1.26E+01	9.12E+00	1.91E+02	5.40E+02	1.03E+02	1.92E+02	1.23E+03	1.89E+03	2.09E+03
Se-79 (Ci)	8.20E-01	3.66E-01	3.19E-01	6.53E+00	8.42E+00	7.85E-03	6.66E-03	2.39E+01	1.91E+01	1.31E+01
Sr-90 (Ci)	7.56E+05	7.27E+04	2.98E+05	5.93E+06	9.19E+06	7.25E+03	7.38E+03	2.39E+07	2.16E+07	1.60E+07
Y-90 (Ci)	7.56E+05	7.28E+04	2.98E+05	5.93E+06	9.19E+06	7.25E+03	7.39E+03	2.39E+07	2.16E+07	1.61E+07
Zr-93 (Ci)	2.20E-01	1.21E+01	1.95E+01	3.91E+02	5.04E+02	4.70E-01	3.99E-01	1.42E+03	1.14E+03	7.75E+02
Nb-93m (Ci)	1.95E-01	1.08E+01	1.68E+01	3.36E+02	4.06E+02	4.02E-01	3.20E-01	1.18E+03	8.96E+02	5.81E+02
Tc-99 (Ci)	3.97E+02	1.21E+02	1.39E+02	2.48E+03	3.15E+03	3.42E+00	2.86E+00	7.49E+03	5.97E+03	3.99E+03
Ru-106 (Ci)	2.43E-10	9.79E-09	9.26E-08	5.21E-06	1.50E-03	1.40E-08	1.19E-06	3.75E-04	8.74E-03	8.55E-02
Cd-113m (Ci)	2.46E+01	1.22E+01	1.09E+01	2.69E+02	5.02E+02	2.16E+01	2.25E+01	1.26E+03	1.31E+03	1.15E+03
Sb-125 (Ci)	7.32E-01	3.31E-01	6.35E-01	1.66E+01	1.53E+02	2.13E-01	1.53E-01	1.86E+02	5.38E+02	1.02E+03
Sn-126 (Ci)	3.09E+00	1.38E+00	1.15E+00	2.64E+01	3.41E+01	3.17E-02	2.67E-02	9.87E+01	7.96E+01	5.62E+01
I-129 (Ci)	3.66E-01	2.67E-01	1.84E-01	3.97E+00	4.88E+00	4.82E-03	4.03E-03	4.46E-01	3.58E-01	0.00E+00
Cs-134 (Ci)	7.79E-03	2.62E-03	4.18E-03	3.70E-01	1.12E+01	6.69E-04	7.90E-03	7.05E+00	3.53E+01	1.44E+02
Cs-137 (Ci)	8.77E+05	2.97E+05	3.39E+05	7.01E+06	1.07E+07	8.55E+03	8.59E+03	2.84E+07	2.56E+07	1.89E+07
Ba-137m (Ci)	8.29E+05	2.81E+05	3.20E+05	6.62E+06	1.02E+07	8.08E+03	8.11E+03	2.68E+07	2.41E+07	1.78E+07
Sm-151 (Ci)	3.04E+04	1.48E+04	1.51E+04	2.74E+05	3.47E+05	3.29E+02	2.79E+02	1.01E+06	8.23E+05	5.09E+05
Eu-152 (Ci)	1.11E+00	5.25E-01	2.52E-01	2.78E+01	9.46E+01	3.68E-02	6.72E-02	1.51E+02	1.90E+02	3.26E+02
Eu-154 (Ci)	8.44E+01	4.00E+01	3.15E+01	1.88E+03	6.28E+03	2.46E+00	4.48E+00	1.12E+04	1.52E+04	2.34E+04
Eu-155 (Ci)	4.94E+01	2.34E+01	4.17E+01	7.72E+02	2.63E+03	1.02E+00	2.24E+00	5.13E+03	8.42E+03	8.61E+03
Ra-226 (Ci)	3.91E-03	1.76E-03	1.63E-03	3.75E-04	5.16E-04	1.37E-05	7.85E-06	9.41E-04	8.43E-04	1.12E-03
Ra-228 (Ci)	1.83E-08	8.12E-09	6.52E-09	2.11E-09	4.46E-09	1.27E-10	1.14E-10	5.79E-09	6.89E-09	1.14E+00
Ac-227 (Ci)	1.89E-02	8.30E-03	8.09E-03	1.61E-03	2.14E-03	6.52E-05	3.55E-05	4.19E-03	3.90E-03	3.01E+00
Pa-231 (Ci)	1.63E-04	9.12E-03	1.70E-02	2.39E-03	3.13E-03	1.39E-04	8.45E-05	5.97E-03	5.96E-03	4.67E+00
Th-229 (Ci)	8.74E-07	7.85E-07	8.90E-07	7.91E-06	2.80E-06	1.89E-08	1.18E-08	1.57E-05	5.11E-06	7.03E-01
Th-232 (Ci)	7.40E-09	6.63E-09	7.96E-09	2.27E-09	4.57E-09	1.55E-10	1.45E-10	5.97E-09	7.17E-09	9.01E-01
U-232 (Ci)	1.08E-02	5.21E-06	3.88E-03	7.25E-04	4.53E-04	1.29E-04	1.41E-04	1.06E-03	1.38E-03	3.99E+00
U-233 (Ci)	8.79E-04	4.19E-07	2.89E-04	3.57E-03	1.29E-03	6.58E-06	4.78E-06	7.47E-03	2.51E-03	2.37E+02
U-234 (Ci)	8.65E+02	4.15E-01	3.89E+02	1.78E+01	5.94E+00	3.41E+00	2.77E+00	1.55E+01	1.77E+01	1.72E+01
U-235 (Ci)	3.86E+01	1.85E-02	1.75E+01	7.67E-01	2.25E-01	1.45E-01	1.05E-01	6.63E-01	7.39E-01	6.63E-01
U-236 (Ci)	9.89E+00	4.66E-03	3.50E+00	3.69E-01	1.72E-01	6.99E-02	7.78E-02	3.42E-01	4.54E-01	7.55E-01
U-238 (Ci)	8.81E+02	4.23E-01	3.96E+02	1.83E+01	4.15E+00	3.33E+00	1.93E+00	1.59E+01	1.73E+01	1.16E+01
U-Total (mols)	1.11E+07	5.33E+03	4.99E+06	2.30E+05	5.23E+04	4.19E+04	2.43E+04	2.00E+05	2.18E+05	1.46E+05
Np-237 (Ci)	2.27E+00	9.87E-01	8.51E-01	1.81E+01	7.76E+00	2.27E-02	1.86E-02	4.09E+01	1.61E+01	1.17E+01
Pu-238 (Ci)	1.62E+00	1.08E+00	2.30E+00	4.86E+01	7.66E+01	6.56E+00	7.25E+00	1.28E+02	1.50E+02	5.57E+02
Pu-239 (Ci)	2.27E+02	1.45E+02	6.36E+02	2.56E+03	1.12E+03	4.12E+02	2.84E+02	5.18E+03	3.12E+03	4.94E+03
Pu-240 (Ci)	2.44E+01	1.62E+01	4.32E+01	4.97E+02	2.62E+02	7.83E+01	6.25E+01	1.04E+03	7.66E+02	1.73E+03
Pu-241 (Ci)	4.77E+01	3.30E+01	5.57E+01	1.73E+03	1.99E+03	2.88E+02	4.03E+02	4.57E+03	6.82E+03	3.27E+04
Pu-242 (Ci)	3.34E-04	2.34E-04	1.59E-04	1.51E-02	1.51E-02	2.32E-03	2.65E-03	3.25E-02	5.54E-02	2.95E-01
Pu-Total (kg)	3.76E+00	2.40E+00	1.04E+01	4.34E+01	1.92E+01	6.99E+00	4.86E+00	8.81E+01	5.38E+01	8.76E+01
Am-241 (Ci)	1.25E+02	5.69E+01	2.22E+01	1.67E+03	3.80E+03	7.05E+01	6.45E+01	6.04E+03	8.39E+03	2.07E+04
Am-243 (Ci)	1.77E-02	7.53E-03	5.43E-04	6.10E-01	3.29E+00	7.66E-04	1.20E-03	2.78E+00	4.47E+00	1.98E+01
Cm-242 (Ci)	3.05E-02	1.30E-02	9.95E-04	1.02E+00	5.95E+00	1.31E-03	2.20E-03	4.73E+00	7.78E+00	3.31E+01
Cm-243 (Ci)	3.61E-04	1.54E-04	4.52E-06	1.82E-02	4.61E-01	2.41E-05	7.94E-05	9.26E-02	4.67E-01	3.57E+00
Cm-244 (Ci)	8.49E-03	3.62E-03	1.27E-04	4.50E-01	1.02E+01	5.89E-04	2.16E-03	2.45E+00	1.09E+01	8.74E+01

Chemicals in [Ci] (Sheet 3)

chemicals in Ci	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3 (Ci)	3.91E+03	1.37E+04	1.39E+03	3.93E+02	4.21E+02	9.06E+02		1.24E+00	4.51E-01	2.90E+00
C-14 (Ci)	3.68E+01	8.72E+01	3.00E+01	2.51E+02	1.08E+02	5.76E+01		5.37E-01	1.88E-04	4.00E-04
Ni-59 (Ci)	1.45E+02	6.38E+02	1.50E+00	1.35E+02	1.05E+02	6.53E+01		1.11E+01	8.09E-03	1.72E-02
Ni-63 (Ci)	1.36E+04	6.16E+04	1.30E+02	1.25E+04	1.01E+04	6.30E+03		1.04E+03	6.89E-01	1.50E+00
Co-60 (Ci)	2.88E+02	1.69E+03	5.89E+01	1.23E+03	1.89E+03	2.09E+03		7.84E+01	1.38E-02	4.42E-02
Se-79 (Ci)	1.53E-02	3.94E-02	3.90E-02	2.39E+01	1.91E+01	1.31E+01		6.63E-02	3.21E-02	6.82E-02
Sr-90 (Ci)	1.49E+04	4.38E+04	4.41E+04	2.39E+07	2.16E+07	1.60E+07		3.71E+06	2.01E+04	4.61E+04
Y-90 (Ci)	1.49E+04	4.38E+04	4.41E+04	2.39E+07	2.16E+07	1.61E+07		3.71E+06	2.01E+04	4.61E+04
Zr-93 (Ci)	9.10E-01	2.27E+00	3.68E+00	1.42E+03	1.14E+03	7.75E+02		3.95E+00	8.54E-01	1.82E+00
Nb-93m (Ci)	7.64E-01	1.78E+00	2.84E+00	1.18E+03	8.97E+02	5.81E+02		3.21E+00	6.69E-01	1.37E+00
Tc-99 (Ci)	6.65E+00	1.64E+01	8.83E+01	7.49E+03	5.97E+03	3.99E+03		2.08E+01	3.62E+00	7.70E+00
Ru-106 (Ci)	9.04E-08	5.77E-05	1.67E-04	3.75E-04	8.74E-03	8.55E-02		5.01E-04	9.54E-07	1.98E-05
Cd-113m (Ci)	4.91E+01	1.64E+02	3.80E+00	1.26E+03	1.31E+03	1.15E+03		3.97E+00	1.69E+00	4.17E+00
Sb-125 (Ci)	1.07E-01	1.72E+00	5.23E+00	1.86E+02	5.39E+02	1.02E+03		1.74E+01	7.57E-01	3.58E+00
Sn-126 (Ci)	6.28E-02	1.62E-01	1.85E-01	9.87E+01	7.97E+01	5.62E+01		2.75E-01	1.05E-01	2.24E-01
I-129 (Ci)	6.65E+00	1.42E+01	1.37E-01	2.53E+00	2.03E+00	1.39E+00		1.24E-03	3.42E-04	7.26E-04
Cs-134 (Ci)	2.88E-03	1.11E-01	4.28E+00	7.05E+00	3.54E+01	1.44E+02		6.59E-02	2.30E-02	1.44E-01
Cs-137 (Ci)	1.77E+04	5.14E+04	3.02E+05	2.84E+07	2.56E+07	1.89E+07		8.33E+04	1.73E+04	3.94E+04
Ba-137m (Ci)	1.67E+04	4.85E+04	2.85E+05	2.68E+07	2.42E+07	1.78E+07		7.87E+04	1.63E+04	3.72E+04
Sm-151 (Ci)	6.45E+02	1.62E+03	1.15E+03	1.01E+06	8.24E+05	5.09E+05		7.46E+04	3.64E+02	7.93E+02
Eu-152 (Ci)	8.82E-02	4.19E-01	1.67E+00	1.51E+02	1.90E+02	3.26E+02		1.51E+01	1.03E-01	2.57E-01
Eu-154 (Ci)	6.40E+00	3.21E+01	1.13E+02	1.12E+04	1.52E+04	2.34E+04		1.18E+03	4.11E+00	1.12E+01
Eu-155 (Ci)	2.78E+00	1.78E+01	1.47E+01	5.13E+03	8.42E+03	8.61E+03		6.26E+02	1.47E+00	4.93E+00
Ra-226 (Ci)	2.01E-05	1.88E-04	1.20E-05	9.41E-04	9.46E-04	1.12E-03		2.76E-06	1.03E-04	3.73E-04
Ra-228 (Ci)	2.15E-10	1.45E+00	4.76E-10	5.79E-09	4.53E-01	1.14E+00		1.96E-11	4.53E-01	1.14E+00
Ac-227 (Ci)	9.78E-05	9.63E-02	7.22E-05	4.19E-03	1.49E+00	3.01E+00		1.25E-05	1.49E+00	3.00E+00
Pa-231 (Ci)	2.15E-04	1.47E-01	1.85E-04	5.97E-03	2.20E+00	4.67E+00		1.84E-05	2.19E+00	4.66E+00
Th-229 (Ci)	3.37E-08	3.24E-01	5.36E-08	1.57E-05	3.85E-01	7.03E-01		3.20E-08	3.85E-01	7.03E-01
Th-232 (Ci)	2.67E-10	1.48E+00	6.34E-10	5.97E-09	4.24E-01	9.01E-01		2.03E-11	4.24E-01	9.01E-01
U-232 (Ci)	2.62E-04	1.62E+00	1.38E-03	1.06E-03	1.82E+00	3.99E+00		6.17E-05	1.82E+00	3.99E+00
U-233 (Ci)	1.24E-05	9.68E+01	2.09E-05	7.47E-03	1.16E+02	2.37E+02		2.60E-04	1.16E+02	2.37E+02
U-234 (Ci)	5.57E+00	1.34E+01	5.60E+00	1.55E+01	1.86E+01	1.72E+01		8.42E-01	8.79E-01	1.87E+00
U-235 (Ci)	2.38E-01	5.23E-01	2.59E-01	6.63E-01	7.39E-01	6.63E-01		3.56E-02	3.12E-06	6.63E-06
U-236 (Ci)	1.27E-01	3.30E-01	3.94E-01	3.42E-01	4.54E-01	7.55E-01		2.01E-02	5.44E-07	1.16E-06
U-238 (Ci)	5.72E+00	1.21E+01	3.92E+00	1.59E+01	1.73E+01	1.16E+01		8.43E-01	4.87E-14	1.03E-13
U-Total (mols)	7.20E+04	1.52E+05	4.96E+04	2.00E+05	2.18E+05	1.46E+05		1.06E+04	5.23E+01	1.07E+02
Np-237 (Ci)	4.46E-02	1.09E-01	6.45E-02	4.09E+01	1.61E+01	1.17E+01		8.78E-02	4.02E-07	8.55E-07
Pu-238 (Ci)	1.43E+01	4.45E+01	6.64E+01	1.28E+02	1.50E+02	5.57E+02	5.29E+02	1.23E+01	6.85E-05	1.49E-04
Pu-239 (Ci)	8.09E+02	1.84E+03	6.53E+02	5.18E+03	3.12E+03	4.94E+03	8.26E+03	3.79E+02	3.47E-09	7.38E-09
Pu-240 (Ci)	1.69E+02	4.34E+02	2.52E+02	1.04E+03	7.66E+02	1.73E+03	2.06E+03	8.18E+01	2.39E-10	5.08E-10
Pu-241 (Ci)	7.31E+02	3.14E+03	5.15E+03	4.57E+03	6.82E+03	3.27E+04	3.32E+04	5.00E+02	9.20E-10	2.27E-09
Pu-242 (Ci)	5.24E-03	2.20E-02	4.87E-02	3.25E-02	5.54E-02	2.95E-01	2.05E-01	3.84E-03	1.95E-15	4.15E-15
Pu-Total (kg)	1.38E+01	3.16E+01	1.17E+01	8.81E+01	5.38E+01	8.76E+01	1.42E+02	6.47E+00	4.06E-09	8.83E-09
Am-241 (Ci)	1.54E+02	4.53E+02	6.22E+02	6.04E+03	8.39E+03	2.07E+04	8.77E+03	1.08E+03	1.33E-10	2.74E-10
Am-243 (Ci)	1.71E-03	1.21E-02	6.49E-02	2.78E+00	4.47E+00	1.98E+01		5.38E-01	4.73E-16	1.01E-15
Cm-242 (Ci)	2.91E-03	1.88E-02	1.16E-01	4.73E+00	7.78E+00	3.31E+01		6.25E-01	8.94E-16	5.54E-16
Cm-243 (Ci)	5.44E-05	9.84E-04	3.27E-02	9.26E-02	4.67E-01	3.57E+00		3.34E-02	1.80E-17	4.11E-17
Cm-244 (Ci)	1.42E-03	3.05E-02	7.01E-01	2.45E+00	1.09E+01	8.74E+01		7.90E-01	3.91E-16	9.35E-16

Chemicals in [Ci] (Sheet 4)

chemicals in Ci	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3 (Ci)	2.45E+00	7.13E+02	9.16E+01	9.65E+01			3.11E+02	1.86E+03	1.63E+03	1.88E+03
C-14 (Ci)	1.06E+00	4.47E+01	6.65E+00	8.78E+00			1.82E+01	7.24E+01	2.14E+02	2.21E+02
Ni-59 (Ci)	2.18E+01	5.22E+01	2.84E+01	7.21E+01			4.51E+00	3.13E+01	2.59E+02	6.47E+02
Ni-63 (Ci)	2.06E+03	5.03E+03	2.69E+03	6.81E+03			4.64E+02	2.97E+03	2.48E+04	6.20E+04
Co-60 (Ci)	1.55E+02	1.67E+03	3.64E+02	6.73E+02			2.10E+01	4.02E+02	1.56E+03	2.41E+03
Se-79 (Ci)	1.31E-01	1.04E+01	1.43E+00	1.69E+00			7.00E-01	6.78E+00	1.91E+01	1.51E+01
Sr-90 (Ci)	7.32E+06	1.28E+07	8.92E+06	2.35E+07	6.02E+05		1.46E+05	1.45E+05	9.41E+05	6.10E+05
Y-90 (Ci)	7.32E+06	1.28E+07	8.92E+06	2.36E+07			1.46E+05	1.45E+05	9.41E+05	6.10E+05
Zr-93 (Ci)	7.80E+00	6.18E+02	8.50E+01	1.01E+02			6.48E+01	4.05E+02	1.14E+03	8.97E+02
Nb-93m (Ci)	6.33E+00	4.63E+02	6.43E+01	7.69E+01			5.77E+01	3.33E+02	9.23E+02	7.22E+02
Tc-99 (Ci)	4.10E+01	3.18E+03	4.39E+02	5.21E+02			2.11E+02	2.52E+03	6.28E+03	4.80E+03
Ru-106 (Ci)	9.90E-04	6.83E-02	9.53E-03	1.15E-02			4.56E-08	8.07E-04	2.23E-03	1.64E-03
Cd-113m (Ci)	7.84E+00	9.15E+02	1.22E+02	1.38E+02			2.36E+01	3.75E+02	1.21E+03	1.12E+03
Sb-125 (Ci)	3.42E+01	8.10E+02	1.36E+02	2.04E+02			6.49E-01	8.00E+01	3.01E+02	2.51E+02
Sn-126 (Ci)	5.43E-01	4.48E+01	6.14E+00	7.23E+00			2.63E+00	2.75E+01	7.87E+01	6.29E+01
I-129 (Ci)	2.45E-03	1.96E-01	2.69E-02	3.18E-02			2.92E-01	3.88E+00	6.89E+00	1.98E+01
Cs-134 (Ci)	1.30E-01	1.15E+02	1.45E+01	1.48E+01			5.16E-03	5.68E+00	1.40E+01	4.61E+00
Cs-137 (Ci)	1.64E+05	1.51E+07	2.05E+06	2.38E+06	1.50E+06		6.13E+05	7.49E+06	1.16E+07	4.00E+06
Ba-137m (Ci)	1.55E+05	1.42E+07	1.93E+06	2.24E+06			5.79E+05	7.07E+06	1.09E+07	3.77E+06
Sm-151 (Ci)	1.47E+05	4.06E+05	1.98E+05	4.93E+05			3.22E+04	1.46E+05	3.60E+05	2.68E+05
Eu-152 (Ci)	2.97E+01	2.61E+02	6.23E+01	1.22E+02			1.09E+00	2.47E+01	6.72E+01	5.28E+01
Eu-154 (Ci)	2.34E+03	1.87E+04	4.68E+03	9.35E+03			8.34E+01	1.67E+03	4.94E+03	3.98E+03
Eu-155 (Ci)	1.24E+03	6.88E+03	2.10E+03	4.57E+03			4.88E+01	6.98E+02	2.26E+03	1.91E+03
Ra-226 (Ci)	5.44E-06	6.01E-04	8.06E-05	9.15E-05			3.41E-03	4.04E-04	2.57E-03	1.72E-03
Ra-228 (Ci)	3.87E-11	8.28E-09	1.07E-09	1.15E-09			1.55E-08	1.60E-02	3.05E-01	2.08E+00
Ac-227 (Ci)	2.47E-05	2.91E-03	3.88E-04	4.37E-04			1.53E-02	1.97E-03	1.59E-02	3.15E-02
Pa-231 (Ci)	3.64E-05	4.74E-03	6.29E-04	7.01E-04			4.75E-02	3.03E-02	8.49E-01	5.74E+00
Th-229 (Ci)	6.31E-08	2.84E-06	4.18E-07	5.44E-07			2.79E-06	4.59E-05	7.36E-04	4.09E-03
Th-232 (Ci)	4.01E-11	8.71E-09	1.13E-09	1.21E-09			2.35E-08	1.64E-04	2.66E-03	1.56E-02
U-232 (Ci)	1.22E-04	1.26E-03	2.79E-04	5.23E-04			3.64E-05	5.12E-03	9.25E-02	4.99E-01
U-233 (Ci)	5.14E-04	4.58E-04	5.71E-04	1.60E-03			2.91E-06	3.03E-01	5.52E+00	3.02E+01
U-234 (Ci)	1.66E+00	4.38E+00	2.21E+00	5.53E+00			2.71E+00	6.45E-01	1.82E+00	1.97E+00
U-235 (Ci)	7.03E-02	1.89E-01	9.39E-02	2.34E-01			1.21E-01	2.61E-02	7.55E-02	7.33E-02
U-236 (Ci)	3.97E-02	2.16E-01	6.67E-02	1.46E-01			3.18E-02	1.62E-02	4.24E-02	5.01E-02
U-238 (Ci)	1.66E+00	3.30E+00	2.08E+00	5.40E+00			2.76E+00	5.55E-01	1.65E+00	1.62E+00
U-Total (mols)	2.09E+04	4.17E+04	2.62E+04	6.80E+04			3.48E+04	6.99E+03	2.08E+04	2.04E+04
Np-237 (Ci)	1.73E-01	9.37E+00	1.35E+00	1.69E+00			1.79E+00	1.00E+01	2.34E+01	1.60E+01
Pu-238 (Ci)	2.44E+01	2.79E+02	5.93E+01	1.08E+02			5.43E+00	1.06E+01	2.77E+01	3.06E+01
Pu-239 (Ci)	7.47E+02	2.47E+03	1.06E+03	2.55E+03	1.14E-05		7.14E+02	2.73E+02	7.67E+02	7.75E+02
Pu-240 (Ci)	1.61E+02	8.65E+02	2.69E+02	5.92E+02			8.09E+01	5.80E+01	1.61E+02	1.86E+02
Pu-241 (Ci)	9.87E+02	1.64E+04	3.03E+03	5.01E+03			1.63E+02	3.30E+02	1.32E+03	1.75E+03
Pu-242 (Ci)	7.59E-03	1.48E-01	2.60E-02	4.12E-02			1.17E-03	2.66E-03	1.06E-02	1.42E-02
Pu-Total (kg)	1.28E+01	4.39E+01	1.82E+01	4.38E+01			1.19E+04	4.66E+03	1.31E+04	1.33E+04
Am-241 (Ci)	2.13E+03	1.66E+04	4.20E+03	8.45E+03			9.91E+01	3.74E+02	1.43E+03	1.73E+03
Am-243 (Ci)	1.06E+00	1.59E+01	3.04E+00	5.17E+00			1.31E-02	2.06E-01	7.79E-01	6.91E-01
Cm-242 (Ci)	1.23E+00	2.65E+01	4.54E+00	7.01E+00			2.25E-02	5.72E-01	1.39E+00	9.14E-01
Cm-243 (Ci)	6.60E-02	2.85E+00	4.23E-01	5.55E-01			2.66E-04	2.41E-02	5.31E-02	3.20E-02
Cm-244 (Ci)	1.56E+00	6.99E+01	1.03E+01	1.34E+01			6.25E-03	5.49E-01	1.28E+00	7.96E-01

Chemicals in [Ci] (Sheet 5)

chemicals in Ci	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (Ci)	1.59E+03	8.62E+02	7.69E+02	9.35E+02	2.20E+03	1.33E+03	3.53E+03	3.28E+03
C-14 (Ci)	3.75E+02	2.06E+02	2.17E+02	2.71E+02	6.97E+00	3.73E+00	1.07E+01	3.97E+01
Ni-59 (Ci)	1.35E+02	2.98E+01	8.68E+01	5.95E+01	2.11E+01	1.14E+01	3.25E+01	8.17E-01
Ni-63 (Ci)	1.28E+04	2.85E+03	8.28E+03	5.68E+03	2.04E+03	1.11E+03	3.15E+03	7.84E+01
Co-60 (Ci)	2.08E+03	8.14E+02	9.32E+02	1.10E+03	4.38E+03	3.07E+03	7.45E+03	2.65E+02
Se-79 (Ci)	3.54E+01	1.92E+01	1.94E+01	2.17E+01	3.34E+00	1.85E+00	5.18E+00	2.10E-02
Sr-90 (Ci)	1.21E+06	9.64E+04	3.50E+05	1.53E+06	5.52E+06	3.21E+06	8.73E+06	3.53E+04
Y-90 (Ci)	1.21E+06	9.64E+04	3.50E+05	1.53E+06	5.52E+06	3.21E+06	8.73E+06	3.53E+04
Zr-93 (Ci)	2.11E+03	1.15E+03	1.15E+03	1.29E+03	2.02E+02	1.12E+02	3.14E+02	1.99E+00
Nb-93m (Ci)	1.72E+03	9.30E+02	9.31E+02	1.04E+03	1.14E+02	5.93E+01	1.73E+02	1.10E+00
Tc-99 (Ci)	1.17E+04	6.32E+03	6.27E+03	7.10E+03	9.86E+02	5.46E+02	1.53E+03	1.14E+02
Ru-106 (Ci)	3.92E-03	1.72E-03	1.57E-03	1.78E+00	3.45E+02	7.06E+02	1.05E+03	4.25E+00
Cd-113m (Ci)	2.19E+03	1.20E+03	1.29E+03	1.28E+03	6.03E+02	3.46E+02	9.49E+02	3.96E+00
Sb-125 (Ci)	5.36E+02	1.51E+02	1.78E+02	4.08E+02	8.91E+03	7.99E+03	1.69E+04	1.66E+02
Sn-126 (Ci)	1.47E+02	7.94E+01	8.04E+01	8.99E+01	1.49E+01	8.09E+00	2.30E+01	9.30E-02
I-129 (Ci)	1.11E+01	6.20E+00	6.46E+00	8.34E+00	8.76E-02	4.77E-02	7.67E-01	7.57E-01
Cs-134 (Ci)	1.57E+01	9.72E+00	1.27E+01	3.97E+02	4.09E+03	3.85E+03	7.93E+03	4.26E+02
Cs-137 (Ci)	1.43E+07	8.56E+06	7.99E+06	9.14E+06	6.31E+06	3.62E+06	9.94E+06	5.33E+05
Ba-137m (Ci)	1.35E+07	8.09E+06	7.55E+06	8.63E+06	5.96E+06	3.42E+06	9.38E+06	5.04E+05
Sm-151 (Ci)	5.92E+05	1.49E+05	1.66E+05	2.29E+05	1.33E+05	7.58E+04	2.09E+05	8.45E+02
Eu-152 (Ci)	1.08E+02	2.74E+01	3.40E+01	5.48E+01	1.83E+02	9.32E+01	2.76E+02	1.12E+00
Eu-154 (Ci)	7.95E+03	2.01E+03	2.54E+03	4.15E+03	2.15E+04	1.18E+04	3.33E+04	1.35E+02
Eu-155 (Ci)	3.62E+03	9.17E+02	1.18E+03	1.94E+03	1.46E+04	1.09E+04	2.55E+04	1.03E+02
Ra-226 (Ci)	2.77E-03	1.75E-03	1.64E-03	1.86E-03	2.99E-04	1.51E-04	4.50E-04	8.41E-06
Ra-228 (Ci)	3.61E-01	2.20E-01	7.73E-01	7.56E-01	1.70E-08	1.00E-08	2.70E-08	6.55E-10
Ac-227 (Ci)	1.69E-02	1.06E-02	1.01E-02	1.09E-02	1.48E-03	7.79E-04	2.26E-03	4.04E-05
Pa-231 (Ci)	8.71E-01	5.58E-01	2.38E+00	2.40E+00	3.29E-03	1.91E-03	5.20E-03	1.72E-04
Th-229 (Ci)	8.58E-04	5.26E-04	8.69E-04	9.19E-04	1.97E-06	1.00E-06	2.97E-06	4.53E-08
Th-232 (Ci)	2.94E-03	1.83E-03	3.15E-03	3.32E-03	1.93E-08	1.17E-08	3.10E-08	1.09E-09
U-232 (Ci)	3.93E-02	1.28E-02	4.84E-02	3.30E-02	4.26E-03	2.07E-03	6.33E-03	2.34E-03
U-233 (Ci)	2.36E+00	7.67E-01	2.91E+00	1.97E+00	1.37E-03	6.40E-04	2.01E-03	2.86E-05
U-234 (Ci)	1.50E+00	3.88E-01	5.08E-01	1.39E+00	1.23E+01	6.90E+00	1.92E+01	1.24E+01
U-235 (Ci)	6.25E-02	1.62E-02	2.06E-02	5.50E-02	4.59E-01	2.75E-01	7.34E-01	4.75E-01
U-236 (Ci)	3.71E-02	9.40E-03	1.33E-02	9.41E-02	1.17E+00	6.81E-01	1.85E+00	1.20E+00
U-238 (Ci)	1.41E+00	3.62E-01	4.57E-01	1.09E+00	8.45E+00	4.75E+00	1.32E+01	8.54E+00
U-Total (mols)	1.77E+04	4.56E+03	5.76E+03	1.37E+04	1.07E+05	6.00E+04	1.67E+05	1.08E+05
Np-237 (Ci)	4.20E+01	1.59E+01	1.57E+01	1.50E+01	1.95E+01	1.06E+01	3.01E+01	1.22E-01
Pu-238 (Ci)	2.52E+01	6.37E+00	9.50E+00	4.21E+01	4.99E+02	2.51E+02	7.51E+02	1.01E+02
Pu-239 (Ci)	7.01E+02	1.77E+02	2.26E+02	5.68E+02	4.72E+03	2.53E+03	7.25E+03	1.00E+03
Pu-240 (Ci)	1.53E+02	3.81E+01	5.24E+01	1.47E+02	1.35E+03	6.91E+02	2.04E+03	2.82E+02
Pu-241 (Ci)	1.13E+03	2.91E+02	4.71E+02	2.99E+03	4.04E+04	2.01E+04	6.05E+04	8.35E+03
Pu-242 (Ci)	9.35E-03	2.38E-03	3.91E-03	1.56E-02	1.75E-01	8.31E-02	2.58E-01	3.55E-02
Pu-Total (kg)	1.20E+04	3.03E+03	3.88E+03	9.83E+03	8.24E+01	4.40E+01	1.26E+02	1.74E+01
Am-241 (Ci)	1.84E+03	2.45E+02	5.50E+02	1.86E+03	2.42E+04	1.57E+04	3.98E+04	4.44E+02
Am-243 (Ci)	1.11E+00	1.42E-01	3.40E-01	1.22E+00	7.57E+00	3.50E+00	1.11E+01	4.45E-02
Cm-242 (Ci)	2.27E+00	7.45E-01	8.08E-01	8.68E-01	1.40E+01	6.38E+00	2.04E+01	8.20E-02
Cm-243 (Ci)	7.99E-02	2.68E-02	3.23E-02	5.07E-02	2.17E+00	9.15E-01	3.08E+00	1.25E-02
Cm-244 (Ci)	1.95E+00	6.53E-01	7.91E-01	1.25E+00	5.63E+01	2.27E+01	7.90E+01	3.19E-01

Species Total Concentration (mol/L). (Sheet 1)

species mol/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
Na	2.32E+00	2.52E+00	3.08E+00	3.03E+00	2.27E+00	1.47E+00	1.69E+00	1.69E+00	4.20E+00	4.21E+00
Al	0.00E+00	0.00E+00	8.20E-02	6.20E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe	1.60E-02	1.60E-02	5.00E-02	5.00E-02	4.00E-02	3.08E-02	1.60E-02	1.60E-02	4.60E-02	3.00E-02
Cr	3.20E-03	3.20E-03	6.50E-03	6.50E-03	4.20E-03	5.79E-03	6.80E-03	6.80E-03	3.20E-03	3.20E-03
Bi	2.86E-04	2.86E-04	1.20E-02	1.20E-02	1.00E-02	6.16E-03	6.00E-03	6.00E-03	1.80E-04	1.80E-04
La							3.80E-03	3.80E-03		
Hg	0.00E+00	5.13E-05	0.00E+00	1.17E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.74E-05	1.74E-05
ZrO(OH)2	0.00E+00	0.00E+00	3.20E-04	3.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	6.60E-03
Sr	2.84E-06	5.19E-06	6.54E-08	9.41E-08	1.35E-09	1.50E-09	1.58E-11	2.86E-11	2.48E-06	2.48E-06
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.10E-03	5.10E-03	0.00E+00	0.00E+00
Ca	1.80E-02	1.80E-02	1.82E-02	1.82E-02	1.82E-02	1.81E-02	1.82E-02	1.82E-02	1.84E-02	1.84E-02
K	7.06E-04	7.06E-04	9.50E-03	9.50E-03	6.53E-03	4.28E-03	2.31E-01	2.31E-01	1.58E-02	1.66E-02
balance	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density										
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
void frac.	2.70E-01	1.45E-01	5.74E-01	5.99E-01	4.76E-01	5.26E-01	7.26E-01	7.89E-01	4.45E-01	2.34E-01
species										
OH	1.49E+00	1.50E+00	4.93E-01	4.21E-01	1.49E-01	1.56E-01	1.51E-01	1.51E-01	1.43E-01	1.09E-01
NO3	1.85E-01	1.85E-01	1.64E+00	1.63E+00	1.24E+00	7.97E-01	1.38E+00	1.38E+00	3.10E+00	3.10E+00
NO2	0.00E+00	0.00E+00	5.80E-02	4.40E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO3	6.00E-01	7.00E-01	1.82E-02	1.82E-02	1.82E-02	1.81E-02	1.82E-02	1.82E-02	2.00E-01	1.84E-02
PO4	1.80E-01	1.80E-01	2.89E-01	2.89E-01	2.10E-01	1.29E-01	3.80E-02	3.80E-02	1.30E-01	1.30E-01
SO4	2.12E-01	2.12E-01	6.96E-02	6.96E-02	4.96E-02	3.12E-02	3.00E-03	3.00E-03	1.42E-01	1.85E-01
SiO3	4.00E-03	4.00E-03	6.00E-02	5.30E-02	3.70E-02	2.28E-02	0.00E+00	0.00E+00	0.00E+00	3.50E-02
F	0.00E+00	0.00E+00	1.86E-01	1.86E-01	2.20E-01	1.36E-01	2.70E-01	2.70E-01	0.00E+00	2.10E-01
Cl	3.25E-03	3.25E-03	4.37E-02	4.37E-02	3.00E-02	1.97E-02	2.88E-02	2.88E-02	9.55E-02	7.62E-02
C6H5O7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate										
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.60E-02	4.60E-02	0.00E+00	0.00E+00
DBP									3.04E-05	
butanol									3.04E-05	
NH3	0.00E+00	0.00E+00	1.10E-01	8.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe(CN)6---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-03

Species Total Concentration (mol/L) (Sheet 2)

species mol/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
Na	4.20E+00	3.61E+00	1.39E+00	5.50E+00	5.46E+00	3.97E+00	1.81E+00	7.90E-01	1.39E+00	3.35E+00
Al	0.00E+00	1.10E-02	0.00E+00	1.13E+00	1.13E+00	2.00E+00	7.80E-01	0.00E+00	0.00E+00	0.00E+00
Fe	3.00E-02	1.69E-03	1.88E-03	4.75E-02	5.30E-02	1.52E-02	1.52E-02	5.98E-02	1.17E-01	6.60E-02
Cr	3.20E-03	4.59E-03	2.00E-03	1.13E-01	1.13E-01	3.04E-03	3.04E-03	8.00E-03	8.00E-03	8.00E-03
Bi	1.80E-04	2.55E-04	1.40E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La		0.00E+00								
Hg	1.74E-05	1.30E-06	1.83E-05	9.21E-06	1.60E-05	0.00E+00	0.00E+00	2.60E-05	2.60E-05	0.00E+00
ZrO(OH)2	0.00E+00	7.77E-05	4.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	6.61E-06	0.00E+00	0.00E+00	0.00E+00	7.67E-03	4.55E-03	1.12E-04	9.44E-04	0.00E+00
Ni	6.60E-03	1.31E-02	1.16E-02	4.00E-03	4.00E-03	1.52E-03	1.52E-03	4.00E-03	4.00E-03	4.00E-03
Sr	4.00E-03	4.41E-07	8.61E-08	1.39E-05	5.04E-05	1.43E-07	2.47E-07	4.99E-05	1.26E-04	2.16E-07
Mn	0.00E+00	0.00E+00	0.00E+00	5.87E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	1.84E-02	2.34E-02	2.00E-02	1.85E-02	1.85E-02	1.81E-02	1.81E-02	1.81E-02	1.81E-02	1.84E-02
K	1.66E-02	1.48E-02	4.20E-03	2.64E-02	2.00E-02	2.29E-03	3.49E-03	3.14E-03	5.64E-03	1.47E-02
balance	0.00E+00	-1.42E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density										
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
void frac.	2.29E-01	9.16E-01	8.51E-01	6.86E-01	6.40E-01	6.90E-01	7.50E-01	7.59E-01	5.47E-01	5.56E-01
species										
OH	1.09E-01	9.78E-02	1.41E-01	6.31E+00	6.47E+00	7.69E+00	3.05E+00	3.64E-01	5.46E-01	3.39E-01
NO3	3.11E+00	2.67E+00	5.44E-01	2.98E+00	2.68E+00	8.84E-01	8.85E-01	4.39E-01	7.12E-01	2.87E+00
NO2	0.00E+00	1.22E-01	1.70E-01	0.00E+00	0.00E+00	1.40E+00	2.80E-01	1.00E-02	1.00E-02	1.00E-02
CO3	1.84E-02	1.20E-01	2.18E-02	1.85E-02	1.85E-02	1.81E-02	1.81E-02	1.81E-02	1.81E-02	1.84E-02
PO4	1.30E-01	6.28E-02	8.46E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.60E-02
SO4	1.85E-01	1.15E-01	2.14E-02	1.90E-02	3.00E-02	9.19E-03	6.07E-03	4.37E-02	1.60E-01	5.60E-02
SiO3	3.50E-02	5.09E-03	3.80E-02	1.47E-02	4.24E-02	3.00E-02	0.00E+00	4.69E-02	9.21E-02	0.00E+00
F	2.10E-01	9.16E-02	2.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl	7.62E-02	8.19E-02	1.93E-02	9.43E-02	9.20E-02	1.05E-02	1.61E-02	1.44E-02	2.59E-02	6.77E-02
C6H5O7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate		0.00E+00								
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP		1.83E-05								
butanol		1.83E-05								
NH3	0.00E+00	2.61E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe(CN)6---	2.50E-03	5.00E-03	5.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Species Total Concentration (mol/L) (Sheet 3)

species mol/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
Na	2.36E+00	1.61E+00	1.07E+00	6.63E-01	1.12E+00	1.58E+00	3.54E+00	2.21E+00	3.61E+00	3.61E+00
Al	1.20E+00	7.80E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	0.00E+00	3.40E-01	3.40E-01
Fe	1.52E-02	1.52E-02	1.52E-02	4.00E-02	4.00E-02	4.00E-02	4.07E-02	7.00E-02	6.50E-02	6.50E-02
Cr	3.04E-03	3.04E-03	3.04E-03	8.00E-03	8.00E-03	8.00E-03	9.40E-03	8.00E-03	8.00E-03	8.00E-03
Bi	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La										
Hg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.55E-05	0.00E+00	0.00E+00
ZrO(OH)2	0.00E+00	0.00E+00	1.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	7.23E-03	5.17E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.40E-03	0.00E+00	0.00E+00
Ni	1.52E-03	1.52E-03	1.52E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03	4.00E-03
Sr	1.31E-07	1.12E-07	1.07E-06	1.06E-07	3.95E-08	7.13E-09		2.04E-05	2.51E-06	2.79E-06
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-02	8.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	1.80E-02	1.81E-02	1.80E-02	1.80E-02	1.80E-02	1.81E-02	1.83E-02	4.90E-03	1.83E-02	1.83E-02
K	1.49E-03	2.49E-03	2.21E-01	1.00E-03	1.35E-02	5.52E-03	1.26E-02	8.87E-02	2.78E-02	2.78E-02
balance	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-04	0.00E+00	0.00E+00
density										
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
void frac.	8.22E-01	7.49E-01	8.55E-01	7.40E-01	7.14E-01	7.39E-01	5.23E-01	9.42E-01	8.43E-01	8.43E-01
species										
OH	4.53E+00	3.04E+00	6.85E-01	2.04E-01	1.92E-01	1.87E-01	2.16E+00	3.47E-01	1.56E+00	1.56E+00
NO3	6.83E-01	6.84E-01	3.13E-01	2.30E-01	3.78E-01	9.43E-01	2.57E+00	1.08E+00	2.75E+00	2.75E+00
NO2	7.80E-01	2.80E-01	7.00E-03	1.00E-02	1.00E-02	1.00E-02	1.40E-02	1.00E-02	1.00E-02	1.00E-02
CO3	1.80E-02	1.81E-02	1.80E-02	2.20E-01	4.00E-01	3.04E-01	2.00E-01	4.90E-03	1.83E-02	1.83E-02
PO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-04	0.00E+00	9.00E-02	9.00E-02
SO4	8.75E-03	6.69E-03	1.52E-03	4.00E-03	4.00E-03	4.00E-03	6.80E-03	6.74E-02	5.40E-02	5.40E-02
SiO3	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F	0.00E+00	0.00E+00	7.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-01	1.20E-01
Cl	6.87E-03	1.15E-02	5.72E-03	4.60E-03	6.90E-03	2.13E-02	8.91E-02	4.92E-02	6.34E-02	6.34E-02
C6H5O7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-02	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.00E-02	0.00E+00	0.00E+00
HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate								5.10E-01		
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP				6.06E-02	2.23E-02	1.85E-02		0.00E+00	3.93E-03	3.89E-03
butanol				6.06E-02	2.23E-02	1.85E-02		0.00E+00	3.93E-03	3.89E-03
NH3	0.00E+00	0.00E+00	7.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe(CN)6---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Species Total Concentration (mol/L) (Sheet 4)

species mol/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
Na	1.50E+00	6.77E-01	3.75E+00	3.48E+00	4.16E+00	1.95E-01	5.59E+00	1.12E+01	1.18E+01	1.33E+01
Al	2.34E-02	8.30E-02	2.80E-01	0.00E+00	3.84E-01	0.00E+00	1.28E-02	1.87E+00	1.27E+00	2.37E+00
Fe	4.22E-02	7.00E-03	1.70E-02	4.10E-02	4.60E-03	4.00E-02	1.32E-02	4.10E-03	9.87E-03	1.65E-02
Cr	1.70E-02	2.00E-03	2.00E-07	0.00E+00	3.17E-02	8.00E-03	8.71E-03	1.07E-01	6.28E-02	5.15E-02
Bi	2.03E-06	0.00E+00	0.00E+00	0.00E+00	5.08E-06	0.00E+00	2.97E-03	2.73E-07	2.68E-04	1.37E-04
La					0.00E+00		0.00E+00	0.00E+00	9.74E-14	1.49E-09
Hg	2.58E-05	7.49E-06	1.11E-05	1.37E-04	2.77E-06	0.00E+00	3.94E-06	3.17E-06	3.66E-06	2.85E-06
ZrO(OH)2	4.07E-08	0.00E+00	0.00E+00	0.00E+00	1.60E-06	0.00E+00	2.72E-04	8.78E-08	1.49E-04	5.12E-05
Pb	2.24E-04	1.06E-03	0.00E+00	0.00E+00	4.90E-04	0.00E+00	0.00E+00	1.07E-04	6.73E-04	2.85E-03
Ni	6.08E-03	2.00E-03	1.00E-02	0.00E+00	4.31E-03	4.00E-03	2.84E-03	3.88E-03	7.93E-03	1.03E-02
Sr	7.02E-05	1.23E-05	1.54E-05	7.77E-05	1.28E-06		5.58E-07	1.25E-06	4.21E-06	1.49E-05
Mn	1.77E-04	0.00E+00	0.00E+00	0.00E+00	3.24E-04	0.00E+00	0.00E+00	6.56E-04	4.84E-04	6.92E-04
Ca	6.11E-03	1.01E-02	1.04E-02	1.23E-02	8.81E-03	1.80E-02	9.43E-03	7.95E-03	1.76E-02	2.23E-02
K	7.65E-03	2.76E-03	1.50E-02	1.36E-02	2.08E-02	6.90E-04	2.09E-02	4.75E-02	5.97E-02	5.43E-02
balance	4.86E-05	1.50E-05	2.22E-05	2.74E-04	1.02E-03	0.00E+00	0.00E+00	5.32E-05	4.77E-04	8.30E-04
density										
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00	1.00E+00	7.96E+00	1.30E+01	4.30E+01	5.40E+01
void frac.	8.22E-01	4.80E-01	6.98E-01	7.81E-01	8.88E-01	8.77E-01	5.08E-01	8.62E-01	7.75E-01	7.08E-01
species										
OH	3.16E-01	5.29E-01	1.15E+00	2.10E+00	2.54E+00	1.70E-01	2.64E-01	1.10E+01	7.07E+00	1.06E+01
NO3	5.00E-01	2.72E-01	8.76E-01	6.38E-01	1.25E+00	1.57E-01	3.83E+00	3.74E+00	5.24E+00	5.77E+00
NO2	2.73E-01	1.00E-02	1.00E-02	1.00E-02	8.59E-01	2.40E-02	1.78E-01	2.11E+00	1.62E+00	2.13E+00
CO3	1.43E-01	1.01E-02	2.70E-01	2.50E-01	1.89E-01	1.10E-02	1.65E-01	2.72E-02	3.62E-01	4.63E-01
PO4	2.23E-02	0.00E+00	1.00E-02	0.00E+00	6.46E-03	0.00E+00	1.66E-01	5.08E-04	5.69E-02	5.25E-02
SO4	7.39E-02	1.71E-02	4.40E-02	1.02E-01	9.40E-02	4.00E-03	1.62E-01	5.16E-02	1.83E-01	1.99E-01
SiO3	8.72E-02	4.00E-02	5.00E-02	8.00E-02	1.80E-02	0.00E+00	1.89E-02	2.13E-02	2.20E-02	2.28E-02
F	4.40E-04	0.00E+00	0.00E+00	0.00E+00	1.64E-03	0.00E+00	1.86E-01	1.80E-04	1.14E-01	8.93E-02
Cl	1.90E-02	1.27E-02	6.91E-02	6.24E-02	7.02E-02	3.17E-03	1.13E-01	1.86E-01	2.13E-01	1.79E-01
C6H5O7	0.00E+00	1.00E-02	1.50E-02	0.00E+00	2.75E-02	0.00E+00	0.00E+00	1.59E-03	1.53E-02	3.09E-02
EDTA	0.00E+00	0.00E+00	1.50E-01	0.00E+00	3.51E-03	0.00E+00	0.00E+00	1.71E-03	3.03E-02	2.40E-02
HEDTA	0.00E+00	0.00E+00	3.00E-01	0.00E+00	7.06E-03	0.00E+00	0.00E+00	3.41E-03	6.03E-02	3.17E-02
					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	3.00E-01	0.00E+00	7.02E-03	0.00E+00	0.00E+00	3.41E-03	6.02E-02	3.16E-02
acetate							0.00E+00	3.37E-05	9.76E-04	5.20E-02
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-10	7.45E-06
DBP				3.04E-05	1.47E-02		2.26E-05	1.23E-03	1.22E-02	3.10E-02
butanol				3.04E-05	1.47E-02		2.26E-05	1.23E-03	1.22E-02	3.10E-02
					0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	1.02E-02	0.00E+00	0.00E+00	0.00E+00	2.46E-02	0.00E+00	8.95E-02	4.05E-02	1.07E-01	4.51E-02
Fe(CN)6—	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Species Total Concentration (mol/L) (Sheet 5)

species mol/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
Na	1.35E+01	1.34E+01	1.38E+01	1.31E+01	3.86E+00	2.25E+00	6.71E-01	1.02E+00
Al	1.77E+00	1.81E+00	1.78E+00	1.45E+00	4.25E-01	2.48E-01	0.00E+00	0.00E+00
Fe	8.00E-03	2.23E-03	5.33E-03	1.36E-02	9.57E-02	1.24E-01	4.00E-02	4.00E-02
Cr	8.64E-02	6.14E-02	6.04E-02	5.33E-02	1.13E-02	1.92E-02	8.00E-03	0.00E+00
Bi	1.44E-04	2.16E-04	1.87E-04	1.56E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	9.02E-09	8.53E-09	6.57E-09	4.87E-09				
Hg	3.43E-06	1.82E-06	2.57E-06	2.08E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZrO(OH)2	7.56E-05	1.16E-04	9.13E-05	2.03E-04	0.00E+00	0.00E+00	0.00E+00	1.00E-01
Pb	7.49E-04	7.94E-04	8.65E-04	5.53E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	6.04E-03	2.13E-03	3.86E-03	8.88E-03	5.30E-03	8.96E-03	4.00E-03	0.00E+00
Sr	4.32E-06	6.75E-07	3.24E-06	8.17E-06	2.43E-04	1.46E-04	1.21E-08	2.77E-07
Mn	8.38E-04	6.48E-04	6.25E-04	9.43E-04	0.00E+00	0.00E+00	6.00E-03	0.00E+00
Ca	1.17E-02	4.36E-03	7.29E-03	1.84E-02	1.34E-02	7.79E-03	1.80E-02	1.80E-02
K	7.17E-02	8.05E-02	8.11E-02	1.72E-01	8.05E-03	4.69E-03	7.00E-03	2.21E-01
balance	9.26E-04	9.34E-04	1.14E-03	8.31E-04	-4.85E-04	-2.92E-04	-2.42E-08	-5.55E-07
density								
vol% solids	3.61E+01	2.80E+01	1.89E+01	2.09E+01	4.43E+00	7.61E+00	2.00E+00	1.05E+01
void frac.	8.28E-01	9.03E-01	8.34E-01	8.18E-01	7.28E-01	8.37E-01	8.50E-01	8.48E-01
species		9.73E-01						
OH	1.02E+01	1.04E+01	1.00E+01	8.05E+00	2.60E+00	1.58E+00	1.77E-01	6.21E-01
NO3	4.54E+00	3.93E+00	3.85E+00	3.87E+00	2.43E+00	1.50E+00	2.57E-01	3.87E-01
NO2	2.28E+00	2.45E+00	2.63E+00	2.05E+00	1.59E-01	9.02E-02	1.00E-02	7.00E-03
CO3	3.72E-01	4.24E-01	5.68E-01	6.73E-01	1.34E-02	7.79E-03	1.20E-01	1.80E-02
PO4	4.48E-02	5.71E-02	6.11E-02	1.25E-01	0.00E+00	0.00E+00	6.95E-02	0.00E+00
SO4	1.57E-01	1.37E-01	1.68E-01	1.25E-01	1.27E-01	1.27E-01	4.00E-03	0.00E+00
SiO3	2.15E-02	1.19E-02	1.58E-02	9.87E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F	6.21E-02	9.22E-02	9.15E-02	1.92E-01	5.18E-02	3.18E-02	0.00E+00	7.70E-01
Cl	2.52E-01	2.83E-01	2.82E-01	2.68E-01	3.70E-02	2.16E-02	4.60E-03	4.60E-03
C6H5O7	2.91E-02	2.94E-02	3.76E-02	3.41E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	4.72E-02	4.95E-02	6.05E-02	1.14E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA	9.28E-02	9.76E-02	1.13E-01	2.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
glycolate	9.28E-02	9.76E-02	1.13E-01	2.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate	5.29E-03	4.62E-03	2.46E-02	1.60E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate	4.51E-05	4.26E-05	3.28E-05	2.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	1.65E-02	1.79E-02	2.67E-02	2.22E-02			3.41E-03	
butanol	1.65E-02	1.79E-02	2.67E-02	2.22E-02			3.41E-03	
	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
NH3	8.06E-02	1.04E-01	8.92E-02	4.17E-01	0.00E+00	0.00E+00	0.00E+00	7.70E-01
Fe(CN)6----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Species Total Concentration (Ci/L) (Sheet 1)

species Ci/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3 (Ci/L)	1.06E-05	2.32E-05	2.74E-06	5.75E-06	8.05E-11	1.75E-09	1.73E-13	1.50E-11	6.03E-06	6.03E-06
C-14 (Ci/L)	2.90E-07	4.71E-07	8.97E-08	7.63E-08	5.57E-09	5.53E-09	3.85E-10	6.21E-10	2.34E-07	2.34E-07
Ni-59 (Ci/L)	7.58E-08	1.23E-07	1.81E-08	2.51E-08	1.46E-09	1.44E-09	1.01E-10	1.62E-10	6.11E-08	6.11E-08
Ni-63 (Ci/L)	6.46E-06	1.09E-05	2.65E-06	3.47E-06	1.24E-07	1.28E-07	8.60E-09	1.43E-08	5.33E-06	5.33E-06
Co-60 (Ci/L)	1.37E-07	4.32E-07	1.05E-07	3.00E-07	2.64E-09	5.08E-09	1.83E-10	5.70E-10	1.82E-07	1.82E-07
Se-79 (Ci/L)	1.29E-08	2.14E-08	1.92E-09	2.51E-09	2.49E-10	2.51E-10	1.72E-11	2.82E-11	1.06E-08	1.06E-08
Sr-90 (Ci/L)	1.11E-02	2.03E-02	2.56E-04	3.69E-04	5.28E-06	5.89E-06	6.19E-08	1.12E-07	9.73E-03	9.73E-03
Y-90 (Ci/L)	1.11E-02	2.03E-02	2.56E-04	3.69E-04	5.28E-06	5.89E-06	6.19E-08	1.12E-07	9.73E-03	9.73E-03
Zr-93 (Ci/L)	3.51E-09	5.72E-09	1.04E-06	1.34E-06	1.52E-07	1.51E-07	0.00E+00	0.00E+00	2.83E-09	2.83E-09
Nb-93m (Ci/L)	3.16E-09	5.01E-09	9.36E-07	1.18E-06	1.36E-07	1.32E-07	0.00E+00	0.00E+00	2.51E-09	2.51E-09
Tc-99 (Ci/L)	6.26E-06	1.03E-05	1.44E-07	1.91E-07	2.98E-09	3.00E-09	3.49E-11	5.70E-11	3.68E-06	3.68E-06
Ru-106 (Ci/L)	1.37E-19	9.08E-18	4.07E-17	1.24E-15	4.74E-18	1.92E-16	8.20E-19	5.38E-17	3.12E-18	3.12E-18
Cd-113m (Ci/L)	3.05E-07	7.04E-07	8.02E-08	1.52E-07	5.86E-09	8.27E-09	4.05E-10	9.28E-10	3.17E-07	3.17E-07
Sb-125 (Ci/L)	3.99E-09	2.47E-08	1.28E-09	4.38E-09	7.67E-11	2.90E-10	5.30E-12	3.26E-11	9.41E-09	9.41E-09
Sn-126 (Ci/L)	4.67E-08	8.23E-08	6.91E-09	9.78E-09	8.98E-10	9.66E-10	6.21E-11	1.08E-10	3.98E-08	3.98E-08
I-129 (Ci/L)	2.77E-09	1.18E-08	7.11E-11	1.67E-09	1.32E-12	0.00E+00	1.54E-14	0.00E+00	4.71E-09	4.71E-09
Cs-134 (Ci/L)	1.72E-11	2.82E-10	3.95E-13	5.11E-12	8.15E-15	8.18E-14	9.55E-17	1.56E-15	1.00E-10	1.00E-10
Cs-137 (Ci/L)	1.28E-02	2.37E-02	2.94E-04	4.32E-04	6.06E-06	6.86E-06	7.11E-08	1.31E-07	1.13E-02	1.13E-02
Ba-137m (Ci/L)	1.21E-02	2.24E-02	2.78E-04	4.08E-04	5.73E-06	6.48E-06	6.71E-08	1.23E-07	1.07E-02	1.07E-02
Sm-151 (Ci/L)	4.90E-04	7.85E-04	1.60E-04	2.00E-04	5.23E-05	5.12E-05	1.21E-05	1.92E-05	3.91E-04	3.91E-04
Eu-152 (Ci/L)	6.07E-09	3.75E-08	1.99E-09	1.10E-08	6.48E-10	2.45E-09	1.49E-10	9.15E-10	1.43E-08	1.43E-08
Eu-154 (Ci/L)	5.88E-07	2.75E-06	1.92E-07	7.66E-07	6.28E-08	1.80E-07	1.45E-08	6.72E-08	1.09E-06	1.09E-06
Eu-155 (Ci/L)	4.77E-07	1.51E-06	1.56E-07	3.48E-07	5.09E-08	9.87E-08	1.17E-08	3.69E-08	6.36E-07	6.36E-07
Ra-226 (Ci/L)	9.51E-11	7.70E-11	1.41E-11	8.26E-12	1.83E-12	9.05E-13	1.27E-13	1.02E-13	5.03E-11	5.03E-11
Ra-228 (Ci/L)	3.19E-16	4.54E-16	4.71E-17	5.36E-17	6.14E-18	5.34E-18	4.24E-19	5.99E-19	2.35E-16	2.35E-16
Ac-227 (Ci/L)	4.55E-10	3.77E-10	4.20E-11	2.50E-11	1.56E-11	7.89E-12	5.38E-12	4.42E-12	2.44E-10	2.44E-10
Pa-231 (Ci/L)	3.78E-12	3.35E-12	8.73E-10	5.47E-10	3.27E-10	1.77E-10	1.13E-10	9.92E-11	2.10E-12	2.10E-12
Th-229 (Ci/L)	1.52E-14	2.17E-14	3.24E-14	3.72E-14	1.21E-14	1.06E-14	4.20E-15	5.94E-15	1.12E-14	1.12E-14
Th-232 (Ci/L)	1.27E-16	1.85E-16	2.71E-16	3.14E-16	1.02E-16	9.01E-17	3.52E-17	5.06E-17	9.52E-17	9.52E-17
U-232 (Ci/L)	1.63E-10	2.86E-10	8.90E-13	1.35E-12	2.26E-14	2.42E-14	5.81E-17	1.01E-16	1.39E-12	1.39E-12
U-233 (Ci/L)	1.45E-11	2.25E-11	7.88E-14	1.02E-13	2.00E-15	1.90E-15	5.14E-18	7.92E-18	1.13E-13	1.13E-13
U-234 (Ci/L)	1.87E-05	1.88E-05	9.86E-08	7.45E-08	2.58E-09	1.59E-09	6.65E-12	6.62E-12	1.11E-07	1.11E-07
U-235 (Ci/L)	8.43E-07	8.31E-07	4.45E-09	3.28E-09	1.17E-10	7.02E-11	3.00E-13	2.93E-13	4.96E-09	4.96E-09
U-236 (Ci/L)	1.60E-07	2.55E-07	8.42E-10	1.11E-09	2.21E-11	2.15E-11	5.67E-14	8.99E-14	1.27E-09	1.27E-09
U-238 (Ci/L)	1.90E-05	1.92E-05	1.00E-07	7.61E-08	2.63E-09	1.62E-09	6.76E-12	6.76E-12	1.13E-07	1.13E-07
U-Total (M)	2.39E-01	2.41E-01	1.26E-03	9.59E-04	3.31E-05	2.04E-05	8.51E-08	8.51E-08	1.43E-03	1.43E-03
Np-237 (Ci/L)	3.53E-08	5.94E-08	3.27E-09	4.39E-09	1.21E-09	1.24E-09	4.18E-10	6.96E-10	2.92E-08	2.92E-08
Pu-238 (Ci/L)	1.27E-08	5.17E-08	6.22E-08	2.22E-07	2.17E-08	5.40E-08	1.60E-08	6.46E-08	2.08E-08	2.08E-08
Pu-239 (Ci/L)	3.67E-06	5.83E-06	1.80E-05	2.18E-05	6.28E-06	6.09E-06	4.63E-06	7.28E-06	2.92E-06	2.92E-06
Pu-240 (Ci/L)	2.48E-07	7.39E-07	1.21E-06	3.09E-06	4.24E-07	7.72E-07	3.12E-07	9.23E-07	3.14E-07	3.14E-07
Pu-241 (Ci/L)	2.40E-07	1.62E-06	1.18E-06	7.13E-06	4.10E-07	1.69E-06	3.02E-07	2.03E-06	6.13E-07	6.13E-07
Pu-242 (Ci/L)	1.12E-12	1.18E-11	5.49E-12	5.40E-11	1.92E-12	1.23E-11	1.41E-12	1.47E-11	4.30E-12	4.30E-12
Pu-Total (g/L)	6.03E-05	9.73E-05	2.95E-04	3.65E-04	1.03E-04	1.02E-04	7.60E-05	1.21E-04	4.84E-05	4.84E-05
Am-241 (Ci/L)	7.66E-07	4.17E-06	9.80E-08	4.90E-07	2.62E-08	8.71E-08	9.05E-09	4.88E-08	1.61E-06	1.61E-06
Am-243 (Ci/L)	3.31E-11	6.45E-10	3.06E-12	5.64E-11	1.13E-12	1.35E-11	3.91E-13	7.55E-12	2.28E-10	2.28E-10
Cm-242 (Ci/L)	5.80E-11	1.11E-09	5.37E-12	9.71E-11	1.99E-12	2.32E-11	6.85E-13	1.30E-11	3.92E-10	3.92E-10
Cm-243 (Ci/L)	3.43E-13	1.34E-11	3.17E-14	1.18E-12	1.17E-14	2.80E-13	4.05E-15	1.57E-13	4.65E-12	4.65E-12
Cm-244 (Ci/L)	8.04E-12	3.15E-10	7.44E-13	2.77E-11	2.75E-13	6.58E-12	9.50E-14	3.69E-12	1.09E-10	1.09E-10

Species Total Concentration (Ci/L) (Sheet 2)

species Ci/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3 (Ci/L)	6.03E-06	6.28E-06	2.43E-07	2.72E-05	1.55E-04	1.51E-04	2.78E-04	3.86E-06	1.16E-05	2.08E-06
C-14 (Ci/L)	2.34E-07	2.18E-07	2.74E-07	1.49E-06	9.64E-07	1.65E-06	1.89E-06	2.43E-06	2.93E-06	2.00E-08
Ni-59 (Ci/L)	6.11E-08	9.45E-08	1.29E-08	3.90E-07	9.39E-07	1.99E-06	1.38E-05	1.34E-06	2.94E-06	4.20E-09
Ni-63 (Ci/L)	5.33E-06	8.81E-06	1.16E-06	3.52E-05	8.89E-05	1.94E-04	1.32E-03	1.25E-04	2.83E-04	4.05E-07
Co-60 (Ci/L)	1.82E-07	3.00E-07	6.31E-08	2.01E-06	1.33E-05	9.13E-06	2.89E-05	1.23E-05	5.28E-05	1.35E-07
Se-79 (Ci/L)	1.06E-08	8.70E-09	2.21E-09	6.89E-08	2.08E-07	6.97E-10	1.00E-09	2.38E-07	5.33E-07	8.40E-10
Sr-90 (Ci/L)	9.73E-03	1.73E-03	3.37E-04	6.25E-02	2.27E-01	6.44E-04	1.11E-03	2.38E-01	6.04E-01	1.03E-03
Y-90 (Ci/L)	9.73E-03	1.73E-03	3.38E-04	6.25E-02	2.27E-01	6.44E-04	1.11E-03	2.38E-01	6.04E-01	1.03E-03
Zr-93 (Ci/L)	2.83E-09	2.88E-07	1.21E-06	4.12E-06	1.24E-05	4.17E-08	6.02E-08	1.42E-05	3.17E-05	4.98E-08
Nb-93m (Ci/L)	2.51E-09	2.56E-07	1.04E-06	3.54E-06	1.00E-05	3.57E-08	4.82E-08	1.18E-05	2.50E-05	3.73E-08
Tc-99 (Ci/L)	3.68E-06	2.89E-06	1.58E-07	2.61E-05	7.80E-05	3.04E-07	4.32E-07	7.46E-05	1.67E-04	3.56E-07
Ru-106 (Ci/L)	3.12E-18	2.33E-16	5.74E-15	5.49E-14	3.70E-11	1.24E-15	1.80E-13	3.74E-12	2.44E-10	5.50E-12
Cd-113m (Ci/L)	3.17E-07	2.91E-07	7.55E-08	2.83E-06	1.24E-05	1.92E-06	3.39E-06	1.25E-05	3.67E-05	7.38E-08
Sb-125 (Ci/L)	9.41E-09	7.87E-09	4.39E-09	1.75E-07	3.78E-06	1.89E-08	2.31E-08	1.85E-06	1.50E-05	6.54E-08
Sn-126 (Ci/L)	3.98E-08	3.28E-08	7.97E-09	2.79E-07	8.42E-07	2.82E-09	4.02E-09	9.84E-07	2.22E-06	3.61E-09
I-129 (Ci/L)	4.71E-09	6.34E-09	1.53E-09	4.18E-08	1.21E-07	4.28E-10	6.08E-10	4.45E-09	1.00E-08	0.00E+00
Cs-134 (Ci/L)	1.00E-10	6.24E-11	4.75E-12	3.90E-09	2.77E-07	5.94E-11	1.19E-09	7.03E-08	9.87E-07	9.27E-09
Cs-137 (Ci/L)	1.13E-02	7.07E-03	3.84E-04	7.39E-02	2.66E-01	7.60E-04	1.30E-03	2.83E-01	7.14E-01	1.21E-03
Ba-137m (Ci/L)	1.07E-02	6.68E-03	3.63E-04	6.98E-02	2.51E-01	7.17E-04	1.22E-03	2.67E-01	6.74E-01	1.15E-03
Sm-151 (Ci/L)	3.91E-04	3.52E-04	1.96E-04	2.89E-03	8.57E-03	2.92E-05	4.21E-05	1.01E-02	2.30E-02	3.27E-05
Eu-152 (Ci/L)	1.43E-08	1.25E-08	3.27E-09	2.93E-07	2.34E-06	3.27E-09	1.01E-08	1.50E-06	5.30E-06	2.10E-08
Eu-154 (Ci/L)	1.09E-06	9.51E-07	4.09E-07	1.98E-05	1.55E-04	2.18E-07	6.76E-07	1.12E-04	4.25E-04	1.51E-06
Eu-155 (Ci/L)	6.36E-07	5.56E-07	5.41E-07	8.14E-06	6.50E-05	9.05E-08	3.38E-07	5.11E-05	2.35E-04	5.53E-07
Ra-226 (Ci/L)	5.03E-11	4.18E-11	1.13E-11	3.95E-12	1.28E-11	1.22E-12	1.18E-12	9.38E-12	2.35E-11	7.23E-14
Ra-228 (Ci/L)	2.35E-16	1.93E-16	4.51E-17	2.22E-17	1.10E-16	1.12E-17	1.71E-17	5.77E-17	1.93E-16	7.31E-11
Ac-227 (Ci/L)	2.44E-10	1.97E-10	3.56E-11	1.70E-11	5.29E-11	5.79E-12	5.36E-12	4.18E-11	1.09E-10	1.93E-10
Pa-231 (Ci/L)	2.10E-12	2.17E-10	8.22E-10	2.52E-11	7.72E-11	1.23E-11	1.27E-11	5.95E-11	1.66E-10	3.00E-10
Th-229 (Ci/L)	1.12E-14	1.87E-14	3.02E-14	8.34E-14	6.92E-14	1.68E-15	1.78E-15	1.56E-13	1.43E-13	4.52E-11
Th-232 (Ci/L)	9.52E-17	1.58E-16	2.70E-16	2.39E-17	1.13E-16	1.38E-17	2.19E-17	5.95E-17	2.00E-16	5.79E-11
U-232 (Ci/L)	1.39E-12	1.24E-13	8.67E-13	7.65E-12	1.12E-11	1.14E-11	2.12E-11	3.78E-12	1.38E-11	4.10E-07
U-233 (Ci/L)	1.13E-13	9.97E-15	6.46E-14	3.76E-11	3.18E-11	5.85E-13	7.20E-13	2.66E-11	2.50E-11	2.43E-05
U-234 (Ci/L)	1.11E-07	9.87E-09	8.70E-08	1.88E-07	1.47E-07	3.03E-07	4.17E-07	5.51E-08	1.77E-07	1.77E-06
U-235 (Ci/L)	4.96E-09	4.41E-10	3.92E-09	8.09E-09	5.56E-09	1.29E-08	1.58E-08	2.36E-09	7.37E-09	6.80E-08
U-236 (Ci/L)	1.27E-09	1.11E-10	7.82E-10	3.89E-09	4.24E-09	6.21E-09	1.17E-08	1.22E-09	4.53E-09	7.75E-08
U-238 (Ci/L)	1.13E-07	1.01E-08	8.85E-08	1.92E-07	1.02E-07	2.96E-07	2.91E-07	5.65E-08	1.72E-07	1.19E-06
U-Total (M)	1.43E-03	1.27E-04	1.11E-03	2.42E-03	1.29E-03	3.72E-03	3.67E-03	7.11E-04	2.17E-03	1.50E-02
Np-237 (Ci/L)	2.92E-08	2.35E-08	3.74E-09	1.90E-07	1.92E-07	2.01E-09	2.81E-09	4.08E-07	4.49E-07	7.54E-10
Pu-238 (Ci/L)	2.08E-08	2.58E-08	8.51E-08	5.12E-07	1.89E-06	5.82E-07	1.09E-06	8.00E-07	2.63E-06	4.01E-05
Pu-239 (Ci/L)	2.92E-06	3.44E-06	2.35E-05	2.70E-05	2.77E-05	3.66E-05	4.28E-05	3.23E-05	5.46E-05	3.55E-04
Pu-240 (Ci/L)	3.14E-07	3.84E-07	1.60E-06	5.24E-06	6.47E-06	6.95E-06	9.42E-06	6.50E-06	1.34E-05	1.24E-04
Pu-241 (Ci/L)	6.13E-07	7.84E-07	2.06E-06	1.82E-05	4.91E-05	2.56E-05	6.08E-05	2.85E-05	1.19E-04	2.35E-03
Pu-242 (Ci/L)	4.30E-12	5.57E-12	5.88E-12	1.59E-10	3.74E-10	2.06E-10	3.99E-10	2.03E-10	9.69E-10	2.12E-08
Pu-Total (g/L)	4.84E-05	5.72E-05	3.86E-04	4.58E-04	4.75E-04	6.21E-04	7.32E-04	5.50E-04	9.41E-04	6.30E-03
Am-241 (Ci/L)	1.61E-06	1.35E-06	9.76E-08	1.76E-05	9.40E-05	6.26E-06	9.73E-06	6.02E-05	2.34E-04	1.33E-06
Am-243 (Ci/L)	2.28E-10	1.79E-10	2.39E-12	6.43E-09	8.13E-08	6.81E-11	1.80E-10	2.77E-08	1.25E-07	1.27E-09
Cm-242 (Ci/L)	3.92E-10	3.09E-10	4.38E-12	1.07E-08	1.47E-07	1.17E-10	3.32E-10	4.71E-08	2.17E-07	2.13E-09
Cm-243 (Ci/L)	4.65E-12	3.66E-12	1.99E-14	1.92E-10	1.14E-08	2.14E-12	1.20E-11	9.23E-10	1.30E-08	2.29E-10
Cm-244 (Ci/L)	1.09E-10	8.60E-11	5.59E-13	4.74E-09	2.51E-07	5.23E-11	3.26E-10	2.44E-08	3.06E-07	5.62E-09

Species Total Concentration (Ci/L) (Sheet 3)

species Ci/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3 (Ci/L)	1.64E-04	1.67E-04	1.60E-04	2.98E-07	1.31E-07	6.86E-08	0.00E+00	3.27E-07	2.69E-07	8.41E-07
C-14 (Ci/L)	1.55E-06	1.06E-06	3.46E-06	4.18E-07	7.38E-08	5.07E-08	0.00E+00	1.42E-07	1.12E-10	1.16E-10
Ni-59 (Ci/L)	*6.10E-06*	*7.79E-06*	*1.74E-07*	*2.86E-09*	*9.18E-10*	*1.39E-10*	*0.00E+00*	*2.92E-06*	*4.82E-09*	*4.98E-09*
Ni-63 (Ci/L)	5.71E-04	7.51E-04	1.51E-05	2.66E-07	8.84E-08	1.34E-08	0.00E+00	2.75E-04	4.11E-07	4.33E-07
Co-60 (Ci/L)	1.21E-05	2.06E-05	6.81E-06	2.61E-08	1.65E-08	4.44E-09	0.00E+00	2.06E-05	8.22E-09	1.28E-08
Se-79 (Ci/L)	6.43E-10	4.80E-10	4.51E-09	5.07E-10	1.67E-10	2.77E-11	0.00E+00	1.75E-08	1.91E-08	1.97E-08
Sr-90 (Ci/L)	6.28E-04	5.35E-04	5.10E-03	5.07E-04	1.89E-04	3.40E-05	0.00E+00	9.76E-02	1.20E-02	1.33E-02
Y-90 (Ci/L)	6.28E-04	5.35E-04	5.10E-03	5.08E-04	1.89E-04	3.41E-05	0.00E+00	9.77E-02	1.20E-02	1.33E-02
Zr-93 (Ci/L)	3.83E-08	2.77E-08	4.25E-07	3.02E-08	9.92E-09	1.64E-09	0.00E+00	1.04E-06	5.09E-07	5.26E-07
Nb-93m (Ci/L)	3.21E-08	2.17E-08	3.28E-07	2.51E-08	7.82E-09	1.23E-09	0.00E+00	8.45E-07	3.99E-07	3.96E-07
Tc-99 (Ci/L)	2.80E-07	2.00E-07	1.02E-05	2.21E-07	7.23E-08	1.18E-08	0.00E+00	5.47E-06	2.16E-06	2.23E-06
Ru-106 (Ci/L)	3.80E-15	7.04E-13	1.93E-11	7.96E-15	7.62E-14	1.81E-13	0.00E+00	1.32E-10	5.69E-13	5.74E-12
Cd-113m (Ci/L)	2.07E-06	2.01E-06	4.39E-07	2.67E-08	1.15E-08	2.44E-09	0.00E+00	1.05E-06	1.01E-06	1.21E-06
Sb-125 (Ci/L)	4.50E-09	2.10E-08	6.04E-07	*3.94E-09*	*4.70E-09*	*2.16E-09*	*0.00E+00*	*4.57E-06*	*4.51E-07*	1.04E-06
Sn-126 (Ci/L)	2.65E-09	1.98E-09	2.14E-08	2.10E-09	6.95E-10	1.19E-10	0.00E+00	7.25E-08	6.27E-08	6.48E-08
I-129 (Ci/L)	2.80E-07	1.74E-07	1.59E-08	1.47E-07	4.85E-08	4.54E-08	0.00E+00	3.27E-10	2.04E-10	2.10E-10
Cs-134 (Ci/L)	1.21E-10	1.35E-09	4.94E-07	1.50E-10	3.09E-10	3.06E-10	0.00E+00	1.74E-08	1.37E-08	4.18E-08
Cs-137 (Ci/L)	7.44E-04	6.27E-04	3.49E-02	6.02E-04	2.23E-04	4.01E-05	0.00E+00	2.19E-02	1.03E-02	1.14E-02
Ba-137m (Ci/L)	7.03E-04	5.92E-04	3.29E-02	5.68E-04	2.11E-04	3.78E-05	0.00E+00	2.07E-02	9.73E-03	1.08E-02
Sm-151 (Ci/L)	2.71E-05	1.98E-05	1.33E-04	2.15E-05	7.19E-06	1.08E-06	0.00E+00	1.97E-02	2.17E-04	2.30E-04
Eu-152 (Ci/L)	3.71E-09	5.11E-09	1.93E-07	3.20E-09	1.66E-09	6.92E-10	0.00E+00	3.97E-06	6.15E-08	7.44E-08
Eu-154 (Ci/L)	2.69E-07	3.92E-07	1.31E-05	2.38E-07	1.33E-07	4.97E-08	0.00E+00	3.12E-04	2.45E-06	3.25E-06
Eu-155 (Ci/L)	1.17E-07	2.17E-07	1.70E-06	1.09E-07	7.34E-08	1.83E-08	0.00E+00	1.65E-04	8.75E-07	1.43E-06
Ra-226 (Ci/L)	*8.45E-13*	*2.29E-12*	*1.39E-12*	*2.00E-14*	*8.25E-15*	*2.39E-15*	*0.00E+00*	*7.26E-13*	*6.16E-11*	1.08E-10
Ra-228 (Ci/L)	9.05E-18	1.77E-08	5.50E-17	1.23E-19	3.95E-12	2.41E-12	0.00E+00	5.17E-18	2.70E-07	3.29E-07
Ac-227 (Ci/L)	4.12E-12	1.18E-09	8.34E-12	8.90E-14	1.30E-11	6.38E-12	0.00E+00	3.29E-12	8.86E-07	8.70E-07
Pa-231 (Ci/L)	9.06E-12	1.80E-09	2.14E-11	1.27E-13	1.92E-11	9.90E-12	0.00E+00	4.86E-12	1.31E-06	1.35E-06
Th-229 (Ci/L)	1.42E-15	3.95E-09	6.19E-15	3.32E-16	3.36E-12	1.49E-12	0.00E+00	8.42E-15	2.30E-07	2.04E-07
Th-232 (Ci/L)	1.12E-17	1.80E-08	7.33E-17	1.27E-19	3.70E-12	1.91E-12	0.00E+00	5.35E-18	2.53E-07	2.61E-07
U-232 (Ci/L)	1.10E-11	1.97E-08	1.59E-10	3.97E-11	2.80E-08	2.14E-08	0.00E+00	1.63E-11	1.09E-06	1.16E-06
U-233 (Ci/L)	5.21E-13	1.18E-06	2.42E-12	2.79E-10	1.78E-06	1.27E-06	0.00E+00	6.86E-11	6.92E-05	6.85E-05
U-234 (Ci/L)	2.35E-07	1.64E-07	6.48E-07	5.79E-07	2.85E-07	9.22E-08	0.00E+00	2.22E-07	5.24E-07	5.41E-07
U-235 (Ci/L)	1.00E-08	6.38E-09	3.00E-08	2.48E-08	1.14E-08	3.55E-09	0.00E+00	9.38E-09	1.86E-12	1.92E-12
U-236 (Ci/L)	5.35E-09	4.03E-09	4.55E-08	1.28E-08	6.98E-09	4.04E-09	0.00E+00	5.30E-09	3.24E-13	3.35E-13
U-238 (Ci/L)	2.41E-07	1.47E-07	4.53E-07	5.94E-07	2.66E-07	6.19E-08	0.00E+00	2.22E-07	2.90E-20	3.00E-20
U-Total (M)	3.03E-03	1.85E-03	5.73E-03	7.48E-03	3.35E-03	7.82E-04	0.00E+00	2.79E-03	3.12E-05	3.09E-05
Np-237 (Ci/L)	1.88E-09	1.33E-09	7.46E-09	8.69E-10	1.40E-10	2.49E-11	0.00E+00	2.31E-08	2.40E-13	2.48E-13
Pu-238 (Ci/L)	6.00E-07	5.42E-07	7.68E-06	2.79E-06	1.34E-06	6.91E-07	4.23E-05	3.25E-06	4.09E-11	4.32E-11
Pu-239 (Ci/L)	3.40E-05	2.25E-05	7.55E-05	1.13E-04	2.79E-05	6.12E-06	6.61E-04	9.97E-05	2.07E-15	2.14E-15
Pu-240 (Ci/L)	7.09E-06	5.30E-06	2.92E-05	2.27E-05	6.85E-06	2.14E-06	1.65E-04	2.15E-05	1.42E-16	1.47E-16
Pu-241 (Ci/L)	3.08E-05	3.83E-05	5.96E-04	9.93E-05	6.09E-05	4.05E-05	2.66E-03	1.32E-04	5.48E-16	6.57E-16
Pu-242 (Ci/L)	2.21E-10	2.69E-10	5.63E-09	7.08E-10	4.95E-10	3.66E-10	1.64E-08	1.01E-09	1.17E-21	1.20E-21
Pu-Total (g/L)	5.80E-04	3.86E-04	1.35E-03	1.92E-03	4.81E-04	1.09E-04	1.14E-02	1.70E-03	2.42E-12	2.56E-12
Am-241 (Ci/L)	6.49E-06	5.52E-06	7.19E-05	1.28E-07	7.32E-08	4.40E-08	7.02E-04	2.84E-04	7.93E-17	7.92E-17
Am-243 (Ci/L)	7.22E-11	1.47E-10	7.50E-09	5.89E-11	3.90E-11	4.21E-11	0.00E+00	1.42E-07	2.82E-22	2.92E-22
Cm-242 (Ci/L)	1.22E-10	2.30E-10	1.34E-08	1.00E-10	6.79E-11	7.02E-11	0.00E+00	1.65E-07	5.33E-22	1.60E-22
Cm-243 (Ci/L)	2.29E-12	1.20E-11	3.78E-09	1.97E-12	4.07E-12	7.57E-12	0.00E+00	8.81E-09	1.07E-23	1.19E-23
Cm-244 (Ci/L)	5.97E-11	3.72E-10	8.10E-08	5.21E-11	9.55E-11	1.85E-10	0.00E+00	2.08E-07	2.33E-22	2.71E-22

Species Total Concentration (Ci/L) (Sheet 4)

species Ci/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3 (Ci/L)	1.05E-05	1.63E-05	1.68E-06	7.60E-06	1.97E-05		4.66E-06	7.27E-05	3.38E-05	6.51E-05
C-14 (Ci/L)	1.92E-06	1.02E-06	1.22E-07	6.91E-07	3.78E-06		2.73E-07	2.83E-06	4.45E-06	7.66E-06
Ni-59 (Ci/L)	1.84E-06	1.20E-06	5.20E-07	5.68E-06	1.66E-06		6.75E-08	1.22E-06	5.38E-06	2.24E-05
Ni-63 (Ci/L)	1.74E-04	1.15E-04	4.93E-05	5.36E-04	1.58E-04		6.95E-06	1.16E-04	5.15E-04	2.14E-03
Co-60 (Ci/L)	1.85E-05	3.83E-05	6.66E-06	5.30E-05	2.72E-05		3.14E-07	1.57E-05	3.24E-05	8.34E-05
Se-79 (Ci/L)	2.30E-07	2.38E-07	2.62E-08	1.33E-07	4.50E-07		1.05E-08	2.65E-07	3.96E-07	5.24E-07
Sr-90 (Ci/L)	3.35E-01	5.86E-02	7.35E-02	3.71E-01	6.03E-03		2.19E-03	5.68E-03	1.95E-02	2.11E-02
Y-90 (Ci/L)	3.35E-01	5.86E-02	7.35E-02	3.71E-01	6.03E-03		2.19E-03	5.68E-03	1.96E-02	2.11E-02
Zr-93 (Ci/L)	1.37E-05	1.42E-05	1.56E-06	7.93E-06	2.68E-05		9.72E-07	1.59E-05	2.37E-05	3.10E-05
Nb-93m (Ci/L)	1.11E-05	1.06E-05	1.18E-06	6.06E-06	2.16E-05		8.65E-07	1.30E-05	1.92E-05	2.50E-05
Tc-99 (Ci/L)	7.20E-05	7.29E-05	8.04E-06	4.10E-05	1.43E-04		3.15E-06	9.85E-05	1.31E-04	1.66E-04
Ru-106 (Ci/L)	5.74E-11	1.57E-09	1.75E-10	9.07E-10	4.05E-11		6.83E-16	3.16E-11	4.63E-11	5.68E-11
Cd-113m (Ci/L)	1.40E-05	2.10E-05	2.24E-06	1.09E-05	2.80E-05		3.53E-07	1.47E-05	2.52E-05	3.88E-05
Sb-125 (Ci/L)	4.21E-06	1.86E-05	2.48E-06	1.61E-05	6.62E-06		9.73E-09	3.13E-06	6.25E-06	8.67E-06
Sn-126 (Ci/L)	9.54E-07	1.03E-06	1.12E-07	5.69E-07	1.87E-06		3.94E-08	1.08E-06	1.64E-06	2.18E-06
I-129 (Ci/L)	3.82E-08	4.49E-09	4.93E-10	2.51E-09	8.47E-08		4.37E-09	1.52E-07	1.43E-07	6.83E-07
Cs-134 (Ci/L)	2.42E-07	1.58E-07	0.00E+00	1.16E-06	1.22E-08		7.74E-11	2.22E-07	2.92E-07	1.59E-07
Cs-137 (Ci/L)	2.90E-01	2.07E-02	0.00E+00	1.87E-01	1.50E-02		9.18E-03	2.93E-01	2.40E-01	1.38E-01
Ba-137m (Ci/L)	2.74E-01	1.96E-02	0.00E+00	1.77E-01	1.42E-02		8.67E-03	2.77E-01	2.27E-01	1.31E-01
Sm-151 (Ci/L)	1.11E-02	9.31E-03	3.63E-03	3.88E-02	9.12E-03		4.83E-04	5.72E-03	7.47E-03	9.29E-03
Eu-152 (Ci/L)	2.09E-06	5.97E-06	1.14E-06	9.59E-06	1.69E-06		1.64E-08	9.68E-07	1.40E-06	1.83E-06
Eu-154 (Ci/L)	1.62E-04	4.29E-04	8.57E-05	7.36E-04	1.26E-04		1.25E-06	6.52E-05	1.03E-04	1.38E-04
Eu-155 (Ci/L)	8.33E-05	1.58E-04	3.84E-05	3.60E-04	5.82E-05		7.32E-07	2.73E-05	4.69E-05	6.61E-05
Ra-226 (Ci/L)	9.92E-12	1.38E-11	1.48E-12	7.20E-12	2.10E-11		5.11E-11	1.58E-11	5.34E-11	5.95E-11
Ra-228 (Ci/L)	5.84E-10	1.90E-16	1.97E-17	9.07E-17	9.75E-10		2.32E-16	6.26E-10	6.35E-09	7.19E-08
Ac-227 (Ci/L)	6.54E-11	6.66E-11	7.11E-12	3.44E-11	1.24E-10		2.29E-10	7.71E-11	3.31E-10	1.09E-09
Pa-231 (Ci/L)	1.37E-10	1.09E-10	1.15E-11	5.52E-11	3.36E-10		7.12E-10	1.19E-09	1.76E-08	1.98E-07
Th-229 (Ci/L)	3.87E-12	6.49E-14	7.65E-15	4.28E-14	5.42E-12		4.19E-14	1.80E-12	1.53E-11	1.41E-10
Th-232 (Ci/L)	9.87E-12	1.99E-16	2.07E-17	9.52E-17	1.51E-11		3.53E-16	6.42E-12	5.52E-11	5.40E-10
U-232 (Ci/L)	5.53E-10	2.88E-11	5.11E-12	4.12E-11	5.85E-10		5.45E-13	2.00E-10	1.92E-09	1.73E-08
U-233 (Ci/L)	3.39E-08	1.05E-11	1.05E-11	1.26E-10	3.61E-08		4.35E-14	1.19E-08	1.15E-07	1.04E-06
U-234 (Ci/L)	8.80E-08	1.00E-07	4.05E-08	4.36E-07	2.48E-08		4.06E-08	2.53E-08	3.79E-08	6.82E-08
U-235 (Ci/L)	3.71E-09	4.34E-09	1.72E-09	1.85E-08	1.04E-09		1.81E-09	1.02E-09	1.57E-09	2.53E-09
U-236 (Ci/L)	2.11E-09	4.94E-09	1.22E-09	1.15E-08	6.73E-10		4.76E-10	6.33E-10	8.81E-10	1.73E-09
U-238 (Ci/L)	8.77E-08	7.56E-08	3.80E-08	4.25E-07	2.32E-08	0.00E+00	4.14E-08	2.17E-08	3.44E-08	5.59E-08
U-Total (M)	1.10E-03	9.55E-04	4.79E-04	5.36E-03	2.93E-04		5.21E-04	2.74E-04	4.33E-04	7.04E-04
Np-237 (Ci/L)	2.96E-07	2.15E-07	2.46E-08	1.33E-07	5.95E-07		2.69E-08	3.93E-07	4.86E-07	5.54E-07
Pu-238 (Ci/L)	1.33E-06	6.39E-06	1.09E-06	8.51E-06	4.86E-07		8.14E-08	4.17E-07	5.75E-07	1.06E-06
Pu-239 (Ci/L)	3.99E-05	5.66E-05	1.93E-05	2.01E-04	1.14E-05		1.07E-05	1.07E-05	1.59E-05	2.68E-05
Pu-240 (Ci/L)	8.67E-06	1.98E-05	4.94E-06	4.66E-05	2.63E-06		1.21E-06	2.27E-06	3.34E-06	6.42E-06
Pu-241 (Ci/L)	5.49E-05	3.75E-04	5.55E-05	3.94E-04	2.19E-05		2.44E-06	1.29E-05	2.74E-05	6.05E-05
Pu-242 (Ci/L)	4.25E-10	3.38E-09	4.77E-10	3.24E-09	1.81E-10		1.76E-11	1.04E-10	2.20E-10	4.90E-10
Pu-Total (g/L)	6.81E-04	1.00E-03	3.34E-04	3.45E-03	1.95E-04	0.00E+00	1.78E-04	1.82E-04	2.72E-04	4.61E-04
Am-241 (Ci/L)	1.02E-04	3.80E-04	7.69E-05	6.65E-04	1.35E-05		1.49E-06	1.47E-05	2.98E-05	5.99E-05
Am-243 (Ci/L)	5.07E-08	3.63E-07	5.57E-08	4.07E-07	7.58E-09		1.96E-10	8.06E-09	1.62E-08	2.39E-08
Cm-242 (Ci/L)	7.68E-08	6.06E-07	8.32E-08	5.52E-07	4.09E-08		3.38E-10	2.24E-08	2.90E-08	3.16E-08
Cm-243 (Ci/L)	3.53E-09	6.54E-08	7.74E-09	4.37E-08	1.24E-09		3.98E-12	9.43E-10	1.10E-09	1.11E-09
Cm-244 (Ci/L)	8.43E-08	1.60E-06	1.89E-07	1.06E-06	3.11E-08		9.36E-11	2.15E-08	2.67E-08	2.75E-08

Species Total Concentration (Ci/L) (Sheet 5)

species Ci/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (Ci/L)	2.65E-05	2.82E-05	2.95E-05	2.37E-05	5.78E-04	3.60E-04	1.06E-06	1.56E-04
C-14 (Ci/L)	6.26E-06	6.74E-06	8.31E-06	6.85E-06	1.80E-06	9.97E-07	7.03E-09	1.89E-06
Ni-59 (Ci/L)	2.25E-06	9.75E-07	3.33E-06	1.51E-06	5.60E-06	3.14E-06	2.72E-10	3.88E-08
Ni-63 (Ci/L)	2.14E-04	9.31E-05	3.18E-04	1.44E-04	5.42E-04	3.07E-04	2.64E-08	3.73E-06
Co-60 (Ci/L)	3.48E-05	2.66E-05	3.57E-05	2.77E-05	1.16E-03	8.45E-04	6.25E-08	1.26E-05
Se-79 (Ci/L)	5.92E-07	6.28E-07	7.43E-07	5.48E-07	8.87E-07	5.09E-07	4.35E-11	9.97E-10
Sr-90 (Ci/L)	2.02E-02	3.15E-03	1.34E-02	3.87E-02	1.47E+00	8.85E-01	7.32E-05	1.68E-03
Y-90 (Ci/L)	2.02E-02	3.15E-03	1.34E-02	3.87E-02	1.47E+00	8.85E-01	7.32E-05	1.68E-03
Zr-93 (Ci/L)	3.53E-05	3.75E-05	4.43E-05	3.26E-05	5.37E-05	3.09E-05	2.63E-09	9.48E-08
Nb-93m (Ci/L)	2.86E-05	3.04E-05	3.57E-05	2.63E-05	3.02E-05	1.63E-05	1.45E-09	5.23E-08
Tc-99 (Ci/L)	1.95E-04	2.07E-04	2.40E-04	1.80E-04	2.62E-04	1.50E-04	1.78E-08	5.43E-06
Ru-106 (Ci/L)	6.55E-11	5.63E-11	6.03E-11	4.51E-08	9.17E-05	1.94E-04	8.81E-09	2.02E-07
Cd-113m (Ci/L)	3.66E-05	3.91E-05	4.93E-05	3.24E-05	1.60E-04	9.52E-05	7.96E-09	1.88E-07
Sb-125 (Ci/L)	8.95E-06	4.93E-06	6.84E-06	1.03E-05	2.37E-03	2.20E-03	1.42E-07	7.88E-06
Sn-126 (Ci/L)	2.45E-06	2.60E-06	3.09E-06	2.28E-06	3.97E-06	2.23E-06	1.93E-10	4.43E-09
I-129 (Ci/L)	1.85E-07	2.03E-07	2.48E-07	2.11E-07	2.33E-08	1.31E-08	1.76E-08	3.60E-08
Cs-134 (Ci/L)	2.62E-07	3.18E-07	4.88E-07	1.01E-05	1.09E-03	1.06E-03	6.65E-08	2.03E-05
Cs-137 (Ci/L)	2.38E-01	2.80E-01	3.07E-01	2.31E-01	1.68E+00	9.98E-01	8.33E-05	2.54E-02
Ba-137m (Ci/L)	2.25E-01	2.65E-01	2.89E-01	2.19E-01	1.59E+00	9.42E-01	7.87E-05	2.40E-02
Sm-151 (Ci/L)	9.89E-03	4.86E-03	6.35E-03	5.80E-03	3.55E-02	2.09E-02	1.75E-06	4.02E-05
Eu-152 (Ci/L)	1.81E-06	8.97E-07	1.30E-06	1.39E-06	4.86E-05	2.57E-05	2.31E-09	5.30E-08
Eu-154 (Ci/L)	1.33E-04	6.58E-05	9.74E-05	1.05E-04	5.71E-03	3.25E-03	2.79E-07	6.40E-06
Eu-155 (Ci/L)	6.04E-05	3.00E-05	4.54E-05	4.90E-05	3.87E-03	3.01E-03	2.14E-07	4.90E-06
Ra-226 (Ci/L)	4.63E-11	5.72E-11	6.28E-11	4.70E-11	7.95E-11	4.16E-11	3.77E-15	4.00E-13
Ra-228 (Ci/L)	6.02E-09	7.21E-09	2.96E-08	1.91E-08	4.53E-15	2.76E-15	2.27E-19	3.12E-17
Ac-227 (Ci/L)	2.82E-10	3.48E-10	3.88E-10	2.75E-10	3.93E-10	2.14E-10	1.89E-14	1.92E-12
Pa-231 (Ci/L)	1.45E-08	1.82E-08	9.11E-08	6.07E-08	8.75E-10	5.25E-10	4.36E-14	8.17E-12
Th-229 (Ci/L)	1.43E-11	1.72E-11	3.33E-11	2.33E-11	5.23E-13	2.76E-13	2.49E-17	2.16E-15
Th-232 (Ci/L)	4.91E-11	6.00E-11	1.21E-10	8.41E-11	5.13E-15	3.24E-15	2.60E-19	5.20E-17
U-232 (Ci/L)	6.56E-10	4.18E-10	1.86E-09	8.34E-10	4.04E-10	2.04E-10	9.35E-11	1.11E-10
U-233 (Ci/L)	3.95E-08	2.51E-08	1.12E-07	4.98E-08	1.30E-10	6.29E-11	2.96E-11	1.36E-12
U-234 (Ci/L)	2.50E-08	1.27E-08	1.95E-08	3.52E-08	1.16E-06	6.78E-07	2.83E-07	5.88E-07
U-235 (Ci/L)	1.04E-09	5.30E-10	7.88E-10	1.39E-09	4.36E-08	2.70E-08	1.08E-08	2.26E-08
U-236 (Ci/L)	6.19E-10	3.08E-10	5.12E-10	2.38E-09	1.11E-07	6.70E-08	2.73E-08	5.69E-08
U-238 (Ci/L)	2.35E-08	1.18E-08	1.75E-08	2.75E-08	8.03E-07	4.67E-07	1.95E-07	4.06E-07
U-Total (M)	2.96E-04	1.49E-04	2.21E-04	3.47E-04	1.01E-02	5.90E-03	2.46E-03	5.13E-03
Np-237 (Ci/L)	7.02E-07	5.20E-07	6.01E-07	3.81E-07	5.19E-06	2.92E-06	2.52E-10	5.79E-09
Pu-238 (Ci/L)	4.21E-07	2.08E-07	3.64E-07	1.07E-06	8.32E-05	4.33E-05	6.45E-06	4.83E-06
Pu-239 (Ci/L)	1.17E-05	5.81E-06	8.67E-06	1.44E-05	7.86E-04	4.36E-04	6.23E-05	4.75E-05
Pu-240 (Ci/L)	2.55E-06	1.25E-06	2.01E-06	3.73E-06	2.25E-04	1.19E-04	1.76E-05	1.34E-05
Pu-241 (Ci/L)	1.89E-05	9.53E-06	1.81E-05	7.57E-05	6.73E-03	3.47E-03	5.20E-04	3.97E-04
Pu-242 (Ci/L)	1.56E-10	7.80E-11	1.50E-10	3.95E-10	2.91E-08	1.43E-08	2.21E-09	1.69E-09
Pu-Total (g/L)	2.00E-04	9.92E-05	1.49E-04	2.49E-04	1.37E-02	7.59E-03	1.09E-03	8.30E-04
Am-241 (Ci/L)	3.08E-05	8.01E-06	2.11E-05	4.70E-05	6.42E-03	4.32E-03	3.34E-07	2.11E-05
Am-243 (Ci/L)	1.86E-08	4.66E-09	1.30E-08	3.08E-08	2.01E-06	9.64E-07	9.29E-11	2.11E-09
Cm-242 (Ci/L)	3.78E-08	2.44E-08	3.10E-08	2.20E-08	3.73E-06	1.76E-06	1.71E-10	3.90E-09
Cm-243 (Ci/L)	1.33E-09	8.77E-10	1.24E-09	1.28E-09	5.77E-07	2.52E-07	2.59E-11	5.93E-10
Cm-244 (Ci/L)	3.25E-08	2.14E-08	3.03E-08	3.17E-08	1.50E-05	6.24E-06	6.62E-10	1.52E-08

Predicted Sludge Species (mol/L) (Sheet 1)

pred. sludge mol/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
Na	5.26E+00	6.60E+00	6.77E+00	6.49E+00	7.51E+00	6.18E+00	5.72E+00	4.79E+00	9.69E+00	9.73E+00
Al	0.00E+00	0.00E+00	5.99E-01	4.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe(total)	1.20E-01	1.20E-01	3.53E-01	3.39E-01	5.63E-01	8.52E-01	7.84E-01	6.06E-01	1.58E+00	7.81E-01
Cr	9.47E-04	5.18E-04	3.96E-03	4.13E-03	2.07E-03	3.10E-03	4.96E-03	5.39E-03	1.45E-03	7.72E-04
Bi	8.46E-05	4.63E-05	8.47E-02	8.12E-02	1.41E-01	1.68E-01	3.07E-01	2.38E-01	8.13E-05	4.34E-05
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.10E-01	1.63E-01	0.00E+00	0.00E+00
Hg	0.00E+00	4.15E-04	0.00E+00	7.22E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.67E-04	3.74E-04
ZrO(OH)2	0.00E+00	0.00E+00	4.80E-04	4.73E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	4.73E-04	2.59E-04	9.76E-04	1.02E-03	7.90E-04	8.56E-04	1.17E-03	1.27E-03	7.23E-04	1.46E-01
Sr	1.90E-05	3.86E-05	3.99E-08	5.98E-08	6.66E-10	8.04E-10	1.15E-11	2.27E-11	6.67E-05	5.27E-05
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-01	1.95E-01	0.00E+00	0.00E+00
Ca	1.23E-01	1.23E-01	1.09E-01	1.05E-01	2.16E-01	4.26E-01	8.02E-01	6.20E-01	5.26E-01	3.48E-01
K	2.09E-04	1.14E-04	5.79E-03	6.04E-03	3.22E-03	2.29E-03	1.69E-01	1.83E-01	7.11E-03	4.00E-03
balance	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density	1.80E+00	1.85E+00	1.41E+00	1.38E+00	1.45E+00	1.42E+00	1.48E+00	1.39E+00	1.78E+00	1.59E+00
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
void frac.	2.70E-01	1.45E-01	5.74E-01	5.99E-01	4.76E-01	5.26E-01	7.26E-01	7.89E-01	4.45E-01	2.34E-01
wt.% H2O	4.38E+01	4.14E+01	6.36E+01	6.51E+01	6.28E+01	6.35E+01	5.03E+01	5.68E+01	5.31E+01	5.46E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E+00	3.03E+00	1.11E-04	5.32E-01
free OH-	9.77E-03	5.26E-03	5.80E-02	5.41E-02	1.71E-02	3.69E-02	5.75E-02	6.24E-02	1.03E-03	1.57E-03
OH-	1.21E+01	1.23E+01	2.96E+00	2.40E+00	1.70E+00	2.59E+00	4.05E+00	3.14E+00	5.01E+00	2.23E+00
NO3-	3.34E-02	1.41E-02	9.98E-01	1.03E+00	6.12E-01	4.26E-01	1.01E+00	1.10E+00	4.83E-01	1.20E-01
NO2-	2.13E-02	1.58E-02	4.02E-02	3.37E-02	5.53E-05	3.46E-05	1.21E-06	1.96E-06	9.17E-01	6.28E-01
CO3--	3.97E-01	1.08E+00	1.09E-01	1.05E-01	2.16E-01	4.26E-01	8.02E-01	6.20E-01	6.08E-01	3.48E-01
PO4---	9.83E-01	9.83E-01	1.66E+00	1.60E+00	2.12E+00	1.79E+00	3.31E-01	2.63E-01	2.20E+00	1.47E+00
SO4--	8.55E-01	8.55E-01	4.25E-02	4.42E-02	2.45E-02	1.67E-02	2.19E-03	2.38E-03	7.53E-01	1.55E+00
SiO3--	1.18E-03	6.48E-04	3.72E-01	3.08E-01	4.00E-01	3.71E-01	0.00E+00	0.00E+00	0.00E+00	5.86E-01
F-	0.00E+00	0.00E+00	1.13E-01	1.18E-01	1.09E-01	7.25E-02	1.97E-01	2.14E-01	0.00E+00	5.07E-02
Cl-	9.61E-04	5.26E-04	2.67E-02	2.78E-02	1.48E-02	1.05E-02	2.10E-02	2.28E-02	4.31E-02	1.84E-02
C6H5O7---	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.28E+00	1.76E+00	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-05	0.00E+00
butanol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-05	0.00E+00
NH3	8.52E-05	4.94E-05	6.32E-02	4.79E-02	2.43E-11	1.64E-11	1.51E-14	4.21E-14	1.30E-02	7.30E-03
Fe(CN)6----										1.18E-01

Predicted Sludge Species (mol/L) (Sheet 2)

pred. sludge mol/L	PFeCN2	TFeCN	ICFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
Na	9.59E+00	3.63E+00	3.37E+00	4.02E+00	5.62E+00	6.67E+00	1.37E+00	3.86E+00	6.78E+00	5.39E+00
Al	0.00E+00	3.50E-02	0.00E+00	7.11E+00	5.53E+00	9.47E+00	5.85E+00	0.00E+00	0.00E+00	0.00E+00
Fe(total)	7.22E-01	1.68E-01	1.69E-01	1.02E+00	1.71E+00	1.66E-01	4.61E-01	2.63E+00	2.96E+00	2.92E+00
Cr	7.58E-04	4.22E-03	1.71E-03	1.34E+00	1.98E+00	2.15E-03	2.30E-03	6.10E-03	4.45E-03	4.49E-03
Bi	4.27E-05	2.35E-04	4.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	3.74E-04	1.19E-06	5.58E-04	1.70E-04	4.81E-04	0.00E+00	0.00E+00	1.11E-03	6.27E-04	0.00E+00
ZrO(OH)2	0.00E+00	7.14E-05	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	6.07E-06	0.00E+00	0.00E+00	0.00E+00	8.65E-02	1.33E-01	8.51E-05	6.46E-03	0.00E+00
Ni	1.30E-01	4.02E-01	3.54E-01	5.02E-02	7.44E-02	1.08E-03	1.15E-03	1.01E-01	5.76E-02	1.01E-01
Sr	9.23E-02	1.32E-05	2.63E-06	2.96E-04	1.66E-03	1.01E-07	1.86E-07	2.24E-03	3.23E-03	1.21E-07
Mn	0.00E+00	0.00E+00	0.00E+00	1.19E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	3.48E-01	6.58E-01	5.45E-01	3.31E-01	4.95E-01	1.80E-01	4.98E-01	6.55E-01	3.73E-01	6.68E-01
K	3.92E-03	1.36E-02	3.59E-03	1.84E-02	1.29E-02	1.62E-03	2.64E-03	2.40E-03	3.14E-03	8.26E-03
balance	0.00E+00	-1.30E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density	1.58E+00	1.32E+00	1.40E+00	1.72E+00	1.79E+00	1.60E+00	1.46E+00	1.38E+00	1.51E+00	1.79E+00
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
void frac.	2.29E-01	9.16E-01	8.51E-01	6.86E-01	6.40E-01	6.90E-01	7.50E-01	7.59E-01	5.47E-01	5.56E-01
wt.% H2O	5.44E+01	6.96E+01	6.90E+01	4.08E+01	4.25E+01	3.14E+01	5.17E+01	6.26E+01	5.36E+01	4.62E+01
TOC wt.%C	2.68E-01	9.10E-01	8.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
free OH-	-3.19E-04	2.95E-02	8.59E-02	1.20E+00	1.13E+00	1.24E-02	1.50E-02	1.39E-01	1.01E-01	2.97E-02
OH-	2.50E+00	6.11E-01	1.15E+00	3.09E+01	2.97E+01	3.39E+01	2.04E+01	8.40E+00	9.44E+00	1.30E+01
NO3-	1.28E-01	8.77E-01	4.28E-01	7.98E-03	8.11E-10	6.20E-01	6.61E-01	6.48E-17	7.42E-19	1.60E+00
NO2-	6.09E-01	1.69E+00	1.82E-01	2.06E+00	1.73E+00	9.96E-01	2.19E-01	3.43E-01	4.02E-01	1.53E-02
CO3--	3.48E-01	7.47E-01	5.47E-01	3.31E-01	4.95E-01	1.80E-01	4.98E-01	6.55E-01	3.73E-01	6.68E-01
PO4---	1.47E+00	5.77E-02	5.38E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E+00
SO4--	1.55E+00	1.05E-01	1.82E-02	1.32E-02	1.94E-02	6.50E-03	4.58E-03	3.34E-02	1.04E+00	3.14E-02
SiO3--	5.86E-01	4.68E-03	9.26E-01	1.03E-01	1.07E+00	2.51E-01	0.00E+00	1.67E+00	2.10E+00	0.00E+00
F-	4.98E-02	8.41E-02	1.95E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl-	1.80E-02	7.53E-02	1.65E-02	6.56E-02	5.95E-02	7.46E-03	1.21E-02	1.10E-02	1.44E-02	3.80E-02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	1.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
butanol	0.00E+00	1.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	6.74E-03	7.40E-02	3.64E-04	1.69E-01	4.34E-01	5.99E-05	1.88E-05	1.49E-01	1.34E-01	5.37E-07
Fe(CN)6----	5.88E-02	1.67E-01	1.67E-01							

Predicted Sludge Species (mol/L) (Sheet 3)

pred. sludge mol/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
Na	2.19E+00	1.21E+00	5.26E+00	4.92E-01	8.05E-01	1.17E+00	1.87E+00	2.09E+00	4.05E+00	4.05E+00
Al	5.14E+00	5.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+01	0.00E+00	6.79E-01	6.79E-01
Fe(total)	1.66E-01	4.61E-01	1.29E-01	3.47E+00	3.47E+00	3.47E+00	1.69E+00	1.86E+00	1.09E+00	1.09E+00
Cr	2.53E-03	2.29E-03	2.64E-03	5.94E-03	5.73E-03	5.93E-03	4.97E-03	3.65E-02	6.81E-03	6.81E-03
Bi	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-03	0.00E+00	0.00E+00
ZrO(OH)2	0.00E+00	0.00E+00	9.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	8.10E-02	1.54E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-01	0.00E+00	0.00E+00
Ni	1.27E-03	1.15E-03	1.32E-03	2.00E-01	2.00E-01	2.00E-01	9.65E-02	3.77E-03	3.93E-02	3.93E-02
Sr	1.10E-07	8.45E-08	5.75E-06	7.89E 08	2.83E-08	5.28E-09	0.00E+00	1.93E-05	3.49E-05	3.97E-05
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E+00	3.02E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	1.80E-01	4.97E-01	1.40E-01	1.30E+00	1.30E+00	1.31E+00	6.37E-01	4.62E-03	2.55E-01	2.55E-01
K	1.25E-03	1.88E-03	1.92E-01	7.42E-04	9.66E-03	4.09E-03	6.68E-03	8.36E-02	2.37E-02	2.37E-02
balance	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-04	0.00E+00	0.00E+00
density	1.35E+00	1.43E+00	1.30E+00	1.64E+00	1.56E+00	1.42E+00	1.76E+00	1.30E+00	1.32E+00	1.32E+00
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
void frac.	8.22E-01	7.49E-01	8.55E-01	7.40E-01	7.14E-01	7.39E-01	5.23E-01	9.42E-01	8.43E-01	8.43E-01
wt.% H2O	5.74E+01	5.28E+01	6.53E+01	5.16E+01	4.85E+01	5.56E+01	2.91E+01	6.32E+01	6.35E+01	6.35E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	3.96E-01	1.47E-01	1.39E-01	0.00E+00	1.79E+00	3.66E-02	3.63E-02
free OH-	1.54E-02	1.41E-02	1.85E-01	3.05E-02	5.90E-03	4.68E-02	1.55E-01	2.47E-01	2.13E-02	2.13E-02
OH-	1.70E+01	2.01E+01	4.68E+00	1.48E+01	1.67E+01	1.13E+01	3.86E+01	7.34E+00	5.67E+00	5.67E+00
NO3-	5.65E-01	5.14E-01	2.23E-01	1.70E-01	2.70E-01	6.98E-01	1.36E+00	5.65E-01	1.51E+00	1.56E+00
NO2-	6.55E-01	2.14E-01	5.49E-02	8.49E-03	7.63E-03	7.58E-03	7.40E-03	4.61E-01	8.47E-01	7.94E-01
CO3--	1.80E-01	4.97E-01	1.40E-01	1.45E+00	1.58E+00	1.52E+00	7.33E-01	4.62E-03	2.55E-01	2.55E-01
PO4---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-05	0.00E+00	4.04E-01	4.04E-01
SO4--	7.29E-03	5.05E-03	1.32E-03	2.97E-03	2.86E-03	2.96E-03	3.60E-03	6.35E-02	4.60E-02	4.60E-02
SiO3--	1.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F-	0.00E+00	0.00E+00	5.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-01	1.02E-01
Cl-	5.73E-03	8.65E-03	4.97E-03	3.42E-03	4.94E-03	1.58E-02	4.71E-02	4.63E-02	5.40E-02	5.40E-02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.77E-02	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.54E-02	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.81E-01	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	4.50E-02	1.59E-02	1.37E-02	0.00E+00	0.00E+00	3.34E-03	3.32E-03
butanol	0.00E+00	0.00E+00	0.00E+00	4.50E-02	1.59E-02	1.37E-02	0.00E+00	0.00E+00	3.34E-03	3.32E-03
NH3	4.99E-05	7.75E-06	6.59E-01	4.22E-07	9.75E-08	1.42E-08	0.00E+00	3.85E-03	1.13E-02	9.89E-03
Fe(CN)6----										

Predicted Sludge Species (mol/L) (Sheet 4)

pred. sludge mol/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
Na	6.06E+00	1.21E+01	1.20E+01	7.97E+00	5.18E+00	2.27E-01	1.26E+01	1.30E+01	1.35E+01	1.51E+01
Al	7.09E-02	1.20E+00	2.14E+00	0.00E+00	3.42E-01	0.00E+00	6.80E-03	2.63E+00	1.09E+00	2.89E+00
Fe(total)	1.30E+00	1.03E+00	1.19E-02	1.51E+00	2.75E-01	1.65E-03	1.44E-01	1.89E-02	2.05E-02	2.89E-02
Cr	1.41E-02	9.62E-04	1.40E-07	0.00E+00	2.81E-02	7.03E-03	4.61E-03	4.55E-01	7.25E-02	4.82E-02
Bi	1.68E-06	0.00E+00	0.00E+00	0.00E+00	4.52E-06	0.00E+00	3.20E-02	2.39E-07	2.30E-04	1.15E-04
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.36E-14	1.25E-09
Hg	7.82E-04	1.18E-03	9.51E-04	5.21E-03	1.17E-04	0.00E+00	3.08E-05	1.36E-05	6.37E-06	3.90E-06
ZrO(OH)2	3.36E-08	0.00E+00	0.00E+00	0.00E+00	1.43E-06	0.00E+00	1.44E-04	7.70E-08	1.28E-04	4.31E-05
Pb	1.85E-04	6.77E-02	0.00E+00	0.00E+00	4.36E-04	0.00E+00	0.00E+00	9.42E-05	6.11E-04	4.66E-03
Ni	1.39E-01	3.72E-02	7.00E-03	0.00E+00	2.50E-01	4.02E-01	1.46E-02	1.76E-02	1.60E-02	1.75E-02
Sr	2.25E-03	2.35E-03	1.08E-05	2.97E-03	7.59E-05	0.00E+00	2.95E-07	5.94E-06	9.07E-06	2.61E-05
Mn	1.46E-04	0.00E+00	0.00E+00	0.00E+00	2.88E-04	0.00E+00	0.00E+00	1.33E-03	4.15E-04	8.08E-04
Ca	7.98E-02	1.27E+00	7.25E-03	3.34E-01	5.10E-01	9.11E-01	7.51E-02	3.60E-02	3.59E-02	3.80E-02
K	6.32E-03	1.33E-03	1.05E-02	1.06E-02	1.85E-02	6.06E-04	1.11E-02	4.17E-02	5.12E-02	4.57E-02
balance	4.01E-05	7.21E-06	1.56E-05	2.15E-04	9.07E-04	0.00E+00	0.00E+00	4.67E-05	4.09E-04	6.98E-04
density	1.34E+00	1.74E+00	1.50E+00	1.51E+00	1.31E+00	1.12E+00	1.70E+00	1.64E+00	1.63E+00	1.72E+00
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00	1.00E+00	7.96E+00	1.30E+01	4.30E+01	5.40E+01
void frac.	8.22E-01	4.80E-01	6.98E-01	7.81E-01	8.88E-01	8.77E-01	5.08E-01	8.62E-01	7.75E-01	7.08E-01
wt.% H2O	6.86E+01	5.27E+01	5.24E+01	6.22E+01	6.86E+01	8.69E+01	4.30E+01	4.02E+01	3.74E+01	2.74E+01
TOC wt.%C	0.00E+00	1.99E-02	2.90E+00	2.28E-04	3.28E-01	0.00E+00	1.01E-04	5.29E-02	7.99E-01	7.52E-01
free OH-	7.32E-02	8.74E-02	2.99E-02	1.53E+00	8.83E-01	4.50E-02	9.18E-02	2.91E+00	1.65E+00	9.06E-01
OH-	4.67E+00	8.00E+00	6.85E+00	7.27E+00	3.66E+00	8.45E-01	6.05E-01	1.47E+01	6.18E+00	1.26E+01
NO3-	1.03E-09	3.25E-11	4.92E-01	1.80E-11	1.11E+00	1.38E-01	7.59E+00	5.34E+00	7.55E+00	7.69E+00
NO2-	6.39E-01	1.36E-01	1.28E-01	5.09E-01	7.64E-01	2.11E-02	9.40E-02	1.85E+00	1.39E+00	1.79E+00
CO3--	1.93E-01	1.27E+00	1.89E-01	5.20E-01	6.71E-01	9.05E-01	1.58E-01	5.28E-02	3.31E-01	4.09E-01
PO4---	1.84E-02	0.00E+00	7.00E-03	0.00E+00	5.74E-03	0.00E+00	1.06E+00	4.45E-04	4.88E-02	4.41E-02
SO4--	6.11E-02	8.21E-03	3.08E-02	8.01E-02	8.36E-02	3.15E-02	6.01E-01	4.53E-02	2.61E-01	2.63E-01
SiO3--	2.48E+00	5.90E+00	4.70E+00	2.68E+00	7.55E-01	0.00E+00	1.16E-01	9.30E-02	3.71E-02	3.32E-02
F-	3.64E-04	0.00E+00	0.00E+00	0.00E+00	1.45E-03	0.00E+00	9.84E-02	1.58E-04	9.74E-02	7.51E-02
Cl-	1.57E-02	6.11E-03	4.84E-02	4.90E-02	6.25E-02	2.79E-03	6.00E-02	1.63E-01	1.83E-01	1.50E-01
C6H5O7---	0.00E+00	4.81E-03	1.05E-02	0.00E+00	2.45E-02	0.00E+00	0.00E+00	1.39E-03	1.31E-02	2.59E-02
EDTA----	0.00E+00	0.00E+00	1.05E-01	0.00E+00	3.12E-03	0.00E+00	0.00E+00	1.50E-03	2.60E-02	2.02E-02
HEDTA---	0.00E+00	0.00E+00	2.10E-01	0.00E+00	6.28E-03	0.00E+00	0.00E+00	2.99E-03	5.17E-02	2.66E-02
				0.00E+00	0.00E+00					
glycolate-	0.00E+00	0.00E+00	2.10E-01	0.00E+00	6.24E-03	0.00E+00	0.00E+00	2.99E-03	5.17E-02	2.66E-02
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.96E-05	8.37E-04	4.37E-02
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-10	6.26E-06
DBP	0.00E+00	0.00E+00	0.00E+00	2.38E-05	1.31E-02		1.19E-05	1.08E-03	1.05E-02	2.61E-02
butanol	0.00E+00	0.00E+00	0.00E+00	2.38E-05		0.00E+00	1.19E-05	1.08E-03	1.05E-02	2.61E-02
NH3	2.03E-01	2.68E-02	2.58E-04	1.73E-01	2.19E-02	0.00E+00	4.74E-02	3.56E-02	9.19E-02	3.79E-02
Fe(CN)6----										

Predicted Sludge Species (mol/L) (Sheet 5)

pred. sludge mol/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
Na	1.47E+01	1.42E+01	1.47E+01	1.42E+01	3.47E+00	1.98E+00	5.72E-01	5.21E+00
Al	1.79E+00	1.97E+00	1.89E+00	1.23E+00	3.65E+00	3.04E+00	0.00E+00	0.00E+00
Fe(total)	1.88E-02	3.14E-03	2.01E-02	5.81E-02	2.12E+00	1.60E+00	1.91E+00	3.65E-01
Cr	1.41E-01	7.71E-02	8.20E-02	4.53E-02	8.32E-03	1.63E-02	6.82E-03	0.00E+00
Bi	1.27E-04	2.00E-04	1.61E-04	1.33E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	7.96E-09	7.92E-09	5.66E-09	4.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	6.63E-06	2.34E-06	6.66E-06	3.83E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZrO(OH)2	6.67E-05	1.07E-04	7.87E-05	1.73E-04	0.00E+00	0.00E+00	0.00E+00	9.50E-01
Pb	8.01E-04	9.87E-04	1.49E-03	4.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	1.35E-02	2.91E-03	1.26E-02	3.56E-02	8.03E-02	9.56E-02	1.11E-01	0.00E+00
Sr	1.10E-05	1.05E-06	1.46E-05	3.71E-05	5.47E-03	1.91E-03	1.03E-08	2.39E-07
Mn	1.34E-03	8.86E-04	9.25E-04	2.41E-03	0.00E+00	0.00E+00	2.73E-01	0.00E+00
Ca	2.58E-02	5.92E-03	2.24E-02	7.40E-02	2.22E-01	5.68E-02	7.17E-01	1.40E-01
K	6.33E-02	7.47E-02	6.98E-02	1.47E-01	5.93E-03	3.97E-03	5.97E-03	1.91E-01
balance	8.17E-04	8.67E-04	9.82E-04	7.07E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density	1.67E+00	1.64E+00	1.67E+00	1.65E+00	1.56E+00	1.38E+00	1.28E+00	1.31E+00
vol% solids	3.61E+01	2.80E+01	1.89E+01	2.09E+01	4.43E+00	7.61E+00	2.00E+00	1.05E+01
void frac.	8.28E-01	9.03E-01	8.34E-01	8.18E-01	7.28E-01	8.37E-01	8.50E-01	8.48E-01
wt.% H2O	3.52E+01	3.78E+01	3.52E+01	3.57E+01	4.64E+01	5.71E+01	6.88E+01	6.36E+01
TOC wt.%C	1.25E+00	1.41E+00	1.59E+00	2.68E+00	0.00E+00	0.00E+00	3.27E-02	0.00E+00
free OH-	2.68E+00	2.90E+00	2.48E+00	1.87E+00	5.18E-01	3.40E-01	1.90E-02	6.68E-02
OH-	1.02E+01	1.09E+01	1.02E+01	7.06E+00	1.96E+01	1.49E+01	7.75E+00	5.24E+00
NO3-	6.36E+00	5.05E+00	5.35E+00	5.26E+00	6.76E-11	7.59E-03	2.19E-01	3.24E-01
NO2-	2.01E+00	2.28E+00	2.27E+00	1.75E+00	1.91E+00	1.34E+00	8.56E-03	1.53E-02
CO3--	3.44E-01	3.96E-01	5.05E-01	8.28E-01	2.22E-01	5.68E-02	8.04E-01	1.40E-01
PO4---	3.96E-02	5.30E-02	5.27E-02	3.29E-01	0.00E+00	0.00E+00	5.93E-02	0.00E+00
SO4--	2.14E-01	1.70E-01	3.56E-01	1.31E-01	4.05E-01	1.49E-01	3.41E-03	0.00E+00
SiO3--	4.10E-02	1.55E-02	3.84E-02	8.40E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F-	5.48E-02	8.56E-02	7.89E-02	1.63E-01	3.81E-02	2.69E-02	0.00E+00	5.00E+00
Cl-	2.22E-01	2.63E-01	2.43E-01	2.28E-01	2.72E-02	1.83E-02	3.92E-03	3.97E-03
C6H5O7---	2.57E-02	2.73E-02	3.24E-02	2.90E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	4.17E-02	4.60E-02	5.21E-02	9.69E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	8.20E-02	9.06E-02	9.75E-02	1.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	8.19E-02	9.06E-02	9.75E-02	1.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	4.67E-03	4.29E-03	2.12E-02	1.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	3.98E-05	3.96E-05	2.83E-05	2.07E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	1.45E-02	1.66E-02	2.30E-02	1.89E-02	0.00E+00	0.00E+00	2.91E-03	0.00E+00
butanol	1.45E-02	1.66E-02	2.30E-02	1.89E-02	0.00E+00	0.00E+00	2.91E-03	0.00E+00
NH3	7.12E-02	9.70E-02	7.68E-02	3.55E-01	5.87E-01	1.21E-01	1.30E-08	6.53E-01
Fe(CN)6----								

Predicted Sludge Species (Ci/L) (Sheet 1)

pred. sludge Ci/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3 (Ci/L)	3.13E-06	3.76E-06	1.67E-06	3.66E-06	3.97E-11	9.39E-10	1.26E-13	1.19E-11	2.72E-06	1.46E-06
C-14 (Ci/L)	1.48E-07	7.68E-07	5.47E-08	4.85E-08	2.75E-09	2.96E-09	2.81E-10	4.92E-10	1.06E-07	5.64E-08
Ni-59 (Ci/L)	2.24E-08	1.99E-08	1.10E-08	1.59E-08	7.20E-10	7.72E-10	7.36E-11	1.28E-10	2.76E-08	1.34E-06
Ni-63 (Ci/L)	1.91E-06	1.76E-06	1.62E-06	2.21E-06	6.14E-08	6.82E-08	6.27E-09	1.13E-08	2.41E-06	1.17E-04
Co-60 (Ci/L)	4.07E-08	7.00E-08	6.38E-08	1.90E-07	1.30E-09	2.71E-09	1.33E-10	4.52E-10	8.21E-08	4.39E-08
Se-79 (Ci/L)	3.83E-09	3.46E-09	1.17E-09	1.59E-09	1.23E-10	1.34E-10	1.26E-11	2.23E-11	4.76E-09	2.55E-09
Sr-90 (Ci/L)	7.45E-02	1.51E-01	1.56E-04	2.34E-04	2.61E-06	3.15E-06	4.52E-08	8.88E-08	2.61E-01	2.06E-01
Y-90 (Ci/L)	7.45E-02	1.51E-01	1.56E-04	2.34E-04	2.61E-06	3.15E-06	4.52E-08	8.88E-08	2.61E-01	2.06E-01
Zr-93 (Ci/L)	1.04E-09	9.27E-10	1.56E-06	1.98E-06	7.48E-08	8.07E-08	0.00E+00	0.00E+00	1.28E-09	6.84E-10
Nb-93m (Ci/L)	9.34E-10	8.12E-10	1.41E-06	1.74E-06	6.73E-08	7.08E-08	0.00E+00	0.00E+00	1.13E-09	6.05E-10
Tc-99 (Ci/L)	1.85E-06	1.67E-06	8.80E-08	1.21E-07	1.47E-09	1.60E-09	2.54E-11	4.52E-11	1.66E-06	8.87E-07
Ru-106 (Ci/L)	4.06E-20	1.47E-18	2.48E-17	7.91E-16	2.34E-18	1.02E-16	5.99E-19	4.26E-17	1.41E-18	7.53E-19
Cd-113m (Ci/L)	9.01E-08	1.14E-07	4.89E-08	9.67E-08	2.89E-09	4.42E-09	2.96E-10	7.36E-10	1.43E-07	7.65E-08
Sb-125 (Ci/L)	1.18E-09	4.00E-09	7.79E-10	2.78E-09	3.78E-11	1.55E-10	3.87E-12	2.58E-11	4.25E-09	2.27E-09
Sn-126 (Ci/L)	1.38E-08	1.33E-08	4.22E-09	6.21E-09	4.43E-10	5.17E-10	4.53E-11	8.59E-11	1.80E-08	9.61E-09
I-129 (Ci/L)	8.20E-10	1.91E-09	4.34E-11	1.06E-09	6.50E-13	0.00E+00	1.13E-14	0.00E+00	2.13E-09	1.14E-09
Cs-134 (Ci/L)	5.08E-12	4.57E-11	2.41E-13	3.25E-12	4.02E-15	4.37E-14	6.97E-17	1.23E-15	4.53E-11	2.36E-09
Cs-137 (Ci/L)	3.78E-03	3.83E-03	1.79E-04	2.74E-04	2.99E-06	3.67E-06	5.19E-08	1.03E-07	5.10E-03	2.65E-01
Ba-137m (Ci/L)	3.57E-03	3.62E-03	1.69E-04	2.59E-04	2.83E-06	3.47E-06	4.90E-08	9.77E-08	4.81E-03	2.51E-01
Sm-151 (Ci/L)	1.45E-04	1.27E-04	9.78E-05	1.27E-04	2.58E-05	2.74E-05	8.80E-06	1.52E-05	1.77E-04	9.44E-05
Eu-152 (Ci/L)	1.79E-09	6.07E-09	1.21E-09	6.96E-09	3.20E-10	1.31E-09	1.09E-10	7.25E-10	6.45E-09	3.45E-09
Eu-154 (Ci/L)	1.74E-07	4.46E-07	1.17E-07	4.87E-07	3.10E-08	9.61E-08	1.06E-08	5.33E-08	4.90E-07	2.62E-07
Eu-155 (Ci/L)	1.41E-07	2.45E-07	9.52E-08	2.21E-07	2.51E-08	5.28E-08	8.57E-09	2.93E-08	2.87E-07	1.53E-07
Ra-226 (Ci/L)	3.38E-10	1.88E-10	8.57E-12	5.25E-12	9.03E-13	4.84E-13	9.24E-14	8.05E-14	2.27E-11	1.21E-11
Ra-228 (Ci/L)	1.13E-15	1.11E-15	2.87E-17	3.41E-17	3.03E-18	2.85E-18	3.10E-19	4.75E-19	1.06E-16	5.68E-17
Ac-227 (Ci/L)	1.15E-09	5.06E-10	2.56E-11	1.59E-11	7.69E-12	4.22E-12	3.93E-12	3.50E-12	1.10E-10	5.88E-11
Pa-231 (Ci/L)	1.12E-12	5.42E-13	5.32E-10	3.47E-10	1.62E-10	9.45E-11	8.27E-11	7.86E-11	9.47E-13	5.06E-13
Th-229 (Ci/L)	4.50E-15	3.52E-15	1.98E-14	2.36E-14	6.00E-15	5.66E-15	3.07E-15	4.71E-15	5.08E-15	2.71E-15
Th-232 (Ci/L)	3.77E-17	2.99E-17	1.65E-16	1.99E-16	5.02E-17	4.82E-17	2.57E-17	4.01E-17	4.30E-17	2.30E-17
U-232 (Ci/L)	1.34E-09	2.35E-09	5.92E-12	8.35E-12	1.11E-14	1.29E-14	4.24E-17	8.00E-17	4.52E-11	2.98E-11
U-233 (Ci/L)	1.19E-10	1.85E-10	5.24E-13	6.31E-13	9.86E-16	1.01E-15	3.75E-18	6.28E-18	3.68E-12	2.43E-12
U-234 (Ci/L)	1.53E-04	1.54E-04	6.56E-07	4.61E-07	1.27E-09	8.48E-10	4.85E-12	5.25E-12	3.62E-06	2.39E-06
U-235 (Ci/L)	6.92E-06	6.83E-06	2.96E-08	2.03E-08	5.75E-11	3.75E-11	2.19E-13	2.32E-13	1.62E-07	1.07E-07
U-236 (Ci/L)	1.31E-06	2.09E-06	5.60E-09	6.83E-09	1.09E-11	1.15E-11	4.14E-14	7.13E-14	4.14E-08	2.73E-08
U-238 (Ci/L)	1.56E-04	1.57E-04	6.67E-07	4.71E-07	1.30E-09	8.65E-10	4.93E-12	5.36E-12	3.69E-06	2.43E-06
U-Total (M)	1.96E+00	1.98E+00	8.40E-03	5.93E-03	1.63E-05	1.09E-05	6.21E-08	6.74E-08	4.65E-02	3.06E-02
Np-237 (Ci/L)	1.05E-08	9.62E-09	2.00E-09	2.79E-09	5.97E-10	6.64E-10	3.05E-10	5.52E-10	1.32E-08	7.04E-09
Pu-238 (Ci/L)	3.76E-09	9.30E-08	3.39E-07	1.24E-06	6.92E-08	2.78E-07	1.17E-08	8.37E-07	9.40E-09	5.02E-09
Pu-239 (Ci/L)	1.09E-06	1.05E-05	9.81E-05	1.21E-04	2.00E-05	3.14E-05	3.38E-06	9.44E-05	1.32E-06	7.04E-07
Pu-240 (Ci/L)	7.34E-08	1.33E-06	6.62E-06	1.72E-05	1.35E-06	3.98E-06	2.28E-07	1.20E-05	1.42E-07	7.59E-08
Pu-241 (Ci/L)	7.10E-08	2.92E-06	6.41E-06	3.97E-05	1.31E-06	8.73E-06	2.21E-07	2.63E-05	2.77E-07	1.48E-07
Pu-242 (Ci/L)	3.32E-13	2.12E-11	2.99E-11	3.01E-10	6.10E-12	6.35E-11	1.03E-12	1.91E-10	1.94E-12	1.04E-12
Pu-Total (g/L)	1.78E-05	1.75E-04	1.61E-03	2.03E-03	3.28E-04	5.23E-04	5.55E-05	1.57E-03	2.18E-05	1.17E-05
Am-241 (Ci/L)	2.27E-07	6.75E-07	5.98E-08	3.12E-07	1.29E-08	4.66E-08	6.61E-09	3.87E-08	7.27E-07	3.89E-07
Am-243 (Ci/L)	9.80E-12	1.04E-10	1.87E-12	3.59E-11	5.59E-13	7.20E-12	2.86E-13	5.98E-12	1.03E-10	5.49E-11
Cm-242 (Ci/L)	1.72E-11	1.80E-10	3.27E-12	6.17E-11	9.80E-13	1.24E-11	5.00E-13	1.03E-11	1.77E-10	9.47E-11
Cm-243 (Ci/L)	1.01E-13	2.17E-12	1.93E-14	7.50E-13	5.79E-15	1.50E-13	2.96E-15	1.24E-13	2.10E-12	1.12E-12
Cm-244 (Ci/L)	2.38E-12	5.10E-11	4.54E-13	1.76E-11	1.36E-13	3.52E-12	6.94E-14	2.93E-12	4.93E-11	2.64E-11

Predicted Sludge Species (Ci/L) (Sheet 2)

pred. sludge Ci/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3 (Ci/L)	1.43E-06	5.77E-06	2.08E-07	1.90E-05	1.00E-04	1.07E-04	2.10E-04	2.95E-06	6.46E-06	1.17E-06
C-14 (Ci/L)	5.54E-08	2.01E-07	2.35E-07	1.03E-06	6.23E-07	1.17E-06	1.43E-06	1.86E-06	1.63E-06	1.12E-08
Ni-59 (Ci/L)	1.20E-06	2.91E-06	3.93E-07	4.89E-06	1.75E-05	1.41E-06	1.04E-05	3.39E-05	4.23E-05	1.06E-07
Ni-63 (Ci/L)	1.05E-04	2.71E-04	3.53E-05	4.41E-04	1.65E-03	1.37E-04	9.96E-04	3.15E-03	4.08E-03	1.02E-05
Co-60 (Ci/L)	4.31E-08	2.76E-07	5.40E-08	1.40E-06	8.63E-06	6.46E-06	1.93E-04	9.36E-06	7.64E-04	7.55E-08
Se-79 (Ci/L)	2.50E-09	7.99E-09	1.89E-09	4.79E-08	1.35E-07	4.93E-10	7.58E-10	1.82E-07	2.97E-07	4.71E-10
Sr-90 (Ci/L)	2.24E-01	5.18E-02	1.03E-02	1.34E+00	7.49E+00	4.56E-04	8.41E-04	1.07E+01	1.54E+01	5.79E-04
Y-90 (Ci/L)	2.24E-01	5.18E-02	1.03E-02	1.34E+00	7.49E+00	4.56E-04	8.41E-04	1.07E+01	1.54E+01	5.79E-04
Zr-93 (Ci/L)	6.72E-10	2.65E-07	3.74E-05	2.87E-06	8.05E-06	2.95E-08	4.54E-08	1.08E-05	1.77E-05	2.79E-08
Nb-93m (Ci/L)	5.94E-10	2.35E-07	3.22E-05	2.47E-06	6.48E-06	2.53E-08	3.64E-08	8.99E-06	1.39E-05	2.10E-08
Tc-99 (Ci/L)	8.71E-07	2.65E-06	1.35E-07	1.82E-05	5.04E-05	2.15E-07	3.26E-07	5.69E-05	9.28E-05	2.00E-07
Ru-106 (Ci/L)	7.40E-19	2.14E-16	4.91E-15	3.82E-14	2.39E-11	8.79E-16	1.36E-13	2.85E-12	5.00E-09	3.08E-12
Cd-113m (Ci/L)	7.51E-08	2.67E-07	6.45E-08	1.97E-06	8.02E-06	1.36E-06	2.56E-06	9.56E-06	2.04E-05	4.14E-08
Sb-125 (Ci/L)	2.23E-09	7.23E-09	3.75E-09	1.22E-07	1.93E-05	1.34E-08	1.74E-08	1.41E-06	1.70E-04	3.67E-08
Sn-126 (Ci/L)	9.44E-09	3.01E-08	6.81E-09	1.94E-07	5.44E-07	1.99E-09	3.03E-09	7.50E-07	1.24E-06	2.03E-09
I-129 (Ci/L)	1.12E-09	5.83E-09	1.30E-09	2.91E-08	7.79E-08	3.03E-10	4.59E-10	3.39E-09	5.57E-09	0.00E+00
Cs-134 (Ci/L)	2.36E-09	2.08E-09	1.58E-10	2.72E-09	1.79E-07	4.20E-11	9.00E-10	5.36E-08	5.50E-07	5.20E-09
Cs-137 (Ci/L)	2.65E-01	2.35E-01	1.28E-02	5.14E-02	1.72E-01	5.38E-04	9.78E-04	2.16E-01	3.97E-01	6.81E-04
Ba-137m (Ci/L)	2.51E-01	2.22E-01	1.21E-02	4.86E-02	1.62E-01	5.08E-04	9.23E-04	2.04E-01	3.75E-01	6.43E-04
Sm-151 (Ci/L)	9.27E-05	3.23E-04	1.68E-04	2.01E-03	1.99E-01	2.07E-05	3.18E-05	1.31E-01	4.81E-01	1.84E-05
Eu-152 (Ci/L)	3.39E-09	1.15E-08	2.80E-09	2.04E-07	5.44E-05	2.31E-09	7.65E-09	1.96E-05	1.11E-04	1.18E-08
Eu-154 (Ci/L)	2.57E-07	8.73E-07	3.50E-07	1.38E-05	3.61E-03	1.54E-07	5.10E-07	1.46E-03	8.88E-03	8.45E-07
Eu-155 (Ci/L)	1.51E-07	5.11E-07	4.63E-07	5.66E-06	1.51E-03	6.41E-08	2.55E-07	6.65E-04	4.91E-03	3.10E-07
Ra-226 (Ci/L)	1.19E-11	3.84E-11	9.63E-12	2.75E-12	8.25E-12	8.61E-13	8.93E-13	7.15E-12	1.31E-11	4.06E-14
Ra-228 (Ci/L)	5.58E-17	1.77E-16	3.86E-17	1.55E-17	7.12E-17	7.95E-18	1.29E-17	4.40E-17	1.07E-16	4.10E-11
Ac-227 (Ci/L)	5.78E-11	1.81E-10	3.04E-11	1.18E-11	3.42E-11	4.10E-12	4.05E-12	3.19E-11	6.06E-11	1.08E-10
Pa-231 (Ci/L)	4.97E-13	1.99E-10	7.02E-10	1.75E-11	4.99E-11	8.70E-12	9.62E-12	4.54E-11	9.26E-11	1.68E-10
Th-229 (Ci/L)	2.66E-15	1.72E-14	2.58E-14	5.81E-14	4.48E-14	1.19E-15	1.35E-15	1.19E-13	7.94E-14	2.54E-11
Th-232 (Ci/L)	2.26E-17	1.45E-16	2.31E-16	1.66E-17	7.30E-17	9.75E-18	1.65E-17	4.54E-17	1.11E-16	3.25E-11
U-232 (Ci/L)	2.98E-11	1.14E-13	2.56E-11	1.61E-10	3.37E-10	1.37E-10	7.07E-10	1.41E-10	3.33E-10	1.85E-05
U-233 (Ci/L)	2.43E-12	9.16E-15	1.91E-12	7.94E-10	9.56E-10	6.98E-12	2.40E-11	9.92E-10	6.05E-10	1.09E-03
U-234 (Ci/L)	2.39E-06	9.07E-09	2.57E-06	3.96E-06	4.41E-06	3.62E-06	1.39E-05	2.06E-06	4.27E-06	7.97E-05
U-235 (Ci/L)	1.07E-07	4.05E-10	1.16E-07	1.71E-07	1.67E-07	1.54E-07	5.27E-07	8.80E-08	1.78E-07	3.07E-06
U-236 (Ci/L)	2.73E-08	1.02E-10	2.31E-08	8.19E-08	1.28E-07	7.42E-08	3.90E-07	4.54E-08	1.09E-07	3.49E-06
U-238 (Ci/L)	2.43E-06	9.24E-09	2.62E-06	4.06E-06	3.08E-06	3.53E-06	9.68E-06	2.11E-06	4.17E-06	5.35E-05
U-Total (M)	3.06E-02	1.16E-04	3.30E-02	5.11E-02	3.89E-02	4.45E-02	1.22E-01	2.65E-02	5.25E-02	6.76E-01
Np-237 (Ci/L)	6.91E-09	2.16E-08	3.20E-09	1.32E-07	1.24E-07	1.43E-09	2.12E-09	3.11E-07	2.50E-07	4.23E-10
Pu-238 (Ci/L)	4.93E-09	2.37E-08	2.22E-06	9.32E-06	5.19E-05	6.27E-06	3.34E-05	3.07E-05	6.14E-05	1.80E-03
Pu-239 (Ci/L)	6.91E-07	3.16E-06	6.14E-04	4.91E-04	7.59E-04	3.94E-04	1.31E-03	1.24E-03	1.28E-03	1.59E-02
Pu-240 (Ci/L)	7.45E-08	3.53E-07	4.17E-05	9.53E-05	1.78E-04	7.48E-05	2.87E-04	2.50E-04	3.13E-04	5.58E-03
Pu-241 (Ci/L)	1.45E-07	7.20E-07	5.38E-05	3.31E-04	1.35E-03	2.75E-04	1.86E-03	1.10E-03	2.79E-03	1.06E-01
Pu-242 (Ci/L)	1.02E-12	5.12E-12	1.53E-10	2.90E-09	1.02E-08	2.22E-09	1.22E-08	7.81E-09	2.26E-08	9.51E-07
Pu-Total (g/L)	1.15E-05	5.25E-05	1.01E-02	8.33E-03	1.30E-02	6.68E-03	2.24E-02	2.11E-02	2.20E-02	2.83E-01
Am-241 (Ci/L)	3.82E-07	1.24E-06	8.34E-08	2.48E-04	2.92E-03	4.43E-06	1.10E-04	2.44E-03	5.85E-03	7.48E-07
Am-243 (Ci/L)	5.39E-11	1.65E-10	2.04E-12	9.07E-08	2.52E-06	4.82E-11	2.04E-09	1.12E-06	3.11E-06	7.15E-10
Cm-242 (Ci/L)	9.30E-11	2.84E-10	3.74E-12	7.47E-09	4.54E-06	8.24E-11	2.51E-10	4.97E-07	5.24E-06	1.19E-09
Cm-243 (Ci/L)	1.10E-12	3.36E-12	1.70E-14	1.34E-10	3.52E-07	1.51E-12	9.04E-12	9.73E-09	3.14E-07	1.29E-10
Cm-244 (Ci/L)	2.59E-11	7.90E-11	4.78E-13	3.30E-09	7.75E-06	3.70E-11	2.46E-10	2.58E-07	7.37E-06	3.15E-09

Predicted Sludge Species (Ci/L) (Sheet 3)

pred. sludge Ci/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3 (Ci/L)	1.37E-04	1.26E-04	1.39E-04	2.21E-07	9.39E-08	5.08E-08	0.00E+00	3.08E-07	2.29E-07	7.16E-07
C-14 (Ci/L)	1.29E-06	8.03E-07	3.01E-06	3.10E-07	5.28E-08	3.76E-08	0.00E+00	1.33E-07	9.56E-11	9.87E-11
Ni-59 (Ci/L)	5.09E-06	5.88E-06	1.51E-07	1.43E-07	4.58E-08	6.91E-09	0.00E+00	2.75E-06	4.74E-08	4.90E-08
Ni-63 (Ci/L)	4.76E-04	5.67E-04	1.31E-05	1.33E-05	4.41E-06	6.67E-07	0.00E+00	2.59E-04	4.04E-06	4.26E-06
Co-60 (Ci/L)	1.01E-05	1.55E-05	5.92E-06	1.94E-08	1.18E-08	3.29E-09	0.00E+00	1.95E-05	7.00E-09	1.09E-08
Se-79 (Ci/L)	5.36E-10	3.62E-10	3.92E-09	3.76E-10	1.19E-10	2.05E-11	0.00E+00	1.65E-08	1.63E-08	1.68E-08
Sr-90 (Ci/L)	5.23E-04	4.03E-04	2.75E-02	3.77E-04	1.35E-04	2.52E-05	0.00E+00	9.20E-02	1.67E-01	1.90E-01
Y-90 (Ci/L)	5.24E-04	4.04E-04	2.75E-02	3.77E-04	1.35E-04	2.52E-05	0.00E+00	9.20E-02	1.67E-01	1.90E-01
Zr-93 (Ci/L)	3.20E-08	2.09E-08	4.04E-06	2.24E-08	7.10E-09	1.22E-09	0.00E+00	9.81E-07	4.34E-07	4.48E-07
Nb-93m (Ci/L)	2.68E-08	1.64E-08	3.12E-06	1.86E-08	5.60E-09	9.13E-10	0.00E+00	7.96E-07	3.40E-07	3.37E-07
Tc-99 (Ci/L)	2.34E-07	1.51E-07	8.87E-06	1.64E-07	5.18E-08	8.71E-09	0.00E+00	5.16E-06	1.84E-06	1.90E-06
Ru-106 (Ci/L)	3.17E-15	5.31E-13	1.67E-11	5.91E-15	5.46E-14	1.34E-13	0.00E+00	7.66E-09	4.84E-13	4.89E-12
Cd-113m (Ci/L)	1.72E-06	1.51E-06	3.82E-07	1.98E-08	8.21E-09	1.81E-09	0.00E+00	9.86E-07	8.56E-07	1.03E-06
Sb-125 (Ci/L)	3.75E-09	1.58E-08	5.25E-07	2.93E-09	3.37E-09	1.60E-09	0.00E+00	4.31E-06	3.84E-07	8.83E-07
Sn-126 (Ci/L)	2.21E-09	1.50E-09	1.85E-08	1.56E-09	4.98E-10	8.84E-11	0.00E+00	6.83E-08	5.34E-08	5.51E-08
I-129 (Ci/L)	2.81E-07	1.31E-07	1.38E-08	1.09E-07	3.47E-08	3.36E-08	0.00E+00	3.08E-10	1.73E-10	1.79E-10
Cs-134 (Ci/L)	1.01E-10	1.02E-09	4.30E-07	1.11E-10	2.21E-10	2.27E-10	0.00E+00	1.64E-08	1.17E-08	3.56E-08
Cs-137 (Ci/L)	6.21E-04	4.73E-04	3.03E-02	4.47E-04	1.60E-04	2.97E-05	0.00E+00	2.07E-02	8.77E-03	9.72E-03
Ba-137m (Ci/L)	5.86E-04	4.46E-04	2.86E-02	4.22E-04	1.51E-04	2.80E-05	0.00E+00	1.95E-02	8.28E-03	9.18E-03
Sm-151 (Ci/L)	2.26E-05	1.49E-05	1.15E-04	1.59E-05	5.15E-06	8.00E-07	0.00E+00	1.85E-02	1.85E-04	1.96E-04
Eu-152 (Ci/L)	3.10E-09	3.85E-09	1.68E-07	2.38E-09	1.19E-09	5.13E-10	0.00E+00	3.74E-06	5.24E-08	6.33E-08
Eu-154 (Ci/L)	2.25E-07	2.95E-07	1.14E-05	1.77E-07	9.50E-08	3.68E-08	0.00E+00	2.94E-04	2.09E-06	2.77E-06
Eu-155 (Ci/L)	9.77E-08	1.63E-07	1.48E-06	8.08E-08	5.26E-08	1.35E-08	0.00E+00	1.56E-04	7.45E-07	1.21E-06
Ra-226 (Ci/L)	7.05E-13	1.73E-12	1.21E-12	1.48E-14	5.91E-15	1.77E-15	0.00E+00	6.84E-13	5.49E-11	8.58E-10
Ra-228 (Ci/L)	7.54E-18	1.33E-08	4.78E-17	9.12E-20	2.83E-12	1.79E-12	0.00E+00	4.87E-18	2.41E-07	2.61E-06
Ac-227 (Ci/L)	3.43E-12	2.85E-08	7.25E-12	6.61E-14	9.30E-12	4.72E-12	0.00E+00	3.10E-12	1.53E-05	1.50E-05
Pa-231 (Ci/L)	7.56E-12	1.36E-09	1.86E-11	9.41E-14	1.37E-11	7.33E-12	0.00E+00	4.58E-12	1.11E-06	1.15E-06
Th-229 (Ci/L)	1.18E-15	1.35E-07	5.38E-15	2.47E-16	2.41E-12	1.11E-12	0.00E+00	7.93E-15	3.96E-06	3.51E-06
Th-232 (Ci/L)	9.37E-18	6.14E-07	6.37E-17	9.40E-20	2.65E-12	1.42E-12	0.00E+00	5.04E-18	4.36E-06	4.50E-06
U-232 (Ci/L)	1.31E-10	6.34E-07	1.49E-09	3.54E-09	2.45E-06	1.62E-06	0.00E+00	1.29E-09	1.75E-05	1.86E-05
U-233 (Ci/L)	6.18E-12	3.80E-05	2.25E-11	2.49E-08	1.56E-04	9.62E-05	0.00E+00	5.45E-09	1.11E-03	1.10E-03
U-234 (Ci/L)	2.78E-06	5.27E-06	6.05E-06	5.17E-05	2.50E-05	7.00E-06	0.00E+00	1.76E-05	8.44E-06	8.71E-06
U-235 (Ci/L)	1.19E-07	2.05E-07	2.80E-07	2.21E-06	9.93E-07	2.69E-07	0.00E+00	7.45E-07	2.99E-11	3.09E-11
U-236 (Ci/L)	6.35E-08	1.30E-07	4.25E-07	1.14E-06	6.10E-07	3.07E-07	0.00E+00	4.21E-07	5.22E-12	5.39E-12
U-238 (Ci/L)	2.86E-06	4.73E-06	4.23E-06	5.31E-05	2.32E-05	4.70E-06	0.00E+00	1.76E-05	4.67E-19	4.82E-19
U-Total (M)	3.60E-02	5.96E-02	5.35E-02	6.68E-01	2.92E-01	5.94E-02	0.00E+00	2.22E-01	5.02E-04	4.97E-04
Np-237 (Ci/L)	1.57E-09	1.00E-09	6.48E-09	6.45E-10	1.00E-10	1.84E-11	0.00E+00	2.18E-08	2.04E-13	2.11E-13
Pu-238 (Ci/L)	6.39E-06	1.46E-05	6.89E-05	2.42E-04	1.00E-04	1.32E-05	1.83E-03	2.55E-04	3.48E-11	3.68E-11
Pu-239 (Ci/L)	3.63E-04	6.05E-04	6.78E-04	9.78E-03	2.09E-03	1.17E-04	2.85E-02	7.82E-03	1.76E-15	1.82E-15
Pu-240 (Ci/L)	7.56E-05	1.43E-04	2.62E-04	1.97E-03	5.11E-04	4.10E-05	7.13E-03	1.69E-03	1.21E-16	1.25E-16
Pu-241 (Ci/L)	3.28E-04	1.03E-03	5.35E-03	8.62E-03	4.55E-03	7.76E-04	1.15E-01	1.03E-02	4.67E-16	5.59E-16
Pu-242 (Ci/L)	2.35E-09	7.25E-09	5.06E-08	6.15E-08	3.70E-08	7.00E-09	7.09E-07	7.94E-08	9.92E-22	1.02E-21
Pu-Total (g/L)	6.18E-03	1.04E-02	1.21E-02	1.66E-01	3.59E-02	2.08E-03	4.91E-01	1.34E-01	2.06E-12	2.18E-12
Am-241 (Ci/L)	5.41E-06	4.17E-06	6.28E-04	9.52E-08	5.24E-08	3.26E-08	3.02E-02	2.67E-04	6.75E-17	6.74E-17
Am-243 (Ci/L)	6.02E-11	1.11E-10	6.55E-08	4.38E-11	2.79E-11	3.12E-11	0.00E+00	1.34E-07	2.40E-22	2.48E-22
Cm-242 (Ci/L)	1.02E-10	1.73E-10	1.01E-07	7.45E-11	4.86E-11	5.20E-11	0.00E+00	1.25E-05	4.54E-22	1.37E-22
Cm-243 (Ci/L)	1.91E-12	9.06E-12	2.84E-08	1.46E-12	2.92E-12	5.61E-12	0.00E+00	6.67E-07	9.12E-24	1.01E-23
Cm-244 (Ci/L)	4.98E-11	2.80E-10	6.08E-07	3.86E-11	6.84E-11	1.37E-10	0.00E+00	1.58E-05	1.99E-22	2.31E-22

Predicted Sludge Species (Ci/L) (Sheet 4)

pred. sludge Ci/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3 (Ci/L)	8.72E-06	7.86E-06	1.17E-06	5.96E-06	1.75E-05	0.00E+00	2.47E-06	6.38E-05	2.90E-05	5.48E-05
C-14 (Ci/L)	1.58E-06	4.93E-07	8.53E-08	5.43E-07	3.36E-06	0.00E+00	1.44E-07	2.49E-06	3.82E-06	6.44E-06
Ni-59 (Ci/L)	4.20E-05	2.22E-05	3.64E-07	4.46E-06	9.63E-05	0.00E+00	3.48E-07	5.56E-06	1.09E-05	3.80E-05
Ni-63 (Ci/L)	3.98E-03	2.14E-03	3.45E-05	4.21E-04	9.15E-03	0.00E+00	3.58E-05	5.27E-04	1.04E-03	3.65E-03
Co-60 (Ci/L)	1.53E-05	2.89E-03	4.66E-06	1.14E-03	3.44E-04	0.00E+00	1.66E-07	1.38E-05	4.36E-05	1.34E-04
Se-79 (Ci/L)	1.90E-07	1.15E-07	1.83E-08	1.05E-07	4.00E-07	0.00E+00	5.55E-09	2.33E-07	3.40E-07	4.40E-07
Sr-90 (Ci/L)	1.07E+01	1.12E+01	5.14E-02	1.42E+01	3.57E-01	0.00E+00	1.16E-03	2.70E-02	4.22E-02	3.70E-02
Y-90 (Ci/L)	1.07E+01	1.12E+01	5.14E-02	1.42E+01	3.58E-01	0.00E+00	1.16E-03	2.70E-02	4.22E-02	3.70E-02
Zr-93 (Ci/L)	1.13E-05	6.81E-06	1.09E-06	6.22E-06	2.38E-05	0.00E+00	5.14E-07	1.39E-05	2.03E-05	2.61E-05
Nb-93m (Ci/L)	9.16E-06	5.11E-06	8.24E-07	4.76E-06	1.92E-05	0.00E+00	4.57E-07	1.14E-05	1.65E-05	2.10E-05
Tc-99 (Ci/L)	5.94E-05	3.51E-05	5.63E-06	3.22E-05	1.28E-04	0.00E+00	1.67E-06	8.64E-05	1.12E-04	1.40E-04
Ru-106 (Ci/L)	2.54E-10	3.03E-07	1.34E-08	3.30E-08	3.60E-11	0.00E+00	3.61E-16	2.77E-11	3.98E-11	1.05E-10
Cd-113m (Ci/L)	1.15E-05	1.01E-05	1.57E-06	8.53E-06	2.49E-05	0.00E+00	1.87E-07	1.29E-05	2.16E-05	3.26E-05
Sb-125 (Ci/L)	3.48E-06	1.97E-03	1.74E-06	2.91E-04	5.89E-06	0.00E+00	5.15E-09	2.75E-06	5.37E-06	1.58E-05
Sn-126 (Ci/L)	7.88E-07	4.94E-07	7.87E-08	4.47E-07	1.66E-06	0.00E+00	2.09E-08	9.45E-07	1.40E-06	1.83E-06
I-129 (Ci/L)	3.16E-08	2.16E-09	3.45E-10	1.97E-09	7.53E-08	0.00E+00	2.31E-09	1.33E-07	1.23E-07	1.03E-06
Cs-134 (Ci/L)	2.00E-07	7.62E-08	0.00E+00	9.15E-07	1.08E-08	0.00E+00	4.09E-11	1.95E-07	2.50E-07	1.34E-07
Cs-137 (Ci/L)	2.39E-01	9.96E-03	0.00E+00	1.47E-01	1.33E-02	0.00E+00	4.86E-03	2.57E-01	2.06E-01	1.16E-01
Ba-137m (Ci/L)	2.26E-01	9.41E-03	0.00E+00	1.39E-01	1.26E-02	0.00E+00	4.59E-03	2.43E-01	1.95E-01	1.10E-01
Sm-151 (Ci/L)	1.84E-01	1.51E+00	2.54E-03	1.33E+00	3.28E-01	0.00E+00	2.55E-04	1.56E-02	9.50E-03	1.66E-02
Eu-152 (Ci/L)	3.45E-05	9.68E-04	7.99E-07	3.29E-04	6.08E-05	0.00E+00	8.66E-09	2.64E-06	1.78E-06	3.26E-06
Eu-154 (Ci/L)	2.68E-03	6.96E-02	5.99E-05	2.53E-02	4.53E-03	0.00E+00	6.61E-07	1.78E-04	1.30E-04	2.46E-04
Eu-155 (Ci/L)	1.38E-03	2.55E-02	2.69E-05	1.23E-02	2.09E-03	0.00E+00	3.87E-07	7.47E-05	5.96E-05	1.18E-04
Ra-226 (Ci/L)	8.19E-12	6.62E-12	1.03E-12	5.65E-12	1.86E-11	0.00E+00	2.70E-11	1.39E-11	4.59E-11	5.74E-11
Ra-228 (Ci/L)	4.83E-10	9.13E-17	1.38E-17	7.12E-17	8.67E-10	0.00E+00	1.23E-16	5.49E-10	5.45E-09	6.93E-08
Ac-227 (Ci/L)	5.40E-11	3.20E-11	4.97E-12	2.70E-11	1.10E-10	0.00E+00	1.21E-10	6.76E-11	2.92E-10	1.71E-09
Pa-231 (Ci/L)	1.14E-10	5.22E-11	8.06E-12	4.34E-11	2.99E-10	0.00E+00	3.77E-10	1.04E-09	1.51E-08	1.67E-07
Th-229 (Ci/L)	3.20E-12	3.13E-14	5.35E-15	3.36E-14	4.82E-12	0.00E+00	2.22E-14	1.58E-12	1.31E-11	2.12E-10
Th-232 (Ci/L)	8.16E-12	9.59E-17	1.45E-17	7.47E-17	1.34E-11	0.00E+00	1.87E-16	5.63E-12	4.74E-11	8.09E-10
U-232 (Ci/L)	1.58E-08	4.97E-09	3.73E-10	1.55E-09	3.27E-08	0.00E+00	5.28E-12	9.01E-10	3.70E-09	2.92E-08
U-233 (Ci/L)	9.68E-07	1.81E-09	7.65E-10	4.73E-09	2.02E-06	0.00E+00	4.21E-13	5.33E-08	2.21E-07	1.77E-06
U-234 (Ci/L)	2.52E-06	1.74E-05	2.96E-06	1.64E-05	1.39E-06	0.00E+00	3.93E-07	1.14E-07	7.30E-08	1.15E-07
U-235 (Ci/L)	1.06E-07	7.49E-07	1.26E-07	6.93E-07	5.79E-08	0.00E+00	1.75E-08	4.59E-09	3.02E-09	4.29E-09
U-236 (Ci/L)	6.04E-08	8.53E-07	8.92E-08	4.32E-07	3.76E-08	0.00E+00	4.61E-09	2.85E-09	1.70E-09	2.94E-09
U-238 (Ci/L)	2.50E-06	1.31E-05	2.78E-06	1.60E-05	1.30E-06	0.00E+00	4.00E-07	9.76E-08	6.63E-08	9.46E-08
U-Total (M)	3.15E-02	1.65E-01	3.50E-02	2.01E-01	1.64E-02	0.00E+00	5.04E-03	1.23E-03	8.35E-04	1.19E-03
Np-237 (Ci/L)	2.45E-07	1.03E-07	1.72E-08	1.05E-07	1.31E-05	0.00E+00	1.42E-08	3.44E-07	5.09E-07	6.26E-07
Pu-238 (Ci/L)	3.77E-05	1.17E-03	7.58E-05	3.19E-04	2.72E-05	0.00E+00	5.64E-07	1.87E-06	1.09E-06	1.79E-06
Pu-239 (Ci/L)	1.13E-03	1.04E-02	1.35E-03	7.54E-03	6.37E-04	0.00E+00	7.41E-05	4.80E-05	3.03E-05	4.53E-05
Pu-240 (Ci/L)	2.45E-04	3.62E-03	3.45E-04	1.75E-03	1.47E-04	0.00E+00	8.39E-06	1.02E-05	6.36E-06	1.09E-05
Pu-241 (Ci/L)	1.55E-03	6.85E-02	3.88E-03	1.48E-02	1.23E-03	0.00E+00	1.69E-05	5.82E-05	5.22E-05	1.02E-04
Pu-242 (Ci/L)	1.20E-08	6.18E-07	3.33E-08	1.22E-07	1.01E-08	0.00E+00	1.22E-10	4.69E-10	4.19E-10	8.29E-10
Pu-Total (g/L)	1.93E-02	1.84E-01	2.33E-02	1.29E-01	1.09E-02	0.00E+00	1.23E-03	8.20E-04	5.17E-04	7.79E-04
Am-241 (Ci/L)	3.07E-03	7.46E-02	5.38E-05	2.53E-02	6.80E-04	0.00E+00	7.86E-07	6.75E-05	6.03E-05	1.05E-04
Am-243 (Ci/L)	1.53E-06	7.13E-05	3.90E-08	1.55E-05	3.83E-07	0.00E+00	1.04E-10	3.71E-08	3.28E-08	4.20E-08
Cm-242 (Ci/L)	1.93E-06	1.20E-04	7.48E-06	2.08E-05	1.59E-06	0.00E+00	1.79E-10	3.84E-08	3.97E-08	3.98E-08
Cm-243 (Ci/L)	8.87E-08	1.29E-05	6.96E-07	1.65E-06	4.83E-08	0.00E+00	2.11E-12	1.62E-09	1.51E-09	1.39E-09
Cm-244 (Ci/L)	2.12E-06	3.16E-04	1.70E-05	3.99E-05	1.20E-06	0.00E+00	4.95E-11	3.69E-08	3.66E-08	3.46E-08

Predicted Sludge Species (Ci/L) (Sheet 5)

pred. sludge Ci/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (Ci/L)	2.34E-05	2.62E-05	2.54E-05	2.01E-05	4.25E-04	3.05E-04	9.00E-07	1.35E-04
C-14 (Ci/L)	5.52E-06	6.26E-06	7.16E-06	8.12E-06	1.33E-06	8.45E-07	5.99E-09	1.63E-06
Ni-59 (Ci/L)	5.03E-06	1.33E-06	1.09E-05	6.04E-06	8.49E-05	3.35E-05	7.53E-09	3.35E-08
Ni-63 (Ci/L)	4.79E-04	1.27E-04	1.04E-03	5.76E-04	8.20E-03	3.27E-03	7.31E-07	3.21E-06
Co-60 (Ci/L)	5.39E-05	3.34E-05	8.61E-05	4.18E-05	2.58E-02	1.08E-02	5.33E-08	1.09E-05
Se-79 (Ci/L)	5.22E-07	5.83E-07	6.40E-07	4.66E-07	6.54E-07	4.31E-07	3.71E-11	8.59E-10
Sr-90 (Ci/L)	5.16E-02	4.88E-03	6.03E-02	1.76E-01	3.31E+01	1.16E+01	6.24E-05	1.45E-03
Y-90 (Ci/L)	5.16E-02	4.89E-03	6.03E-02	1.76E-01	3.31E+01	1.16E+01	6.24E-05	1.45E-03
Zr-93 (Ci/L)	3.12E-05	3.48E-05	3.81E-05	2.77E-05	3.95E-05	2.62E-05	2.25E-09	9.01E-07
Nb-93m (Ci/L)	2.53E-05	2.82E-05	3.08E-05	2.24E-05	2.22E-05	1.38E-05	1.24E-09	4.97E-07
Tc-99 (Ci/L)	1.72E-04	1.92E-04	2.07E-04	1.53E-04	1.93E-04	1.27E-04	1.52E-08	4.69E-06
Ru-106 (Ci/L)	9.11E-11	6.97E-11	1.00E-10	2.15E-07	7.47E-04	1.65E-04	4.38E-07	1.92E-06
Cd-113m (Ci/L)	3.23E-05	3.63E-05	7.62E-05	2.75E-05	2.69E-03	7.29E-04	6.79E-09	1.62E-07
Sb-125 (Ci/L)	1.89E-05	4.58E-06	5.89E-06	1.63E-05	3.89E-02	1.54E-02	1.21E-07	6.80E-06
Sn-126 (Ci/L)	2.16E-06	2.41E-06	2.66E-06	1.94E-06	2.93E-06	1.89E-06	1.65E-10	3.82E-09
I-129 (Ci/L)	1.63E-07	1.88E-07	2.13E-07	1.80E-07	1.72E-08	1.11E-08	1.50E-08	3.10E-08
Cs-134 (Ci/L)	2.31E-07	2.95E-07	4.21E-07	8.55E-06	8.00E-04	8.98E-04	5.67E-08	1.75E-05
Cs-137 (Ci/L)	2.10E-01	2.60E-01	2.64E-01	1.97E-01	1.24E+00	8.45E-01	7.11E-05	2.19E-02
Ba-137m (Ci/L)	1.98E-01	2.46E-01	2.49E-01	1.86E-01	1.17E+00	7.98E-01	6.71E-05	2.07E-02
Sm-151 (Ci/L)	2.10E-02	4.51E-03	1.08E-02	1.07E-02	7.23E-01	2.28E-01	1.50E-06	3.47E-05
Eu-152 (Ci/L)	3.85E-06	8.32E-07	2.21E-06	2.55E-06	9.90E-04	2.81E-04	1.97E-09	4.57E-08
Eu-154 (Ci/L)	2.82E-04	6.11E-05	1.65E-04	1.93E-04	1.16E-01	3.56E-02	2.38E-07	5.52E-06
Eu-155 (Ci/L)	1.28E-04	2.78E-05	7.69E-05	9.01E-05	7.89E-02	3.29E-02	1.82E-07	4.22E-06
Ra-226 (Ci/L)	4.09E-11	5.31E-11	6.63E-11	4.00E-11	4.57E-10	3.52E-11	3.22E-15	3.45E-13
Ra-228 (Ci/L)	5.32E-09	6.70E-09	3.13E-08	1.63E-08	2.60E-14	2.34E-15	1.93E-19	2.69E-17
Ac-227 (Ci/L)	2.49E-10	3.23E-10	5.09E-10	2.34E-10	1.11E-09	1.82E-10	1.61E-14	1.66E-12
Pa-231 (Ci/L)	1.28E-08	1.69E-08	7.85E-08	5.16E-08	6.44E-10	4.45E-10	3.72E-14	7.05E-12
Th-229 (Ci/L)	1.26E-11	1.60E-11	2.87E-11	1.98E-11	3.85E-13	2.34E-13	2.12E-17	1.86E-15
Th-232 (Ci/L)	4.33E-11	5.57E-11	1.04E-10	7.15E-11	3.78E-15	2.74E-15	2.22E-19	4.48E-17
U-232 (Ci/L)	1.30E-09	5.55E-10	5.12E-09	2.81E-09	9.01E-09	2.62E-09	4.43E-09	1.04E-09
U-233 (Ci/L)	7.86E-08	3.33E-08	3.08E-07	1.67E-07	2.89E-09	8.10E-10	1.41E-09	1.27E-11
U-234 (Ci/L)	4.97E-08	1.69E-08	5.37E-08	1.18E-07	2.59E-05	8.73E-06	1.34E-05	5.48E-06
U-235 (Ci/L)	2.08E-09	7.03E-10	2.17E-09	4.68E-09	9.73E-07	3.48E-07	5.14E-07	2.10E-07
U-236 (Ci/L)	1.23E-09	4.08E-10	1.41E-09	8.02E-09	2.47E-06	8.62E-07	1.30E-06	5.29E-07
U-238 (Ci/L)	4.67E-08	1.57E-08	4.83E-08	9.27E-08	1.79E-05	6.01E-06	9.25E-06	3.78E-06
U-Total (M)	5.88E-04	1.98E-04	6.09E-04	1.17E-03	2.26E-01	7.59E-02	1.17E-01	4.77E-02
Np-237 (Ci/L)	1.11E-06	6.51E-07	1.17E-06	3.24E-07	1.07E-04	3.26E-05	2.15E-10	4.99E-09
Pu-238 (Ci/L)	8.43E-07	2.76E-07	1.02E-06	3.69E-06	1.87E-03	5.63E-04	2.97E-04	4.17E-05
Pu-239 (Ci/L)	2.34E-05	7.69E-06	2.42E-05	4.98E-05	1.76E-02	5.67E-03	2.87E-03	4.10E-04
Pu-240 (Ci/L)	5.10E-06	1.65E-06	5.61E-06	1.29E-05	5.05E-03	1.55E-03	8.10E-04	1.16E-04
Pu-241 (Ci/L)	3.78E-05	1.26E-05	5.04E-05	2.62E-04	1.51E-01	4.51E-02	2.40E-02	3.43E-03
Pu-242 (Ci/L)	3.13E-10	1.03E-10	4.18E-10	1.37E-09	6.52E-07	1.86E-07	1.02E-07	1.46E-08
Pu-Total (g/L)	4.01E-04	1.31E-04	4.15E-04	8.63E-04	3.08E-01	9.87E-02	5.01E-02	7.16E-03
Am-241 (Ci/L)	7.33E-05	1.13E-05	8.26E-05	1.99E-04	1.45E-01	5.67E-02	2.85E-07	1.44E-04
Am-243 (Ci/L)	4.42E-08	6.57E-09	5.11E-08	1.31E-07	4.54E-05	1.27E-05	7.92E-11	1.44E-08
Cm-242 (Ci/L)	6.53E-08	3.07E-08	7.98E-08	5.47E-08	8.41E-05	2.30E-05	1.46E-10	3.36E-09
Cm-243 (Ci/L)	2.30E-09	1.11E-09	3.18E-09	3.20E-09	1.30E-05	3.30E-06	2.21E-11	5.11E-10
Cm-244 (Ci/L)	5.61E-08	2.69E-08	7.80E-08	7.90E-08	3.38E-04	8.18E-05	5.65E-10	1.31E-08

Predicted Supernatant Species (mol/L) (Sheet 1)

pred. su mol/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
Na	1.91E+00	1.91E+00	2.49E+00	2.45E+00	1.89E+00	1.30E+00	1.62E+00	1.62E+00	4.04E+00	3.95E+00
Al(OH)4 -	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe	1.87E-03	1.87E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03
Cr	3.51E-03	3.57E-03	6.90E-03	6.90E-03	4.36E-03	5.88E-03	6.83E-03	6.83E-03	3.25E-03	3.31E-03
Bi	3.13E-04	3.19E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.60E-04	4.60E-04	1.83E-04	1.86E-04
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-06	1.00E-06	0.00E+00	0.00E+00
Hg	0.00E+00	1.62E-06	0.00E+00	1.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-06	1.62E-06
Zr	0.00E+00	0.00E+00	2.95E-04	2.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	1.75E-03	1.78E-03	1.70E-03	1.70E-03	1.66E-03	1.63E-03	1.61E-03	1.61E-03	1.63E-03	1.82E-03
Sr	6.33E-07	6.33E-07	6.95E-08	9.98E-08	1.40E-09	1.53E-09	1.59E-11	2.87E-11	6.33E-07	2.55E-07
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.56E-04	5.56E-04	0.00E+00	0.00E+00
Ca	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
K	7.74E-04	7.87E-04	1.01E-02	1.01E-02	6.77E-03	4.35E-03	2.32E-01	2.32E-01	1.60E-02	1.71E-02
balance	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density	1.10E+00	1.10E+00	1.13E+00	1.13E+00	1.10E+00	1.07E+00	1.09E+00	1.09E+00	1.21E+00	1.21E+00
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
void frac.	2.70E-01	1.45E-01	5.74E-01	5.99E-01	4.76E-01	5.26E-01	7.26E-01	7.89E-01	4.45E-01	2.34E-01
wt.% H2O	8.96E+01	8.96E+01	8.29E+01	8.32E+01	8.70E+01	9.10E+01	8.68E+01	8.68E+01	7.36E+01	7.37E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-02	1.10E-02	3.66E-04	0.00E+00
species	excludes hydroxide bound to Al									
OH-	3.62E-02	3.62E-02	1.01E-01	9.03E-02	3.59E-02	7.02E-02	7.91E-02	7.91E-02	2.31E-03	6.71E-03
NO3-	1.86E-01	1.83E-01	1.74E+00	1.73E+00	1.29E+00	8.10E-01	1.39E+00	1.39E+00	2.99E+00	3.19E+00
NO2-	1.66E-02	2.30E-02	6.69E-02	5.27E-02	7.87E-05	4.30E-05	9.65E-07	1.39E-06	1.62E-01	1.25E-02
CO3--	6.24E-01	6.27E-01	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	1.88E-01	3.75E-03
PO4---	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.07E-02	7.06E-02	3.26E-02	3.26E-02	7.06E-02	7.06E-02
SO4--	1.24E-01	1.24E-01	7.39E-02	7.38E-02	5.14E-02	3.17E-02	3.01E-03	3.01E-03	1.24E-01	1.24E-01
SiO3--	4.38E-03	4.46E-03	1.05E-02	1.05E-02	1.05E-02	1.05E-02	0.00E+00	0.00E+00	0.00E+00	1.05E-02
F-	0.00E+00	0.00E+00	1.98E-01	1.97E-01	2.28E-01	1.38E-01	2.71E-01	2.71E-01	0.00E+00	2.17E-01
Cl-	3.56E-03	3.62E-03	4.64E-02	4.64E-02	3.12E-02	2.00E-02	2.89E-02	2.89E-02	9.70E-02	7.87E-02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-03	5.00E-03	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.08E-05	0.00E+00
butanol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.08E-05	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	7.18E-05	1.37E-04	1.17E-01	8.49E-02	2.40E-10	1.12E-10	3.24E-14	6.69E-14	4.08E-04	2.42E-06
Fe(CN)6---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Species (mol/L) (Sheet 2)

pred. su mol/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
Na	3.95E+00	3.60E+00	1.32E+00	5.57E+00	5.45E+00	3.73E+00	1.83E+00	7.21E-01	1.17E+00	3.31E+00
Al(OH)4 -	0.00E+00	1.02E-02	0.00E+00	8.48E-01	9.94E-01	1.34E+00	6.29E-01	0.00E+00	0.00E+00	0.00E+00
Fe	1.88E-03	1.69E-03	1.87E-03	1.87E-03	1.87E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03
Cr	3.31E-03	4.60E-03	2.01E-03	5.54E-02	5.54E-02	3.12E-03	3.06E-03	8.04E-03	8.14E-03	8.08E-03
Bi	1.86E-04	2.56E-04	4.59E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	1.62E-06	1.30E-06	1.62E-06	1.62E-06	1.62E-06	0.00E+00	0.00E+00	1.62E-06	1.62E-06	0.00E+00
Zr	0.00E+00	7.79E-05	2.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	6.63E-06	0.00E+00	0.00E+00	0.00E+00	7.20E-04	7.20E-04	1.12E-04	7.20E-04	0.00E+00
Ni	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.56E-03	1.53E-03	1.82E-03	1.82E-03	1.82E-03
Sr	8.19E-05	4.65E-08	7.43E-09	5.50E-07	5.50E-07	1.46E-07	2.49E-07	5.19E-07	5.19E-07	2.18E-07
Mn	0.00E+00	0.00E+00	0.00E+00	5.55E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	3.75E-03	3.76E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
K	1.71E-02	1.48E-02	4.22E-03	2.67E-02	2.02E-02	2.35E-03	3.52E-03	3.16E-03	5.74E-03	1.49E-02
balance	0.00E+00	-1.42E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density	1.21E+00	1.19E+00	1.06E+00	1.26E+00	1.25E+00	1.16E+00	1.08E+00	1.03E+00	1.05E+00	1.18E+00
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
void frac.	2.29E-01	9.16E-01	8.51E-01	6.86E-01	6.40E-01	6.90E-01	7.50E-01	7.59E-01	5.47E-01	5.56E-01
wt.% H2O	7.37E+01	7.60E+01	9.17E+01	7.01E+01	7.15E+01	7.50E+01	8.62E+01	9.53E+01	9.24E+01	7.68E+01
TOC wt.%C	0.00E+00	9.55E-04	1.76E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
species										
OH-	-1.39E-03	3.21E-02	1.01E-01	1.76E+00	1.77E+00	1.80E-02	2.00E-02	1.84E-01	1.85E-01	5.35E-02
NO3-	3.21E+00	2.67E+00	5.47E-01	2.25E+00	1.30E+00	9.02E-01	8.86E-01	1.75E-01	1.20E-01	2.89E+00
NO2-	2.39E-03	1.24E-01	1.71E-01	7.69E-01	1.41E+00	1.44E+00	2.88E-01	2.77E-01	6.15E-01	2.13E-02
CO3--	3.75E-03	1.01E-01	5.51E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
PO4---	7.07E-02	6.30E-02	7.06E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.06E-02
SO4--	1.24E-01	1.15E-01	2.14E-02	1.93E-02	3.03E-02	9.43E-03	6.12E-03	4.40E-02	1.24E-01	5.66E-02
SiO3--	1.05E-02	5.10E-03	1.05E-02	1.05E-02	1.05E-02	1.05E-02	0.00E+00	1.05E-02	1.05E-02	0.00E+00
F-	2.17E-01	9.18E-02	2.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl-	7.87E-02	8.21E-02	1.94E-02	9.57E-02	9.30E-02	1.08E-02	1.62E-02	1.45E-02	2.64E-02	6.84E-02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	1.83E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
butanol	0.00E+00	1.83E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	8.85E-08	2.61E-02	4.32E-07	9.57E-03	3.67E-02	1.87E-04	4.45E-05	8.43E-03	3.08E-02	3.05E-06
Fe(CN)6----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Species (mol/L) (Sheet 3)

pred. su mol/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
Na	2.38E+00	1.62E+00	5.79E-01	6.64E-01	1.13E+00	1.58E+00	3.58E+00	2.22E+00	3.58E+00	3.58E+00
Al(OH)4 -	8.52E-01	6.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.53E-01	0.00E+00	3.19E-01	3.19E-01
Fe	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	4.82E-02	1.88E-03	1.88E-03
Cr	3.08E-03	3.06E-03	3.09E-03	8.02E-03	8.03E-03	8.02E-03	9.50E-03	7.65E-03	8.07E-03	8.07E-03
Bi	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-06	0.00E+00	0.00E+00
Zr	0.00E+00	0.00E+00	2.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	7.20E-04	7.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.19E-03	0.00E+00	0.00E+00
Ni	1.54E-03	1.53E-03	1.54E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	4.00E-03	1.82E-03	1.82E-03
Sr	1.33E-07	1.13E-07	5.19E-07	1.07E-07	3.97E-08	7.15E-09	0.00E+00	2.05E-05	5.19E-07	5.19E-07
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.56E-04	5.56E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	4.90E-03	3.75E-03	3.75E-03
K	1.52E-03	2.51E-03	2.25E-01	1.00E-03	1.35E-02	5.54E-03	1.28E-02	8.88E-02	2.80E-02	2.80E-02
balance	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-04	0.00E+00	0.00E+00
density	1.10E+00	1.07E+00	1.03E+00	1.03E+00	1.06E+00	1.08E+00	1.18E+00	1.08E+00	1.19E+00	1.19E+00
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
void frac.	8.22E-01	7.49E-01	8.55E-01	7.40E-01	7.14E-01	7.39E-01	5.23E-01	9.42E-01	8.43E-01	8.43E-01
wt.% H2O	8.30E+01	8.77E+01	9.39E+01	9.41E+01	9.23E+01	8.88E+01	7.65E+01	8.22E+01	7.53E+01	7.53E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	8.47E-01	3.04E-01	2.47E-01	0.00E+00	2.29E+00	4.81E-02	4.78E-02
species										
OH-	1.88E-02	1.88E-02	2.16E-01	4.11E-02	8.27E-03	6.33E-02	2.97E-01	2.62E-01	2.52E-02	2.52E-02
NO3-	6.90E-01	6.87E-01	2.94E-01	2.30E-01	3.78E-01	9.45E-01	2.60E+00	7.98E-01	2.70E+00	2.71E+00
NO2-	7.95E-01	2.84E-01	3.11E-02	1.09E-02	1.04E-02	1.02E-02	1.42E-02	2.91E-01	9.30E-02	8.35E-02
CO3--	3.75E-03	3.75E-03	3.75E-03	2.06E-01	3.87E-01	2.91E-01	1.87E-01	4.90E-03	3.75E-03	3.75E-03
PO4---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-04	0.00E+00	7.07E-02	7.07E-02
SO4--	8.87E-03	6.74E-03	1.54E-03	4.01E-03	4.01E-03	4.01E-03	6.88E-03	6.74E-02	5.45E-02	5.45E-02
SiO3--	1.05E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F-	0.00E+00	0.00E+00	2.74E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-01	1.21E-01
Cl-	6.97E-03	1.16E-02	5.81E-03	4.61E-03	6.92E-03	2.14E-02	9.01E-02	4.92E-02	6.40E-02	6.40E-02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-02	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.01E-02	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.10E-01	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	6.08E-02	2.23E-02	1.86E-02	0.00E+00	0.00E+00	3.96E-03	3.93E-03
butanol	0.00E+00	0.00E+00	0.00E+00	6.08E-02	2.23E-02	1.86E-02	0.00E+00	0.00E+00	3.96E-03	3.93E-03
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	9.10E-05	1.85E-05	7.82E-01	1.01E-06	2.65E-07	3.52E-08	0.00E+00	3.61E-03	1.27E-04	1.00E-04
Fe(CN)6---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Species (mol/L) (Sheet 4)

pred. su mol/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
Na	1.35E+00	6.20E-01	3.67E+00	3.36E+00	4.15E+00	1.95E-01	4.93E+00	1.09E+01	1.06E+01	1.11E+01
Al(OH)4 -	2.19E-02	7.74E-02	2.61E-01	0.00E+00	3.85E-01	0.00E+00	1.34E-02	1.75E+00	1.40E+00	1.75E+00
Fe	1.88E-03	1.88E-03	1.71E-02	1.87E-03	1.88E-03	1.88E-03	1.87E-03	1.87E-03	1.88E-03	1.88E-03
Cr	1.71E-02	2.01E-03	2.01E-07	0.00E+00	3.17E-02	8.01E-03	9.06E-03	5.54E-02	5.54E-02	5.54E-02
Bi	2.05E-06	0.00E+00	0.00E+00	0.00E+00	5.09E-06	0.00E+00	4.59E-04	2.78E-07	2.97E-04	1.62E-04
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-13	1.77E-09
Hg	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	0.00E+00	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Zr	4.09E-08	0.00E+00	0.00E+00	0.00E+00	1.61E-06	0.00E+00	2.83E-04	8.94E-08	1.65E-04	6.08E-05
Pb	2.26E-04	7.20E-04	0.00E+00	0.00E+00	4.90E-04	0.00E+00	0.00E+00	1.09E-04	7.20E-04	7.20E-04
Ni	1.82E-03	1.82E-03	1.00E-02	0.00E+00	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03
Sr	5.19E-07	5.19E-07	1.54E-05	5.19E-07	5.27E-07	0.00E+00	5.81E-07	5.45E-07	5.34E-07	1.75E-06
Mn	1.78E-04	0.00E+00	0.00E+00	0.00E+00	3.24E-04	0.00E+00	0.00E+00	5.55E-04	5.36E-04	5.56E-04
Ca	3.75E-03	3.75E-03	1.04E-02	3.75E-03	3.75E-03	8.99E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
K	7.69E-03	2.77E-03	1.51E-02	1.36E-02	2.08E-02	6.91E-04	2.18E-02	4.84E-02	6.61E-02	6.45E-02
balance	4.89E-05	1.50E-05	2.23E-05	2.75E-04	1.02E-03	0.00E+00	0.00E+00	5.41E-05	5.28E-04	9.86E-04
density	1.07E+00	1.02E+00	1.09E+00	1.15E+00	1.19E+00	1.01E+00	1.26E+00	1.50E+00	1.48E+00	1.51E+00
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00	1.00E+00	7.96E+00	1.30E+01	4.30E+01	5.40E+01
void frac.	8.22E-01	4.80E-01	6.98E-01	7.81E-01	8.88E-01	8.77E-01	5.08E-01	8.62E-01	7.75E-01	7.08E-01
wt.% H2O	9.11E+01	9.58E+01	6.97E+01	8.61E+01	7.62E+01	9.83E+01	6.96E+01	5.19E+01	4.99E+01	4.62E+01
TOC wt.%C	0.00E+00	7.05E-02	5.71E+00	3.84E-04	4.66E-01	0.00E+00	2.69E-04	6.73E-02	1.13E+00	1.21E+00
species							excludes hydroxide bound to Al			
OH-	8.91E-02	1.82E-01	4.29E-02	1.96E+00	9.94E-01	5.13E-02	1.81E-01	3.38E+00	2.13E+00	1.28E+00
NO3-	3.00E-01	2.60E-01	7.72E-01	4.68E-01	1.25E+00	1.57E-01	3.50E+00	3.50E+00	3.50E+00	3.50E+00
NO2-	4.78E-01	2.22E-02	1.17E-01	1.84E-01	8.60E-01	2.40E-02	1.85E-01	2.15E+00	1.79E+00	2.53E+00
CO3--	1.41E-01	3.75E-03	2.71E-01	2.43E-01	1.84E-01	1.97E-03	1.66E-01	2.33E-02	3.85E-01	5.27E-01
PO4---	2.24E-02	0.00E+00	1.00E-02	0.00E+00	6.46E-03	0.00E+00	7.06E-02	5.17E-04	6.30E-02	6.23E-02
SO4--	7.43E-02	1.71E-02	4.41E-02	1.03E-01	9.41E-02	4.00E-03	1.24E-01	5.26E-02	1.24E-01	1.24E-01
SiO3--	1.05E-02	1.05E-02	3.00E-03	1.05E-02	1.05E-02	0.00E+00	1.05E-02	1.05E-02	1.05E-02	1.05E-02
F-	4.43E-04	0.00E+00	0.00E+00	0.00E+00	1.64E-03	0.00E+00	1.94E-01	1.84E-04	1.26E-01	1.06E-01
Cl-	1.91E-02	1.27E-02	6.93E-02	6.27E-02	7.03E-02	3.18E-03	1.18E-01	1.90E-01	2.36E-01	2.12E-01
C6H5O7---	0.00E+00	1.00E-02	1.50E-02	0.00E+00	2.76E-02	0.00E+00	0.00E+00	1.62E-03	1.69E-02	3.66E-02
EDTA----	0.00E+00	0.00E+00	1.50E-01	0.00E+00	3.51E-03	0.00E+00	0.00E+00	1.74E-03	3.35E-02	2.85E-02
HEDTA---	0.00E+00	0.00E+00	3.01E-01	0.00E+00	7.07E-03	0.00E+00	0.00E+00	3.48E-03	6.67E-02	3.76E-02
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	3.01E-01	0.00E+00	7.03E-03	0.00E+00	0.00E+00	3.47E-03	6.67E-02	3.76E-02
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-05	1.08E-03	6.18E-02
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.39E-10	8.84E-06
DBP	0.00E+00	0.00E+00	0.00E+00	3.05E-05	1.48E-02	0.00E+00	2.35E-05	1.26E-03	1.35E-02	3.68E-02
butanol	0.00E+00	0.00E+00	0.00E+00	3.05E-05	1.48E-02	0.00E+00	2.35E-05	1.26E-03	1.35E-02	3.68E-02
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	1.77E-02	3.71E-05	6.55E-04	2.36E-03	2.46E-02	0.00E+00	9.32E-02	4.13E-02	1.19E-01	5.35E-02
Fe(CN)6----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Species (mol/L) (Sheet 5)

pred. su mol/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
Na	1.29E+01	1.31E+01	1.35E+01	1.28E+01	3.88E+00	2.27E+00	6.73E-01	5.25E-01
Al(OH)4 -	1.75E+00	1.75E+00	1.75E+00	1.51E+00	2.75E-01	1.76E-02	0.00E+00	0.00E+00
Fe	1.88E-03	1.87E-03	1.87E-03	1.88E-03	1.88E-03	1.87E-03	1.88E-03	1.88E-03
Cr	5.54E-02	5.54E-02	5.54E-02	5.54E-02	1.14E-02	1.94E-02	8.02E-03	0.00E+00
Bi	1.54E-04	2.22E-04	1.93E-04	1.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	9.62E-09	8.77E-09	6.78E-09	5.06E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	1.62E-06	1.62E-06	1.62E-06	1.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr	8.06E-05	1.19E-04	9.43E-05	2.11E-04	0.00E+00	0.00E+00	0.00E+00	2.95E-04
Pb	7.20E-04	7.20E-04	7.20E-04	5.75E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	0.00E+00
Sr	5.29E-07	5.31E-07	5.99E-07	5.23E-07	4.10E-07	4.09E-07	1.21E-08	2.82E-07
Mn	5.56E-04	5.55E-04	5.55E-04	5.56E-04	0.00E+00	0.00E+00	5.56E-04	0.00E+00
Ca	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
K	7.64E-02	8.27E-02	8.37E-02	1.79E-01	8.15E-03	4.75E-03	7.02E-03	2.25E-01
balance	9.87E-04	9.60E-04	1.18E-03	8.64E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
density	1.56E+00	1.58E+00	1.59E+00	1.54E+00	1.17E+00	1.11E+00	1.04E+00	1.03E+00
vol% solids	3.61E+01	2.80E+01	1.89E+01	2.09E+01	4.43E+00	7.61E+00	2.00E+00	1.05E+01
void frac.	8.28E-01	9.03E-01	8.34E-01	8.18E-01	7.28E-01	8.37E-01	8.50E-01	8.48E-01
wt.% H2O	4.42E+01	4.36E+01	4.15E+01	3.93E+01	7.78E+01	8.54E+01	9.54E+01	9.37E+01
TOC wt.%C	1.61E+00	1.62E+00	1.99E+00	3.50E+00	0.00E+00	0.00E+00	4.75E-02	0.00E+00
species				excludes hydroxide bound to Al				
OH-	3.23E+00	3.21E+00	2.97E+00	2.28E+00	7.12E-01	4.06E-01	2.23E-02	7.87E-02
NO3-	3.50E+00	3.50E+00	3.50E+00	3.50E+00	7.92E-01	1.03E+00	2.58E-01	3.87E-01
NO2-	2.43E+00	2.52E+00	2.72E+00	2.13E+00	1.83E+00	5.78E-01	1.01E-02	1.31E-02
CO3--	3.88E-01	4.35E-01	5.82E-01	6.26E-01	3.75E-03	3.75E-03	1.06E-01	3.75E-03
PO4---	4.78E-02	5.87E-02	6.31E-02	7.06E-02	0.00E+00	0.00E+00	6.97E-02	0.00E+00
SO4--	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.14E-01	1.25E-01	4.01E-03	0.00E+00
SiO3--	1.05E-02	1.05E-02	1.05E-02	1.03E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F-	6.62E-02	9.47E-02	9.45E-02	2.00E-01	5.24E-02	3.22E-02	0.00E+00	2.74E-01
Cl-	2.68E-01	2.91E-01	2.91E-01	2.79E-01	3.75E-02	2.19E-02	4.61E-03	4.67E-03
C6H5O7---	3.10E-02	3.02E-02	3.88E-02	3.54E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	5.04E-02	5.09E-02	6.24E-02	1.18E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	9.90E-02	1.00E-01	1.17E-01	2.32E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	9.90E-02	1.00E-01	1.17E-01	2.32E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	5.64E-03	4.75E-03	2.54E-02	1.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	4.81E-05	4.38E-05	3.39E-05	2.53E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	1.76E-02	1.84E-02	2.75E-02	2.31E-02	0.00E+00	0.00E+00	3.42E-03	0.00E+00
butanol	1.76E-02	1.84E-02	2.75E-02	2.31E-02	0.00E+00	0.00E+00	3.42E-03	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	8.59E-02	1.07E-01	9.21E-02	4.34E-01	6.45E-02	8.48E-03	2.12E-08	7.82E-01
Fe(CN)6----								

Predicted Supernatant Species (Ci/L) (Sheet 1)

pred. sn Ci/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3 (Ci/L)	1.16E-05	2.59E-05	2.91E-06	6.10E-06	8.35E-11	1.78E-09	1.73E-13	1.51E-11	6.13E-06	6.23E-06
C-14 (Ci/L)	3.09E-07	4.31E-07	9.53E-08	8.09E-08	5.78E-09	5.62E-09	3.87E-10	6.24E-10	2.37E-07	2.42E-07
Ni-59 (Ci/L)	8.31E-08	1.37E-07	1.92E-08	2.66E-08	1.51E-09	1.47E-09	1.01E-10	1.63E-10	6.20E-08	4.09E-09
Ni-63 (Ci/L)	7.08E-06	1.21E-05	2.81E-06	3.68E-06	1.29E-07	1.30E-07	8.64E-09	1.44E-08	5.42E-06	3.57E-07
Co-60 (Ci/L)	1.51E-07	4.82E-07	1.11E-07	3.18E-07	2.74E-09	5.16E-09	1.84E-10	5.72E-10	1.85E-07	1.88E-07
Se-79 (Ci/L)	1.42E-08	2.38E-08	2.03E-09	2.66E-09	2.58E-10	2.55E-10	1.73E-11	2.83E-11	1.07E-08	1.09E-08
Sr-90 (Ci/L)	2.48E-03	2.48E-03	2.72E-04	3.91E-04	5.48E-06	5.99E-06	6.22E-08	1.13E-07	2.48E-03	1.00E-03
Y-90 (Ci/L)	2.48E-03	2.48E-03	2.72E-04	3.91E-04	5.48E-06	5.99E-06	6.22E-08	1.13E-07	2.48E-03	1.00E-03
Zr-93 (Ci/L)	3.84E-09	6.37E-09	9.57E-07	1.23E-06	1.57E-07	1.53E-07	0.00E+00	0.00E+00	2.88E-09	2.93E-09
Nb-93m (Ci/L)	3.46E-09	5.59E-09	8.62E-07	1.09E-06	1.41E-07	1.34E-07	0.00E+00	0.00E+00	2.55E-09	2.59E-09
Tc-99 (Ci/L)	6.86E-06	1.15E-05	1.53E-07	2.02E-07	3.09E-09	3.05E-09	3.50E-11	5.73E-11	3.73E-06	3.80E-06
Ru-106 (Ci/L)	1.50E-19	1.01E-17	4.32E-17	1.32E-15	4.92E-18	1.95E-16	8.24E-19	5.40E-17	3.17E-18	3.23E-18
Cd-113m (Ci/L)	3.34E-07	7.85E-07	8.52E-08	1.61E-07	6.07E-09	8.41E-09	4.07E-10	9.33E-10	3.22E-07	3.27E-07
Sb-125 (Ci/L)	4.37E-09	2.75E-08	1.36E-09	4.64E-09	7.95E-11	2.95E-10	5.33E-12	3.27E-11	9.56E-09	9.73E-09
Sn-126 (Ci/L)	5.12E-08	9.17E-08	7.34E-09	1.04E-08	9.32E-10	9.82E-10	6.24E-11	1.09E-10	4.04E-08	4.12E-08
I-129 (Ci/L)	3.04E-09	1.31E-08	7.55E-11	1.77E-09	1.37E-12	0.00E+00	1.55E-14	0.00E+00	4.79E-09	4.87E-09
Cs-134 (Ci/L)	1.88E-11	3.14E-10	4.20E-13	5.42E-12	8.45E-15	8.31E-14	9.60E-17	1.56E-15	1.02E-10	8.33E-14
Cs-137 (Ci/L)	1.40E-02	2.64E-02	3.12E-04	4.58E-04	6.29E-06	6.98E-06	7.14E-08	1.31E-07	1.15E-02	9.37E-06
Ba-137m (Ci/L)	1.32E-02	2.49E-02	2.95E-04	4.32E-04	5.94E-06	6.59E-06	6.74E-08	1.24E-07	1.08E-02	8.85E-06
Sm-151 (Ci/L)	5.37E-04	8.75E-04	1.70E-04	2.12E-04	5.43E-05	5.21E-05	1.21E-05	1.93E-05	3.97E-04	4.04E-04
Eu-152 (Ci/L)	6.65E-09	4.18E-08	2.11E-09	1.16E-08	6.72E-10	2.49E-09	1.50E-10	9.19E-10	1.45E-08	1.48E-08
Eu-154 (Ci/L)	6.44E-07	3.07E-06	2.04E-07	8.12E-07	6.51E-08	1.83E-07	1.45E-08	6.75E-08	1.10E-06	1.12E-06
Eu-155 (Ci/L)	5.22E-07	1.69E-06	1.66E-07	3.69E-07	5.28E-08	1.00E-07	1.18E-08	3.71E-08	6.46E-07	6.57E-07
Ra-226 (Ci/L)	6.20E-11	6.20E-11	1.49E-11	8.76E-12	1.90E-12	9.19E-13	1.27E-13	1.02E-13	5.11E-11	5.20E-11
Ra-228 (Ci/L)	2.08E-16	3.66E-16	5.00E-17	5.69E-17	6.36E-18	5.42E-18	4.26E-19	6.02E-19	2.39E-16	2.43E-16
Ac-227 (Ci/L)	3.60E-10	3.60E-10	4.46E-11	2.65E-11	1.62E-11	8.02E-12	5.41E-12	4.44E-12	2.48E-10	2.52E-10
Pa-231 (Ci/L)	4.15E-12	3.73E-12	9.27E-10	5.80E-10	3.40E-10	1.80E-10	1.14E-10	9.97E-11	2.13E-12	2.17E-12
Th-229 (Ci/L)	1.67E-14	2.42E-14	3.44E-14	3.94E-14	1.26E-14	1.08E-14	4.22E-15	5.97E-15	1.14E-14	1.16E-14
Th-232 (Ci/L)	1.40E-16	2.06E-16	2.88E-16	3.33E-16	1.05E-16	9.16E-17	3.53E-17	5.08E-17	9.67E-17	9.84E-17
U-232 (Ci/L)	2.73E-12	4.74E-12	9.18E-14	1.84E-13	2.34E-14	2.46E-14	5.83E-17	1.01E-16	1.27E-13	1.27E-13
U-233 (Ci/L)	2.41E-13	3.72E-13	8.13E-15	1.39E-14	2.07E-15	1.93E-15	5.17E-18	7.96E-18	1.03E-14	1.03E-14
U-234 (Ci/L)	3.12E-07	3.11E-07	1.02E-08	1.01E-08	2.68E-09	1.61E-09	6.68E-12	6.65E-12	1.02E-08	1.02E-08
U-235 (Ci/L)	1.41E-08	1.38E-08	4.59E-10	4.46E-10	1.21E-10	7.13E-11	3.01E-13	2.95E-13	4.53E-10	4.53E-10
U-236 (Ci/L)	2.67E-09	4.23E-09	8.69E-11	1.50E-10	2.29E-11	2.19E-11	5.70E-14	9.04E-14	1.16E-10	1.16E-10
U-238 (Ci/L)	3.17E-07	3.18E-07	1.03E-08	1.03E-08	2.72E-09	1.64E-09	6.79E-12	6.79E-12	1.03E-08	1.03E-08
U-Total (M)	4.00E-03	4.00E-03	1.30E-04	1.30E-04	3.43E-05	2.07E-05	8.55E-08	8.55E-08	1.30E-04	1.30E-04
Np-237 (Ci/L)	3.87E-08	6.62E-08	3.47E-09	4.65E-09	1.25E-09	1.26E-09	4.20E-10	7.00E-10	2.96E-08	3.01E-08
Pu-238 (Ci/L)	1.39E-08	4.61E-08	1.83E-08	5.27E-08	1.83E-08	4.61E-08	1.61E-08	4.61E-08	2.11E-08	2.15E-08
Pu-239 (Ci/L)	4.03E-06	5.20E-06	5.28E-06	5.18E-06	5.28E-06	5.20E-06	4.65E-06	5.20E-06	2.96E-06	3.01E-06
Pu-240 (Ci/L)	2.72E-07	6.59E-07	3.56E-07	7.34E-07	3.56E-07	6.59E-07	3.14E-07	6.59E-07	3.19E-07	3.25E-07
Pu-241 (Ci/L)	2.63E-07	1.45E-06	3.45E-07	1.69E-06	3.45E-07	1.45E-06	3.04E-07	1.45E-06	6.23E-07	6.34E-07
Pu-242 (Ci/L)	1.23E-12	1.05E-11	1.61E-12	1.28E-11	1.61E-12	1.05E-11	1.42E-12	1.05E-11	4.37E-12	4.45E-12
Pu-Total (g/L)	6.61E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	7.63E-05	8.67E-05	4.91E-05	5.00E-05
Am-241 (Ci/L)	8.39E-07	4.64E-06	1.04E-07	5.20E-07	2.72E-08	8.85E-08	9.10E-09	4.90E-08	1.64E-06	1.67E-06
Am-243 (Ci/L)	3.63E-11	7.18E-10	3.25E-12	5.98E-11	1.18E-12	1.37E-11	3.93E-13	7.59E-12	2.31E-10	2.35E-10
Cm-242 (Ci/L)	6.36E-11	1.24E-09	5.70E-12	1.03E-10	2.06E-12	2.36E-11	6.89E-13	1.31E-11	3.98E-10	4.05E-10
Cm-243 (Ci/L)	3.76E-13	1.49E-11	3.37E-14	1.25E-12	1.22E-14	2.85E-13	4.07E-15	1.58E-13	4.72E-12	4.80E-12
Cm-244 (Ci/L)	8.81E-12	3.51E-10	7.90E-13	2.94E-11	2.85E-13	6.69E-12	9.55E-14	3.71E-12	1.11E-10	1.13E-10

Predicted Supernatant Species (Ci/L) (Sheet 2)

pred. su Ci/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3 (Ci/L)	6.24E-06	6.29E-06	2.44E-07	2.76E-05	1.56E-04	1.54E-04	2.80E-04	3.89E-06	1.18E-05	2.10E-06
C-14 (Ci/L)	2.42E-07	2.19E-07	2.76E-07	1.51E-06	9.74E-07	1.69E-06	1.90E-06	2.44E-06	2.98E-06	2.02E-08
Ni-59 (Ci/L)	1.05E-08	7.46E-09	1.15E-09	1.77E-07	4.28E-07	2.04E-06	1.39E-05	6.12E-07	1.34E-06	1.91E-09
Ni-63 (Ci/L)	9.15E-07	6.96E-07	1.04E-07	1.60E-05	4.05E-05	1.99E-04	1.33E-03	5.70E-05	1.29E-04	1.84E-07
Co-60 (Ci/L)	1.88E-07	3.01E-07	6.34E-08	2.04E-06	1.35E-05	9.37E-06	2.40E-05	1.23E-05	2.40E-05	1.36E-07
Se-79 (Ci/L)	1.09E-08	8.72E-09	2.22E-09	6.98E-08	2.10E-07	7.15E-10	1.01E-09	2.39E-07	5.43E-07	8.48E-10
Sr-90 (Ci/L)	1.99E-04	1.82E-04	2.91E-05	2.48E-03	2.48E-03	6.61E-04	1.12E-03	2.48E-03	2.48E-03	1.04E-03
Y-90 (Ci/L)	1.99E-04	1.82E-04	2.91E-05	2.48E-03	2.48E-03	6.61E-04	1.12E-03	2.48E-03	2.48E-03	1.04E-03
Zr-93 (Ci/L)	2.93E-09	2.89E-07	8.89E-08	4.18E-06	1.26E-05	4.28E-08	6.06E-08	1.43E-05	3.23E-05	5.03E-08
Nb-93m (Ci/L)	2.59E-09	2.57E-07	7.66E-08	3.59E-06	1.01E-05	3.66E-08	4.86E-08	1.18E-05	2.55E-05	3.77E-08
Tc-99 (Ci/L)	3.80E-06	2.90E-06	1.59E-07	2.65E-05	7.88E-05	3.11E-07	4.35E-07	7.50E-05	1.70E-04	3.60E-07
Ru-106 (Ci/L)	3.23E-18	2.33E-16	5.77E-15	5.57E-14	3.74E-11	1.27E-15	1.81E-13	3.76E-12	5.11E-11	5.55E-12
Cd-113m (Ci/L)	3.28E-07	2.92E-07	7.58E-08	2.87E-06	1.25E-05	1.97E-06	3.42E-06	1.26E-05	3.73E-05	7.46E-08
Sb-125 (Ci/L)	9.73E-09	7.89E-09	4.41E-09	1.78E-07	3.30E-06	1.94E-08	2.33E-08	1.86E-06	8.74E-06	6.60E-08
Sn-126 (Ci/L)	4.12E-08	3.29E-08	8.00E-09	2.83E-07	8.51E-07	2.89E-09	4.05E-09	9.89E-07	2.26E-06	3.65E-09
I-129 (Ci/L)	4.87E-09	6.36E-09	1.53E-09	4.24E-08	1.22E-07	4.39E-10	6.12E-10	4.47E-09	1.02E-08	0.00E+00
Cs-134 (Ci/L)	8.33E-14	8.27E-14	3.05E-15	3.96E-09	2.80E-07	6.09E-11	1.20E-09	7.06E-08	1.01E-06	9.36E-09
Cs-137 (Ci/L)	9.38E-06	9.38E-06	2.47E-07	7.50E-02	2.69E-01	7.79E-04	1.30E-03	2.84E-01	7.27E-01	1.23E-03
Ba-137m (Ci/L)	8.85E-06	8.86E-06	2.33E-07	7.08E-02	2.54E-01	7.36E-04	1.23E-03	2.68E-01	6.86E-01	1.16E-03
Sm-151 (Ci/L)	4.04E-04	3.53E-04	1.97E-04	2.93E-03	2.67E-03	3.00E-05	4.24E-05	7.35E-03	4.42E-03	3.30E-05
Eu-152 (Ci/L)	1.48E-08	1.25E-08	3.29E-09	2.97E-07	7.28E-07	3.36E-09	1.02E-08	1.10E-06	1.02E-06	2.12E-08
Eu-154 (Ci/L)	1.12E-06	9.53E-07	4.11E-07	2.01E-05	4.83E-05	2.24E-07	6.81E-07	8.16E-05	8.16E-05	1.52E-06
Eu-155 (Ci/L)	6.57E-07	5.58E-07	5.44E-07	8.25E-06	2.02E-05	9.29E-08	3.41E-07	3.73E-05	4.52E-05	5.59E-07
Ra-226 (Ci/L)	5.20E-11	4.19E-11	1.13E-11	4.01E-12	1.29E-11	1.25E-12	1.19E-12	9.43E-12	2.40E-11	7.30E-14
Ra-228 (Ci/L)	2.43E-16	1.94E-16	4.54E-17	2.25E-17	1.11E-16	1.15E-17	1.72E-17	5.80E-17	1.96E-16	7.38E-11
Ac-227 (Ci/L)	2.52E-10	1.98E-10	3.58E-11	1.72E-11	5.35E-11	5.94E-12	5.40E-12	4.20E-11	1.11E-10	1.95E-10
Pa-231 (Ci/L)	2.17E-12	2.17E-10	8.25E-10	2.55E-11	7.81E-11	1.26E-11	1.28E-11	5.98E-11	1.69E-10	3.03E-10
Th-229 (Ci/L)	1.16E-14	1.87E-14	3.03E-14	8.46E-14	7.00E-14	1.72E-15	1.80E-15	1.57E-13	1.45E-13	4.57E-11
Th-232 (Ci/L)	9.84E-17	1.58E-16	2.71E-16	2.42E-17	1.14E-16	1.41E-17	2.20E-17	5.98E-17	2.04E-16	5.85E-11
U-232 (Ci/L)	1.27E-13	1.24E-13	1.01E-13	4.11E-13	1.13E-12	4.01E-13	7.54E-13	6.91E-13	8.26E-13	3.56E-09
U-233 (Ci/L)	1.03E-14	9.99E-15	7.55E-15	2.02E-12	3.20E-12	2.05E-14	2.56E-14	4.86E-12	1.50E-12	2.11E-07
U-234 (Ci/L)	1.02E-08	9.90E-09	1.02E-08	1.01E-08	1.48E-08	1.06E-08	1.48E-08	1.01E-08	1.06E-08	1.54E-08
U-235 (Ci/L)	4.53E-10	4.42E-10	4.58E-10	4.35E-10	5.60E-10	4.51E-10	5.62E-10	4.32E-10	4.42E-10	5.91E-10
U-236 (Ci/L)	1.16E-10	1.11E-10	9.14E-11	2.09E-10	4.27E-10	2.17E-10	4.17E-10	2.23E-10	2.72E-10	6.73E-10
U-238 (Ci/L)	1.04E-08	1.01E-08	1.03E-08	1.03E-08	1.03E-08	1.04E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08
U-Total (M)	1.30E-04	1.27E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237 (Ci/L)	3.02E-08	2.35E-08	3.76E-09	1.93E-07	1.94E-07	2.07E-09	2.83E-09	4.10E-07	4.57E-07	7.61E-10
Pu-238 (Ci/L)	2.15E-08	2.59E-08	1.91E-08	9.69E-08	3.45E-07	8.13E-08	1.29E-07	1.26E-07	2.42E-07	5.52E-07
Pu-239 (Ci/L)	3.01E-06	3.45E-06	5.28E-06	5.10E-06	5.05E-06	5.11E-06	5.07E-06	5.10E-06	5.03E-06	4.89E-06
Pu-240 (Ci/L)	3.25E-07	3.85E-07	3.59E-07	9.91E-07	1.18E-06	9.71E-07	1.11E-06	1.02E-06	1.23E-06	1.71E-06
Pu-241 (Ci/L)	6.34E-07	7.86E-07	4.63E-07	3.45E-06	8.95E-06	3.57E-06	7.20E-06	4.49E-06	1.10E-05	3.23E-05
Pu-242 (Ci/L)	4.45E-12	5.58E-12	1.32E-12	3.01E-11	6.81E-11	2.88E-11	4.73E-11	3.20E-11	8.93E-11	2.92E-10
Pu-Total (g/L)	5.00E-05	5.73E-05	8.67E-05	8.66E-05	8.66E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05
Am-241 (Ci/L)	1.67E-06	1.36E-06	9.80E-08	6.73E-06	6.73E-06	6.42E-06	6.73E-06	6.73E-06	6.73E-06	1.35E-06
Am-243 (Ci/L)	2.35E-10	1.80E-10	2.40E-12	2.46E-09	5.82E-09	6.98E-11	1.25E-10	3.09E-09	3.59E-09	1.29E-09
Cm-242 (Ci/L)	4.05E-10	3.09E-10	4.40E-12	1.09E-08	1.12E-08	1.20E-10	3.35E-10	3.70E-08	1.37E-08	2.15E-09
Cm-243 (Ci/L)	4.80E-12	3.67E-12	2.00E-14	1.95E-10	8.71E-10	2.20E-12	1.21E-11	7.25E-10	8.19E-10	2.32E-10
Cm-244 (Ci/L)	1.13E-10	8.62E-11	5.61E-13	4.81E-09	1.92E-08	5.37E-11	3.28E-10	1.92E-08	1.92E-08	5.68E-09

Predicted Supernatant Species (Ci/L) (Sheet 3)

pred. su Ci/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3 (Ci/L)	1.67E-04	1.68E-04	1.63E-04	2.99E-07	1.32E-07	6.88E-08	0.00E+00	3.27E-07	2.71E-07	8.48E-07
C-14 (Ci/L)	1.57E-06	1.07E-06	3.52E-06	4.19E-07	7.40E-08	5.09E-08	0.00E+00	1.42E-07	1.13E-10	1.17E-10
Ni-59 (Ci/L)	6.19E-06	7.85E-06	1.77E-07	1.31E-09	4.19E-10	6.32E-11	0.00E+00	2.92E-06	2.20E-09	2.27E-09
Ni-63 (Ci/L)	5.79E-04	7.57E-04	1.53E-05	1.21E-07	4.03E-08	6.09E-09	0.00E+00	2.75E-04	1.87E-07	1.98E-07
Co-60 (Ci/L)	1.23E-05	2.07E-05	6.92E-06	2.62E-08	1.66E-08	4.45E-09	0.00E+00	2.07E-05	8.30E-09	1.29E-08
Se-79 (Ci/L)	6.52E-10	4.84E-10	4.58E-09	5.08E-10	1.67E-10	2.78E-11	0.00E+00	1.75E-08	1.93E-08	1.99E-08
Sr-90 (Ci/L)	6.37E-04	5.39E-04	2.48E-03	5.09E-04	1.89E-04	3.41E-05	0.00E+00	9.77E-02	2.48E-03	2.48E-03
Y-90 (Ci/L)	6.37E-04	5.39E-04	2.48E-03	5.09E-04	1.89E-04	3.42E-05	0.00E+00	9.77E-02	2.48E-03	2.48E-03
Zr-93 (Ci/L)	3.89E-08	2.79E-08	1.25E-09	3.03E-08	9.95E-09	1.65E-09	0.00E+00	1.04E-06	5.14E-07	5.31E-07
Nb-93m (Ci/L)	3.26E-08	2.19E-08	9.67E-10	2.52E-08	7.85E-09	1.24E-09	0.00E+00	8.46E-07	4.03E-07	3.99E-07
Tc-99 (Ci/L)	2.84E-07	2.01E-07	1.04E-05	2.21E-07	7.26E-08	1.18E-08	0.00E+00	5.48E-06	2.18E-06	2.25E-06
Ru-106 (Ci/L)	3.86E-15	7.09E-13	1.96E-11	7.98E-15	7.65E-14	1.82E-13	0.00E+00	4.06E-11	5.74E-13	5.79E-12
Cd-113m (Ci/L)	2.10E-06	2.02E-06	4.46E-07	2.68E-08	1.15E-08	2.44E-09	0.00E+00	1.05E-06	1.02E-06	1.22E-06
Sb-125 (Ci/L)	4.57E-09	2.11E-08	6.14E-07	3.96E-09	4.72E-09	2.16E-09	0.00E+00	4.57E-06	4.56E-07	1.05E-06
Sn-126 (Ci/L)	2.68E-09	2.00E-09	2.17E-08	2.10E-09	6.98E-10	1.20E-10	0.00E+00	7.26E-08	6.33E-08	6.53E-08
I-129 (Ci/L)	2.80E-07	1.75E-07	1.61E-08	1.47E-07	4.87E-08	4.55E-08	0.00E+00	3.27E-10	2.06E-10	2.12E-10
Cs-134 (Ci/L)	1.23E-10	1.36E-09	5.02E-07	1.50E-10	3.10E-10	3.07E-10	0.00E+00	1.74E-08	1.39E-08	4.22E-08
Cs-137 (Ci/L)	7.55E-04	6.31E-04	3.54E-02	6.04E-04	2.24E-04	4.02E-05	0.00E+00	2.20E-02	1.04E-02	1.15E-02
Ba-137m (Ci/L)	7.13E-04	5.96E-04	3.35E-02	5.70E-04	2.11E-04	3.79E-05	0.00E+00	2.07E-02	9.82E-03	1.09E-02
Sm-151 (Ci/L)	2.75E-05	1.99E-05	1.35E-04	2.15E-05	7.21E-06	1.08E-06	0.00E+00	1.97E-02	2.19E-04	2.32E-04
Eu-152 (Ci/L)	3.77E-09	5.14E-09	1.96E-07	3.21E-09	1.66E-09	6.94E-10	0.00E+00	3.97E-06	6.21E-08	7.51E-08
Eu-154 (Ci/L)	2.73E-07	3.95E-07	1.33E-05	2.39E-07	1.33E-07	4.99E-08	0.00E+00	3.12E-04	2.47E-06	3.28E-06
Eu-155 (Ci/L)	1.19E-07	2.18E-07	1.73E-06	1.09E-07	7.37E-08	1.83E-08	0.00E+00	1.65E-04	8.83E-07	1.44E-06
Ra-226 (Ci/L)	8.58E-13	2.31E-12	1.41E-12	2.00E-14	8.28E-15	2.39E-15	0.00E+00	7.26E-13	6.20E-11	6.20E-11
Ra-228 (Ci/L)	9.18E-18	1.78E-08	5.58E-17	1.23E-19	3.96E-12	2.42E-12	0.00E+00	5.17E-18	2.72E-07	1.89E-07
Ac-227 (Ci/L)	4.18E-12	3.60E-10	8.47E-12	8.93E-14	1.30E-11	6.40E-12	0.00E+00	3.29E-12	3.60E-10	3.60E-10
Pa-231 (Ci/L)	9.20E-12	1.81E-09	2.18E-11	1.27E-13	1.92E-11	9.93E-12	0.00E+00	4.86E-12	1.32E-06	1.36E-06
Th-229 (Ci/L)	1.44E-15	4.89E-11	6.29E-15	3.33E-16	3.37E-12	1.50E-12	0.00E+00	8.42E-15	2.03E-10	1.74E-10
Th-232 (Ci/L)	1.14E-17	2.23E-10	7.45E-17	1.27E-19	3.71E-12	1.92E-12	0.00E+00	5.35E-18	2.23E-10	2.23E-10
U-232 (Ci/L)	4.74E-13	1.39E-09	3.62E-12	6.91E-13	1.09E-09	3.56E-09	0.00E+00	7.58E-13	7.64E-08	8.13E-08
U-233 (Ci/L)	2.24E-14	8.30E-08	5.49E-14	4.86E-12	6.94E-08	2.11E-07	0.00E+00	3.20E-12	4.87E-06	4.82E-06
U-234 (Ci/L)	1.01E-08	1.15E-08	1.47E-08	1.01E-08	1.11E-08	1.54E-08	0.00E+00	1.03E-08	3.69E-08	3.81E-08
U-235 (Ci/L)	4.30E-10	4.48E-10	6.82E-10	4.32E-10	4.42E-10	5.91E-10	0.00E+00	4.37E-10	1.31E-13	1.35E-13
U-236 (Ci/L)	2.30E-10	2.83E-10	1.03E-09	2.23E-10	2.72E-10	6.73E-10	0.00E+00	2.47E-10	2.28E-14	2.36E-14
U-238 (Ci/L)	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	0.00E+00	1.03E-08	2.04E-21	2.11E-21
U-Total (M)	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	0.00E+00	1.30E-04	2.19E-06	2.17E-06
Np-237 (Ci/L)	1.91E-09	1.34E-09	7.58E-09	8.71E-10	1.41E-10	2.49E-11	0.00E+00	2.31E-08	2.42E-13	2.50E-13
Pu-238 (Ci/L)	8.97E-08	1.22E-07	4.92E-07	1.26E-07	2.42E-07	5.52E-07	3.22E-07	1.95E-07	4.12E-11	4.36E-11
Pu-239 (Ci/L)	5.09E-06	5.05E-06	4.84E-06	5.10E-06	5.03E-06	4.89E-06	5.04E-06	5.97E-06	2.09E-15	2.16E-15
Pu-240 (Ci/L)	1.06E-06	1.19E-06	1.87E-06	1.02E-06	1.23E-06	1.71E-06	1.26E-06	1.29E-06	1.44E-16	1.48E-16
Pu-241 (Ci/L)	4.60E-06	8.61E-06	3.82E-05	4.49E-06	1.10E-05	3.23E-05	2.03E-05	7.88E-06	5.54E-16	6.63E-16
Pu-242 (Ci/L)	3.30E-11	6.05E-11	3.61E-10	3.20E-11	8.93E-11	2.92E-10	1.25E-10	6.06E-11	1.18E-21	1.21E-21
Pu-Total (g/L)	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	1.02E-04	2.44E-12	2.58E-12
Am-241 (Ci/L)	6.58E-06	5.56E-06	6.73E-06	1.29E-07	7.35E-08	4.41E-08	6.73E-06	2.84E-04	8.00E-17	8.00E-17
Am-243 (Ci/L)	7.32E-11	1.48E-10	7.02E-10	5.91E-11	3.91E-11	4.22E-11	0.00E+00	1.42E-07	2.85E-22	2.94E-22
Cm-242 (Ci/L)	1.24E-10	2.32E-10	3.18E-09	1.01E-10	6.81E-11	7.04E-11	0.00E+00	1.52E-08	5.38E-22	1.62E-22
Cm-243 (Ci/L)	2.32E-12	1.21E-11	8.95E-10	1.97E-12	4.09E-12	7.60E-12	0.00E+00	8.13E-10	1.08E-23	1.20E-23
Cm-244 (Ci/L)	6.06E-11	3.74E-10	1.92E-08	5.22E-11	9.58E-11	1.86E-10	0.00E+00	1.92E-08	2.35E-22	2.73E-22

Predicted Supernatant Species (Ci/L) (Sheet 4)

pred. su Ci/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3 (Ci/L)	1.06E-05	1.64E-05	1.68E-06	7.64E-06	1.97E-05	0.00E+00	4.85E-06	7.41E-05	3.74E-05	7.73E-05
C-14 (Ci/L)	1.93E-06	1.03E-06	1.22E-07	6.95E-07	3.78E-06	0.00E+00	2.84E-07	2.89E-06	4.92E-06	9.09E-06
Ni-59 (Ci/L)	5.51E-07	1.09E-06	5.21E-07	5.71E-06	7.02E-07	0.00E+00	4.33E-08	5.75E-07	1.24E-06	3.96E-06
Ni-63 (Ci/L)	5.21E-05	1.05E-04	4.94E-05	5.39E-04	6.67E-05	0.00E+00	4.46E-06	5.45E-05	1.19E-04	3.80E-04
Co-60 (Ci/L)	1.86E-05	2.40E-05	6.69E-06	2.40E-05	2.40E-05	0.00E+00	3.27E-07	1.60E-05	2.40E-05	2.40E-05
Se-79 (Ci/L)	2.31E-07	2.39E-07	2.63E-08	1.34E-07	4.50E-07	0.00E+00	1.09E-08	2.70E-07	4.38E-07	6.22E-07
Sr-90 (Ci/L)	2.48E-03	2.48E-03	7.37E-02	2.48E-03	2.48E-03	0.00E+00	2.28E-03	2.48E-03	2.48E-03	2.48E-03
Y-90 (Ci/L)	2.48E-03	2.48E-03	7.37E-02	2.48E-03	2.48E-03	0.00E+00	2.28E-03	2.48E-03	2.48E-03	2.48E-03
Zr-93 (Ci/L)	1.38E-05	1.42E-05	1.56E-06	7.97E-06	2.68E-05	0.00E+00	1.01E-06	1.62E-05	2.62E-05	3.68E-05
Nb-93m (Ci/L)	1.11E-05	1.06E-05	1.18E-06	6.09E-06	2.17E-05	0.00E+00	9.00E-07	1.33E-05	2.12E-05	2.96E-05
Tc-99 (Ci/L)	7.24E-05	7.31E-05	8.06E-06	4.13E-05	1.44E-04	0.00E+00	3.28E-06	1.00E-04	1.45E-04	1.97E-04
Ru-106 (Ci/L)	5.11E-11	5.11E-11	4.06E-11	5.11E-11	4.05E-11	0.00E+00	7.11E-16	3.22E-11	5.11E-11	3.37E-14
Cd-113m (Ci/L)	1.41E-05	2.10E-05	2.25E-06	1.09E-05	2.80E-05	0.00E+00	3.68E-07	1.50E-05	2.79E-05	4.60E-05
Sb-125 (Ci/L)	4.24E-06	8.74E-06	2.49E-06	8.74E-06	6.63E-06	0.00E+00	1.01E-08	3.19E-06	6.92E-06	2.82E-07
Sn-126 (Ci/L)	9.59E-07	1.03E-06	1.13E-07	5.72E-07	1.87E-06	0.00E+00	4.10E-08	1.10E-06	1.81E-06	2.58E-06
I-129 (Ci/L)	3.84E-08	4.50E-09	4.95E-10	2.52E-09	8.48E-08	0.00E+00	4.55E-09	1.55E-07	1.58E-07	2.80E-07
Cs-134 (Ci/L)	2.43E-07	1.59E-07	0.00E+00	1.17E-06	1.22E-08	0.00E+00	8.05E-11	2.26E-07	3.23E-07	1.89E-07
Cs-137 (Ci/L)	2.91E-01	2.08E-02	0.00E+00	1.88E-01	1.50E-02	0.00E+00	9.56E-03	2.99E-01	2.66E-01	1.64E-01
Ba-137m (Ci/L)	2.75E-01	1.96E-02	0.00E+00	1.78E-01	1.42E-02	0.00E+00	9.03E-03	2.82E-01	2.51E-01	1.55E-01
Sm-151 (Ci/L)	5.61E-03	1.77E-03	3.64E-03	4.30E-03	5.91E-03	0.00E+00	5.02E-04	4.23E-03	5.95E-03	7.28E-04
Eu-152 (Ci/L)	1.05E-06	1.14E-06	1.14E-06	1.06E-06	1.10E-06	0.00E+00	1.70E-08	7.17E-07	1.11E-06	1.43E-07
Eu-154 (Ci/L)	8.16E-05	8.16E-05	8.59E-05	8.16E-05	8.16E-05	0.00E+00	1.30E-06	4.83E-05	8.16E-05	1.08E-05
Eu-155 (Ci/L)	4.20E-05	3.00E-05	3.85E-05	3.99E-05	3.77E-05	0.00E+00	7.62E-07	2.02E-05	3.73E-05	5.18E-06
Ra-226 (Ci/L)	9.97E-12	1.38E-11	1.48E-12	7.24E-12	2.10E-11	0.00E+00	5.32E-11	1.61E-11	5.92E-11	6.20E-11
Ra-228 (Ci/L)	5.88E-10	1.90E-16	1.97E-17	9.12E-17	9.77E-10	0.00E+00	2.41E-16	6.37E-10	7.03E-09	7.49E-08
Ac-227 (Ci/L)	6.57E-11	6.67E-11	7.13E-12	3.46E-11	1.24E-10	0.00E+00	2.39E-10	7.85E-11	3.60E-10	3.60E-10
Pa-231 (Ci/L)	1.38E-10	1.09E-10	1.15E-11	5.55E-11	3.36E-10	0.00E+00	7.41E-10	1.21E-09	1.95E-08	2.36E-07
Th-229 (Ci/L)	3.89E-12	6.51E-14	7.67E-15	4.31E-14	5.42E-12	0.00E+00	4.36E-14	1.83E-12	1.69E-11	5.84E-11
Th-232 (Ci/L)	9.93E-12	2.00E-16	2.07E-17	9.57E-17	1.51E-11	0.00E+00	3.67E-16	6.53E-12	6.11E-11	2.23E-10
U-232 (Ci/L)	6.53E-11	3.92E-12	1.39E-12	1.00E-12	2.60E-10	0.00E+00	1.36E-13	9.54E-11	5.78E-10	3.19E-09
U-233 (Ci/L)	4.00E-09	1.43E-12	2.85E-12	3.06E-12	1.61E-08	0.00E+00	1.09E-14	5.64E-09	3.45E-08	1.93E-07
U-234 (Ci/L)	1.04E-08	1.37E-08	1.10E-08	1.06E-08	1.10E-08	0.00E+00	1.01E-08	1.20E-08	1.14E-08	1.26E-08
U-235 (Ci/L)	4.38E-10	5.91E-10	4.68E-10	4.49E-10	4.61E-10	0.00E+00	4.52E-10	4.86E-10	4.72E-10	4.69E-10
U-236 (Ci/L)	2.50E-10	6.73E-10	3.32E-10	2.80E-10	2.99E-10	0.00E+00	1.19E-10	3.01E-10	2.65E-10	3.21E-10
U-238 (Ci/L)	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	0.00E+00	1.03E-08	1.03E-08	1.03E-08	1.03E-08
U-Total (M)	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	0.00E+00	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237 (Ci/L)	2.98E-07	2.15E-07	2.47E-08	1.34E-07	4.69E-07	0.00E+00	2.80E-08	4.00E-07	4.69E-07	4.69E-07
Pu-238 (Ci/L)	1.70E-07	5.52E-07	3.31E-07	2.14E-07	2.16E-07	0.00E+00	3.97E-08	1.98E-07	1.84E-07	1.99E-07
Pu-239 (Ci/L)	5.07E-06	4.89E-06	5.90E-06	5.05E-06	5.05E-06	0.00E+00	5.22E-06	5.08E-06	5.08E-06	5.04E-06
Pu-240 (Ci/L)	1.10E-06	1.71E-06	1.51E-06	1.17E-06	1.17E-06	0.00E+00	5.91E-07	1.08E-06	1.07E-06	1.21E-06
Pu-241 (Ci/L)	6.99E-06	3.23E-05	1.69E-05	9.92E-06	9.75E-06	0.00E+00	1.19E-06	6.15E-06	8.75E-06	1.14E-05
Pu-242 (Ci/L)	5.41E-11	2.92E-10	1.45E-10	8.16E-11	8.02E-11	0.00E+00	8.57E-12	4.96E-11	7.03E-11	9.23E-11
Pu-Total (g/L)	8.67E-05	8.67E-05	1.02E-04	8.67E-05	8.67E-05	0.00E+00	8.67E-05	8.66E-05	8.67E-05	8.67E-05
Am-241 (Ci/L)	6.73E-06	6.73E-06	7.71E-05	6.73E-06	6.73E-06	0.00E+00	1.55E-06	6.73E-06	6.73E-06	6.73E-06
Am-243 (Ci/L)	3.35E-09	6.43E-09	5.59E-08	4.12E-09	3.79E-09	0.00E+00	2.04E-10	3.70E-09	3.66E-09	2.69E-09
Cm-242 (Ci/L)	1.75E-08	7.26E-09	8.46E-09	1.00E-08	2.53E-08	0.00E+00	3.52E-10	2.00E-08	2.08E-08	2.21E-08
Cm-243 (Ci/L)	8.03E-10	7.84E-10	7.88E-10	7.94E-10	7.70E-10	0.00E+00	4.15E-12	8.42E-10	7.94E-10	7.72E-10
Cm-244 (Ci/L)	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	0.00E+00	9.74E-11	1.92E-08	1.92E-08	1.92E-08

Predicted Supernatant Species (Ci/L) (Sheet 5)

pred. su Ci/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (Ci/L)	2.83E-05	2.90E-05	3.04E-05	2.46E-05	5.85E-04	3.65E-04	1.06E-06	1.59E-04
C-14 (Ci/L)	6.67E-06	6.93E-06	8.58E-06	6.52E-06	1.82E-06	1.01E-06	7.05E-09	1.92E-06
Ni-59 (Ci/L)	6.78E-07	8.36E-07	1.57E-06	3.10E-07	1.93E-06	6.39E-07	1.24E-10	3.95E-08
Ni-63 (Ci/L)	6.46E-05	7.98E-05	1.50E-04	2.95E-05	1.86E-04	6.24E-05	1.20E-08	3.79E-06
Co-60 (Ci/L)	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	6.26E-08	1.28E-05
Se-79 (Ci/L)	6.31E-07	6.45E-07	7.67E-07	5.70E-07	8.98E-07	5.15E-07	4.36E-11	1.01E-09
Sr-90 (Ci/L)	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	7.34E-05	1.70E-03
Y-90 (Ci/L)	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	7.34E-05	1.71E-03
Zr-93 (Ci/L)	3.76E-05	3.85E-05	4.57E-05	3.39E-05	5.43E-05	3.13E-05	2.64E-09	2.79E-10
Nb-93m (Ci/L)	3.05E-05	3.13E-05	3.69E-05	2.73E-05	3.06E-05	1.65E-05	1.45E-09	1.54E-10
Tc-99 (Ci/L)	2.08E-04	2.13E-04	2.48E-04	1.87E-04	2.65E-04	1.52E-04	1.79E-08	5.52E-06
Ru-106 (Ci/L)	5.11E-11	5.11E-11	5.11E-11	5.11E-11	6.13E-05	1.97E-04	5.11E-11	5.11E-11
Cd-113m (Ci/L)	3.91E-05	4.02E-05	4.30E-05	3.37E-05	4.30E-05	4.30E-05	7.98E-09	1.91E-07
Sb-125 (Ci/L)	3.30E-06	5.07E-06	7.06E-06	8.75E-06	6.78E-04	1.11E-03	1.42E-07	8.01E-06
Sn-126 (Ci/L)	2.61E-06	2.67E-06	3.18E-06	2.37E-06	4.02E-06	2.26E-06	1.94E-10	4.50E-09
I-129 (Ci/L)	1.97E-07	2.08E-07	2.56E-07	2.19E-07	2.36E-08	1.33E-08	1.77E-08	3.66E-08
Cs-134 (Ci/L)	2.79E-07	3.27E-07	5.04E-07	1.05E-05	1.10E-03	1.07E-03	6.67E-08	2.06E-05
Cs-137 (Ci/L)	2.54E-01	2.88E-01	3.16E-01	2.41E-01	1.70E+00	1.01E+00	8.36E-05	2.58E-02
Ba-137m (Ci/L)	2.40E-01	2.72E-01	2.99E-01	2.27E-01	1.61E+00	9.54E-01	7.89E-05	2.43E-02
Sm-151 (Ci/L)	3.60E-03	4.99E-03	5.32E-03	4.51E-03	3.60E-03	3.77E-03	1.76E-06	4.09E-05
Eu-152 (Ci/L)	6.58E-07	9.21E-07	1.09E-06	1.08E-06	4.92E-06	4.64E-06	2.32E-09	5.39E-08
Eu-154 (Ci/L)	4.83E-05	6.76E-05	8.16E-05	8.17E-05	5.79E-04	5.88E-04	2.80E-07	6.50E-06
Eu-155 (Ci/L)	2.20E-05	3.08E-05	3.80E-05	3.82E-05	3.93E-04	5.44E-04	2.14E-07	4.98E-06
Ra-226 (Ci/L)	4.94E-11	5.87E-11	6.20E-11	4.89E-11	6.20E-11	4.21E-11	3.78E-15	4.06E-13
Ra-228 (Ci/L)	6.42E-09	7.41E-09	2.93E-08	1.99E-08	3.53E-15	2.79E-15	2.27E-19	3.17E-17
Ac-227 (Ci/L)	3.01E-10	3.58E-10	3.60E-10	2.86E-10	3.60E-10	2.17E-10	1.90E-14	1.95E-12
Pa-231 (Ci/L)	1.55E-08	1.88E-08	9.41E-08	6.31E-08	8.85E-10	5.32E-10	4.37E-14	8.30E-12
Th-229 (Ci/L)	1.53E-11	1.77E-11	3.44E-11	2.42E-11	5.29E-13	2.80E-13	2.50E-17	2.19E-15
Th-232 (Ci/L)	5.23E-11	6.16E-11	1.25E-10	8.74E-11	5.19E-15	3.28E-15	2.61E-19	5.28E-17
U-232 (Ci/L)	2.89E-10	3.65E-10	1.10E-09	3.13E-10	5.20E-12	4.50E-12	4.95E-12	2.83E-12
U-233 (Ci/L)	1.74E-08	2.19E-08	6.59E-08	1.87E-08	1.67E-12	1.39E-12	1.57E-12	3.46E-14
U-234 (Ci/L)	1.10E-08	1.11E-08	1.15E-08	1.32E-08	1.50E-08	1.50E-08	1.50E-08	1.49E-08
U-235 (Ci/L)	4.60E-10	4.63E-10	4.65E-10	5.22E-10	5.61E-10	5.96E-10	5.74E-10	5.74E-10
U-236 (Ci/L)	2.73E-10	2.69E-10	3.02E-10	8.94E-10	1.43E-09	1.48E-09	1.45E-09	1.45E-09
U-238 (Ci/L)	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08	1.03E-08
U-Total (M)	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237 (Ci/L)	4.69E-07	4.69E-07	4.69E-07	3.96E-07	4.69E-07	4.69E-07	2.53E-10	5.88E-09
Pu-238 (Ci/L)	1.82E-07	1.82E-07	2.12E-07	3.71E-07	5.25E-07	4.94E-07	5.14E-07	5.04E-07
Pu-239 (Ci/L)	5.07E-06	5.08E-06	5.05E-06	5.01E-06	4.96E-06	4.98E-06	4.97E-06	4.97E-06
Pu-240 (Ci/L)	1.10E-06	1.09E-06	1.17E-06	1.30E-06	1.42E-06	1.36E-06	1.40E-06	1.40E-06
Pu-241 (Ci/L)	8.17E-06	8.33E-06	1.05E-05	2.64E-05	4.25E-05	3.96E-05	4.15E-05	4.15E-05
Pu-242 (Ci/L)	6.77E-11	6.82E-11	8.72E-11	1.37E-10	1.84E-10	1.64E-10	1.77E-10	1.77E-10
Pu-Total (g/L)	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05
Am-241 (Ci/L)	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	3.35E-07	6.73E-06
Am-243 (Ci/L)	4.06E-09	3.91E-09	4.16E-09	4.41E-09	2.11E-09	1.50E-09	9.31E-11	6.74E-10
Cm-242 (Ci/L)	2.23E-08	2.19E-08	1.96E-08	1.33E-08	4.79E-09	5.40E-09	1.72E-10	3.96E-09
Cm-243 (Ci/L)	7.87E-10	7.89E-10	7.83E-10	7.78E-10	7.40E-10	7.75E-10	2.59E-11	6.02E-10
Cm-244 (Ci/L)	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	6.64E-10	1.54E-08

Predicted Solids Concentration in Layer (mol/L) (Sheet 1)

prec. solids mol/L	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	1.89E-05	3.85E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.64E-05	5.26E-05
Na2CO3.7H2O	1.07E-01	8.64E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.17E+00	0.00E+00
Na3PO4.12H2O	9.64E-01	9.73E-01	1.54E+00	1.47E+00	1.94E+00	1.59E+00	0.00E+00	0.00E+00		1.45E+00
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	8.21E-01	8.37E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.98E-01	1.52E+00
Na2SiO3	0.00E+00	0.00E+00	3.66E-01	3.01E-01	3.95E-01	3.65E-01	0.00E+00	0.00E+00	0.00E+00	5.84E-01
(Al2O3.3H2O)/2	0.00E+00	0.00E+00	5.99E-01	4.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	1.19E-01	1.19E-01	3.52E-01	3.37E-01	5.62E-01	8.51E-01	7.83E-01	6.05E-01	1.58E+00	6.63E-01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-01	1.95E-01	0.00E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	8.44E-02	8.09E-02	1.41E-01	1.68E-01	3.07E-01	2.37E-01	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
(La2O3)/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.10E-01	1.63E-01	0.00E+00	0.00E+00
HgO	0.00E+00	4.15E-04	0.00E+00	7.12E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.66E-04	3.73E-04
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E+00	1.76E+00		
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	1.22E-01	1.22E-01	1.07E-01	1.03E-01	2.14E-01	4.24E-01	7.99E-01	6.17E-01	5.24E-01	3.48E-01
Ni(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.76E-02
ZrO2•2H2O	0.00E+00	0.00E+00	3.11E-04	2.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O										1.18E-01
UO2(OH)2*6H2O	1.96E+00	1.98E+00	8.32E-03	5.85E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.64E-02	3.06E-02

Predicted Solids Concentration in Layer (mol/L) (Sheet 2)

prec. solids mol/L	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	9.23E-02	1.32E-05	2.62E-06	2.96E-04	1.66E-03	0.00E+00	0.00E+00	2.24E-03	3.23E-03	0.00E+00
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	1.45E+00	0.00E+00	2.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E+00
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	1.52E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.73E-01	0.00E+00
Na2SiO3	5.84E-01	0.00E+00	9.17E-01	9.62E-02	1.07E+00	2.43E-01	0.00E+00	1.66E+00	2.10E+00	0.00E+00
(Al2O3.3H2O)/2	0.00E+00	2.56E-02	0.00E+00	6.53E+00	4.90E+00	4.94E+00	5.38E+00	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.61E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	6.63E-01	0.00E+00	2.98E-04	1.01E+00	1.70E+00	1.65E-01	4.60E-01	2.63E+00	2.96E+00	2.92E+00
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	1.30E+00	1.94E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2	0.00E+00	0.00E+00	0.00E+00	1.18E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	4.51E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.60E-02	1.32E-01	0.00E+00	6.07E-03	0.00E+00
(La2O3)/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	3.73E-04	0.00E+00	5.56E-04	1.69E-04	4.80E-04	0.00E+00	0.00E+00	1.11E-03	6.26E-04	0.00E+00
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	3.48E-01	6.54E-01	5.42E-01	3.29E-01	4.92E-01	1.78E-01	4.95E-01	6.52E-01	3.71E-01	6.65E-01
Ni(OH)2	7.07E-02	2.34E-01	1.86E-01	4.90E-02	7.33E-02	0.00E+00	0.00E+00	9.94E-02	5.66E-02	9.98E-02
ZrO2•2H2O	0.00E+00	0.00E+00	1.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O	5.88E-02	1.67E-01	1.67E-01							
UO2(OH)2*6H2O	3.06E-02	0.00E+00	3.28E-02	5.10E-02	3.88E-02	4.44E-02	1.22E-01	2.64E-02	5.24E-02	6.76E-01

Predicted Solids Concentration in Layer (mol/L) (Sheet 3)

prec. solids mol/L	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	4.77E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	0.00E+00	0.00E+00	5.31E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.45E-05	3.93E-05
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-01	3.44E-01
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SiO3	1.19E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
(Al2O3.3H2O)/2	4.44E+00	5.38E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E+01	0.00E+00	4.10E-01	4.10E-01
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	1.65E-01	4.60E-01	1.27E-01	3.47E+00	3.47E+00	3.47E+00	1.69E+00	1.82E+00	1.09E+00	1.09E+00
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-02	0.00E+00	0.00E+00
MnO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E+00	2.98E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	8.04E-02	1.54E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-01	0.00E+00	0.00E+00
(La2O3)/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E-03	0.00E+00	0.00E+00
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	1.77E-01	4.94E-01	1.37E-01	1.30E+00	1.30E+00	1.31E+00	6.35E-01	0.00E+00	2.52E-01	2.52E-01
Ni(OH)2	0.00E+00	0.00E+00	0.00E+00	1.98E-01	1.98E-01	1.98E-01	9.55E-02	0.00E+00	3.78E-02	3.78E-02
ZrO2•2H2O	0.00E+00	0.00E+00	9.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O										
UO2(OH)2*6H2O	3.58E-02	5.95E-02	5.33E-02	6.68E-01	2.92E-01	5.93E-02	0.00E+00	2.22E-01	5.00E-04	4.95E-04

Predicted Solids Concentration in Layer (mol/L) (Sheet 4)

prec. solids mol/L	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
NaNO3	0.00E+00			0.00E+00	0.00E+00	0.00E+00	5.81E+00	2.32E+00	4.84E+00	5.21E+00
NaNO2	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Sr(OH)2	2.25E-03	2.35E-03	0.00E+00	2.97E-03	7.54E-05	0.00E+00	0.00E+00	5.47E-06	8.66E-06	2.48E-05
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.90E-01	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E-02	5.38E-01	0.00E+00	1.65E-01	1.75E-01
Na2SiO3	2.48E+00	5.90E+00	4.70E+00	2.67E+00	7.45E-01	0.00E+00	1.11E-01	8.39E-02	2.90E-02	2.57E-02
(Al2O3.3H2O)/2	5.29E-02	1.16E+00	1.96E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E+00	0.00E+00	1.65E+00
FeO(OH)	1.30E+00	1.03E+00	0.00E+00	1.51E+00	2.73E-01	0.00E+00	1.43E-01	1.73E-02	1.90E-02	2.75E-02
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.07E-01	2.96E-02	8.92E-03
MnO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.51E-04	0.00E+00	4.15E-04
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.17E-02	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	6.74E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E-05	4.15E-03
(La2O3)/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	7.80E-04	1.18E-03	9.50E-04	5.20E-03	1.16E-04	0.00E+00	3.00E-05	1.22E-05	5.11E-06	2.76E-06
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	7.67E-02	1.27E+00	0.00E+00	3.31E-01	5.07E-01	9.03E-01	7.32E-02	3.27E-02	3.30E-02	3.53E-02
Ni(OH)2	1.38E-01	3.63E-02	0.00E+00	0.00E+00	2.48E-01	4.00E-01	1.37E-02	1.61E-02	1.46E-02	1.62E-02
ZrO2·2H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O										
UO2(OH)2*6H2O	3.14E-02	1.65E-01	3.49E-02	2.01E-01	1.63E-02	0.00E+00	4.98E-03	1.12E-03	7.34E-04	1.10E-03

Predicted Solids Concentration in Layer (mol/L) (Sheet 5)

prec. solids mol/L	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
NaNO3	3.46E+00	1.88E+00	2.43E+00	2.39E+00				
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
NaCl					0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF					0.00E+00	0.00E+00	0.00E+00	4.77E+00
Sr(OH)2	1.06E-05	5.66E-07	1.41E-05	3.67E-05	5.47E-03	1.91E-03	0.00E+00	0.00E+00
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	2.45E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	2.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O					0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	1.12E-01	5.85E-02	2.53E-01	2.93E-02	3.22E-01	4.36E-02	0.00E+00	0.00E+00
Na2SiO3	3.23E-02	6.02E-03	2.96E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
(Al2O3.3H2O)/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.45E+00	3.03E+00	0.00E+00	0.00E+00
NaAlO2	3.39E-01	3.89E-01	4.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	1.73E-02	1.44E-03	1.86E-02	5.66E-02	2.12E+00	1.60E+00	1.91E+00	3.63E-01
Cr(OH)3	9.55E-02	2.71E-02	3.58E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2	8.77E-04	3.85E-04	4.61E-04	1.95E-03	0.00E+00	0.00E+00	2.72E-01	0.00E+00
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	2.05E-04	3.37E-04	8.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
(La2O3)/2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	5.29E-06	8.82E-07	5.31E-06	2.50E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3cit.5H2O								
Na Acetate								
Na 2 Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA								
Na4EDTA								
CaCO3.6H2O	2.27E-02	2.53E-03	1.93E-02	7.09E-02	2.19E-01	5.37E-02	7.14E-01	1.37E-01
Ni(OH)2	1.20E-02	1.26E-03	1.11E-02	3.41E-02	7.90E-02	9.41E-02	1.09E-01	0.00E+00
ZrO2•2H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.50E-01
Na2NiFe(CN)6.6H2O								
UO2(OH)2*6H2O	4.80E-04	8.02E-05	5.00E-04	1.06E-03	2.26E-01	7.58E-02	1.17E-01	4.76E-02

Solids Volumes (cc/L) (Sheet 1)

cc/L solids	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	6.33E-04	1.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-03	1.77E-03
Na2CO3.7H2O	1.64E+01	1.33E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2CO3.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E+02	0.00E+00
Na3PO4.12H2O	2.26E+02	2.28E+02	3.61E+02	3.46E+02	4.56E+02	3.72E+02	0.00E+00	0.00E+00	0.00E+00	3.41E+02
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	1.81E+02	1.84E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.54E+02	3.35E+02
Na2SiO3	0.00E+00	0.00E+00	1.86E+01	1.53E+01	2.01E+01	1.86E+01	0.00E+00	0.00E+00	0.00E+00	2.97E+01
Al2O3.3H2O	0.00E+00	0.00E+00	1.93E+01	1.40E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	3.50E+00	3.51E+00	1.04E+01	9.93E+00	1.65E+01	2.50E+01	2.30E+01	1.78E+01	4.64E+01	1.95E+01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.44E+00	4.97E+00	0.00E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	4.06E+00	3.89E+00	6.76E+00	8.07E+00	1.48E+01	1.14E+01	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La2O3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.27E+00	4.07E+00	0.00E+00	0.00E+00
HgO	0.00E+00	8.10E-03	0.00E+00	1.39E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-02	7.29E-03
Na3cit.5H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na Acetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2 Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+02	1.01E+02	0.00E+00	0.00E+00
Na3 HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na4 EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CaCO3.6H2O	1.43E+01	1.44E+01	1.26E+01	1.21E+01	2.51E+01	4.98E+01	9.39E+01	7.25E+01	6.17E+01	4.09E+01
Ni(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.01E-01
ZrO(OH)2	0.00E+00	0.00E+00	1.53E-02	1.45E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.77E+01
UO2(OH)2*6H2O	2.89E+02	2.92E+02	1.22E+00	8.60E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.83E+00	4.51E+00

Solids Volumes (cc/L) (Sheet 2)

cc/L solids	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	3.10E+00	4.42E-04	8.81E-05	9.93E-03	5.57E-02	0.00E+00	0.00E+00	7.53E-02	1.08E-01	0.00E+00
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2CO3.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	3.41E+02	0.00E+00	6.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E+02
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	3.35E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E+02	0.00E+00
Na2SiO3	2.97E+01	0.00E+00	4.66E+01	4.89E+00	5.43E+01	1.24E+01	0.00E+00	8.43E+01	1.07E+02	0.00E+00
Al2O3.3H2O	0.00E+00	8.25E-01	0.00E+00	2.10E+02	1.58E+02	1.59E+02	1.73E+02	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	1.95E+01	0.00E+00	8.76E-03	2.98E+01	5.02E+01	4.86E+00	1.35E+01	7.75E+01	8.72E+01	8.58E+01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	2.57E+01	3.84E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2	0.00E+00	0.00E+00	0.00E+00	3.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	2.17E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.46E+00	5.32E+00	0.00E+00	2.44E-01	0.00E+00
La2O3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	7.29E-03	0.00E+00	1.09E-02	3.30E-03	9.36E-03	0.00E+00	0.00E+00	2.16E-02	1.22E-02	0.00E+00
Na3cit.5H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAcetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na4EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CaCO3.6H2O	4.08E+01	7.69E+01	6.37E+01	3.87E+01	5.79E+01	2.09E+01	5.82E+01	7.66E+01	4.36E+01	7.82E+01
Ni(OH)2	1.80E+00	5.94E+00	4.71E+00	1.24E+00	1.86E+00	0.00E+00	0.00E+00	2.53E+00	1.44E+00	2.53E+00
ZrO(OH)2	0.00E+00	0.00E+00	6.05E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O	1.39E+01	3.93E+01	3.93E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
UO2(OH)2*6H2O	4.51E+00	0.00E+00	4.83E+00	7.50E+00	5.71E+00	6.53E+00	1.79E+01	3.89E+00	7.71E+00	9.94E+01

Solids Volumes (cc/L) (Sheet 3)

cc/L solids	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	7.82E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	0.00E+00	0.00E+00	1.78E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-03	1.32E-03
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2CO3.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.07E+01	8.07E+01
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SiO3	6.04E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Al2O3.3H2O	1.43E+02	1.73E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+02	0.00E+00	1.32E+01	1.32E+01
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	4.85E+00	1.35E+01	3.74E+00	1.02E+02	1.02E+02	1.02E+02	4.97E+01	5.35E+01	3.20E+01	3.20E+01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.80E-01	0.00E+00	0.00E+00
MnO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E+01	7.62E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	3.23E+00	6.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.05E+00	0.00E+00	0.00E+00
La2O3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-01	0.00E+00	0.00E+00
Na3cit.5H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAcetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na4EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CaCO3.6H2O	2.08E+01	5.81E+01	1.60E+01	1.53E+02	1.53E+02	1.54E+02	7.46E+01	0.00E+00	2.96E+01	2.96E+01
Ni(OH)2	0.00E+00	0.00E+00	0.00E+00	5.04E+00	5.04E+00	5.04E+00	2.43E+00	0.00E+00	9.60E-01	9.60E-01
ZrO(OH)2	0.00E+00	0.00E+00	4.65E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
UO2(OH)2*6H2O	5.27E+00	8.75E+00	7.85E+00	9.83E+01	4.30E+01	8.72E+00	0.00E+00	3.27E+01	7.36E-02	7.29E-02

Solids Volumes (cc/L) (Sheet 4)

cc/L solids	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.18E+02	8.73E+01	1.82E+02	1.96E+02
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	7.54E-02	7.89E-02	0.00E+00	9.96E-02	2.53E-03	0.00E+00	0.00E+00	1.84E-04	2.91E-04	8.33E-04
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2CO3.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E+02	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.16E+00	1.18E+02	0.00E+00	3.63E+01	3.86E+01
Na2SiO3	1.26E+02	3.00E+02	2.39E+02	1.36E+02	3.79E+01	0.00E+00	5.64E+00	4.27E+00	1.47E+00	1.31E+00
Al2O3.3H2O	1.71E+00	3.75E+01	6.32E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.40E+01	0.00E+00	5.02E+01
FeO(OH)	3.82E+01	3.02E+01	0.00E+00	4.43E+01	8.03E+00	0.00E+00	4.21E+00	5.09E-01	5.59E-01	8.10E-01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.05E+00	5.85E-01	1.76E-01
MnO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.17E-02	0.00E+00	1.06E-02
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.53E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	2.71E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E-03	1.67E-01
La2O3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	1.52E-02	2.29E-02	1.85E-02	1.02E-01	2.26E-03	0.00E+00	5.85E-04	2.37E-04	9.98E-05	5.38E-05
Na3cit.5H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAcetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na4EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CaCO3.6H2O	9.02E+00	1.49E+02	0.00E+00	3.89E+01	5.96E+01	1.06E+02	8.61E+00	3.85E+00	3.87E+00	4.16E+00
Ni(OH)2	3.50E+00	9.22E-01	0.00E+00	0.00E+00	6.31E+00	1.02E+01	3.49E-01	4.08E-01	3.71E-01	4.12E-01
ZrO(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
UO2(OH)2*6H2O	4.62E+00	2.43E+01	5.14E+00	2.96E+01	2.39E+00	0.00E+00	7.32E-01	1.65E-01	1.08E-01	1.62E-01

Solids Volumes (cc/L) (Sheet 5)

cc/L solids	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
NaNO3	1.30E+02	7.08E+01	9.15E+01	9.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.83E+01
Sr(OH)2	3.55E-04	1.90E-05	4.72E-04	1.23E-03	1.83E-01	6.42E-02	0.00E+00	0.00E+00
Na2CO3.7H2O	0.00E+00	0.00E+00	0.00E+00	3.77E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2CO3.10H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.10H2O	0.00E+00	0.00E+00	0.00E+00	3.68E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4.12H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SO4.10H2O	2.46E+01	1.29E+01	5.57E+01	6.44E+00	7.09E+01	9.60E+00	0.00E+00	0.00E+00
Na2SiO3	1.64E+00	3.06E-01	1.50E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Al2O3.3H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+02	9.77E+01	0.00E+00	0.00E+00
NaAlO2	1.03E+01	1.18E+01	1.30E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FeO(OH)	5.08E-01	4.24E-02	5.47E-01	1.66E+00	6.23E+01	4.71E+01	5.61E+01	1.07E+01
Cr(OH)3	1.89E+00	5.35E-01	7.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2	2.24E-02	9.83E-03	1.18E-02	4.99E-02	0.00E+00	0.00E+00	6.96E+00	0.00E+00
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	8.24E-03	1.35E-02	3.58E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La2O3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HgO	1.03E-04	1.72E-05	1.04E-04	4.88E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3cit.5H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAcetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na4EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CaCO3.6H2O	2.66E+00	2.97E-01	2.27E+00	8.33E+00	2.57E+01	6.31E+00	8.39E+01	1.60E+01
Ni(OH)2	3.05E-01	3.21E-02	2.81E-01	8.66E-01	2.01E+00	2.39E+00	2.77E+00	0.00E+00
ZrO(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.65E+01
Na2NiFe(CN)6.6H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
UO2(OH)2*6H2O	7.07E-02	1.18E-02	7.36E-02	1.56E-01	3.32E+01	1.12E+01	1.72E+01	7.01E+00

Solids Fraction Precipitated (Sheet 1)

frac. prec. solids	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2			0.00E+00	0.00E+00						
NaCl										
NaF			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00
Sr(OH)2	7.97E-01	8.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.49E-01	9.01E-01
Na2CO3	2.68E-02	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4	6.43E-01	6.49E-01	7.60E-01	7.60E-01	6.60E-01	4.38E-01	0.00E+00	0.00E+00	4.66E-01	4.75E-01
Na2SO4	4.66E-01	4.75E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-01	3.50E-01
Na2SiO3	0.00E+00	0.00E+00	8.35E-01	8.13E-01	7.25E-01	5.45E-01				7.09E-01
Al2O3.3H2O	6.00E-01	6.00E-01	1.00E+00	1.00E+00	3.00E-01	6.00E-01	8.00E-01	8.00E-01	7.00E-02	7.00E-02
NaAlO2			0.00E+00	0.00E+00						
FeO(OH)	8.93E-01	8.95E-01	9.65E-01	9.65E-01	9.55E-01	9.40E-01	8.83E-01	8.83E-01	9.60E-01	9.40E-01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2							8.92E-01	8.92E-01		
BiPO4	0.00E+00	0.00E+00	9.64E-01	9.64E-01	9.56E-01	9.27E-01	9.24E-01	9.24E-01	0.00E+00	0.00E+00
Pb(OH)2										
La2O3							1.00E+00	1.00E+00		
HgO		9.72E-01		8.70E-01					9.09E-01	9.10E-01
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate							8.92E-01	8.92E-01		
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	8.10E-01	8.13E-01	8.06E-01	8.06E-01	8.01E-01	7.96E-01	7.94E-01	7.94E-01	7.99E-01	8.03E-01
Ni(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.33E-01
ZrO(OH)2			1.33E-01	1.32E-01						
Na2NiFe(CN)6.6H2O	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Solids Fraction Precipitated (Sheet 2)

frac. prec. solids	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2		0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl										
NaF	0.00E+00	0.00E+00	0.00E+00							
Sr(OH)2	9.80E-01	8.95E-01	9.14E-01	9.61E-01	9.89E-01	0.00E+00	0.00E+00	9.90E-01	9.96E-01	0.00E+00
Na2CO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4	4.75E-01	0.00E+00	1.12E-02							2.71E-01
Na2SO4	3.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.37E-01	0.00E+00
Na2SiO3	7.09E-01	0.00E+00	7.24E-01	2.94E-01	7.54E-01	6.57E-01		7.77E-01	8.88E-01	
Al2O3.3H2O	7.00E-02	7.00E-02	7.00E-02	2.60E-01	1.30E-01	2.00E-01	2.00E-01	7.00E-02	7.00E-02	3.00E-01
NaAlO2		0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-01	0.00E+00			
FeO(OH)	9.40E-01	0.00E+00	4.76E-03	9.61E-01	9.65E-01	8.80E-01	8.78E-01	9.69E-01	9.84E-01	9.72E-01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	5.17E-01	5.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MnO2				9.07E-01						
BiPO4	0.00E+00	0.00E+00	9.67E-01							
Pb(OH)2		0.00E+00				9.08E-01	8.43E-01	0.00E+00	2.51E-01	0.00E+00
La2O3										
HgO	9.10E-01	0.00E+00	9.12E-01	8.27E-01	9.00E-01			9.38E-01	9.39E-01	
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate										
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	8.03E-01	8.40E-01	8.13E-01	8.00E-01	7.99E-01	7.97E-01	7.94E-01	7.94E-01	7.97E-01	7.98E-01
Ni(OH)2	7.33E-01	8.62E-01	8.44E-01	5.51E-01	5.49E-01	0.00E+00	0.00E+00	5.47E-01	5.52E-01	5.49E-01
ZrO(OH)2		0.00E+00	9.27E-01							
Na2NiFe(CN)6.6H2O	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Solids Fraction Precipitated (Sheet 3)

frac. prec. solids	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl										
NaF			6.50E-01						0.00E+00	0.00E+00
Sr(OH)2	0.00E+00	0.00E+00	5.21E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.95E-01	8.16E-01
Na2CO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4							0.00E+00		2.22E-01	2.22E-01
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2SiO3	4.81E-01									
Al2O3.3H2O	3.00E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	1.00E-01	7.00E-02	7.00E-02
NaAlO2	0.00E+00	0.00E+00					0.00E+00		0.00E+00	0.00E+00
FeO(OH)	8.78E-01	8.78E-01	8.78E-01	9.53E-01	9.53E-01	9.53E-01	9.54E-01	3.12E-01	9.71E-01	9.71E-01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.40E-02	0.00E+00	0.00E+00
MnO2					9.54E-01	3.72E-01				
BiPO4										
Pb(OH)2	9.02E-01	8.62E-01						3.55E-01		
La2O3										
HgO								9.79E-01		
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate										
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	7.95E-01	7.94E-01	7.95E-01	7.92E-01	7.93E-01	7.93E-01	7.97E-01	0.00E+00	7.97E-01	7.97E-01
Ni(OH)2	0.00E+00	0.00E+00	0.00E+00	5.45E-01	5.45E-01	5.45E-01	5.49E-01	0.00E+00	5.48E-01	5.48E-01
ZrO(OH)2			9.97E-01							
Na2NiFe(CN)6.6H2O	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Solids Fraction Precipitated (Sheet 4)

frac. prec. solids	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
NaNO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-01	8.10E-02	3.97E-01	4.88E-01
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl										
NaF	0.00E+00				0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr(OH)2	9.93E-01	9.58E-01	0.00E+00	9.93E-01	5.89E-01	0.00E+00	0.00E+00	5.71E-01	8.85E-01	9.01E-01
Na2CO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4	0.00E+00		0.00E+00		0.00E+00		5.86E-01	0.00E+00	0.00E+00	0.00E+00
Na2SO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.65E-01	0.00E+00	3.88E-01	4.76E-01
Na2SiO3	8.80E-01	7.37E-01	9.40E-01	8.69E-01	4.14E-01		4.66E-01	5.14E-01	5.67E-01	6.10E-01
Al2O3.3H2O	7.00E-02	7.00E-02	7.00E-02	7.00E-02	0.00E+00	7.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaAlO2	0.00E+00	0.00E+00	0.00E+00		0.00E+00		0.00E+00	7.83E-02	0.00E+00	3.77E-01
FeO(OH)	9.56E-01	7.33E-01	0.00E+00	9.55E-01	5.93E-01	9.53E-01	8.63E-01	5.51E-01	8.28E-01	9.04E-01
Cr(OH)3	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	4.94E-01	2.03E-01	9.36E-02
MnO2	0.00E+00				0.00E+00			1.69E-01	0.00E+00	3.24E-01
BiPO4	0.00E+00				0.00E+00		8.51E-01	0.00E+00	0.00E+00	0.00E+00
Pb(OH)2	0.00E+00	3.19E-01			0.00E+00			0.00E+00	3.41E-02	7.87E-01
La2O3					0.00E+00			0.00E+00	0.00E+00	0.00E+00
HgO	9.38E-01	7.85E-01	8.55E-01	9.88E-01	4.17E-01		6.06E-01	5.00E-01	6.01E-01	5.22E-01
Na3cit.5H2O										
Na Acetate										
Na 2 Oxalate					0.00E+00			0.00E+00	0.00E+00	0.00E+00
Na3HEDTA										
Na4EDTA										
CaCO3.6H2O	3.89E-01	6.28E-01	0.00E+00	6.97E-01	5.75E-01	5.01E-01	6.18E-01	5.37E-01	8.07E-01	8.58E-01
Ni(OH)2	7.02E-01	9.08E-02	0.00E+00		5.77E-01	5.45E-01	3.84E-01	5.39E-01	7.92E-01	8.51E-01
ZrO(OH)2	0.00E+00				0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na2NiFe(CN)6.6H2O	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Solids Fraction Precipitated (Sheet 5)

frac. prec. solids	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
NaNO3	2.76E-01	1.34E-01	1.20E-01	1.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaNO2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NaCl								
NaF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		6.50E-01
Sr(OH)2	8.85E-01	2.35E-01	8.21E-01	9.38E-01	9.98E-01	9.97E-01	0.00E+00	0.00E+00
Na2CO3	0.00E+00	0.00E+00	0.00E+00	8.51E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Na3PO4	0.00E+00	0.00E+00	0.00E+00	4.55E-01			0.00E+00	
Na2SO4	2.58E-01	1.19E-01	2.85E-01	4.88E-02	1.13E-01	2.61E-02	0.00E+00	
Na2SiO3	5.41E-01	1.41E-01	3.54E-01	0.00E+00	8.87E-01	8.88E-01		
Al2O3.3H2O	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E-01	9.30E-01	3.00E-01	0.00E+00
NaAlO2	6.93E-02	6.00E-02	4.56E-02	0.00E+00	0.00E+00	0.00E+00		
FeO(OH)	7.80E-01	1.81E-01	6.59E-01	8.68E-01	9.81E-01	9.85E-01	9.53E-01	9.54E-01
Cr(OH)3	3.99E-01	1.23E-01	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
MnO2	3.78E-01	1.66E-01	1.40E-01	4.33E-01			9.08E-01	
BiPO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
Pb(OH)2	9.89E-02	1.19E-01	1.94E-01	0.00E+00				
La2O3	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
HgO	5.57E-01	1.36E-01	3.91E-01	2.51E-01				
Na3cit.5H2O								
Na Acetate								
Na 2 Oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00				
Na3HEDTA								
Na4EDTA								
CaCO3.6H2O	6.99E-01	1.63E-01	5.02E-01	8.04E-01	7.23E-01	5.25E-01	7.92E-01	7.95E-01
Ni(OH)2	7.17E-01	1.66E-01	5.42E-01	8.02E-01	6.60E-01	7.99E-01	5.45E-01	
ZrO(OH)2	0.00E+00	0.00E+00	0.00E+00	0.00E+00				9.97E-01
Na2NiFe(CN)6.6H2O	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Solids Fraction Precipitated (Sheet 6)

frac. prec. solids	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3										
C-14	2.68E-02	1.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.35E-01
Ni-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.35E-01
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Se-79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	7.97E-01	8.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.49E-01	9.01E-01
Y-90	7.97E-01	8.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.49E-01	9.01E-01
Zr-93	0.00E+00	0.00E+00	1.33E-01	1.32E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-93m	0.00E+00	0.00E+00	1.33E-01	1.32E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99										
Ru-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-113m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134										9.99E-01
Cs-137										9.99E-01
Ba-137m										9.99E-01
Sm-151	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-155	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-226	4.06E-01	2.78E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-228	4.06E-01	2.78E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ac-227	2.79E-01	1.44E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pa-231	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-229	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-232	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
U-233	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
U-234	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
U-235	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
U-236	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
U-238	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
U-Total	9.85E-01	9.85E-01	9.03E-01	8.72E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.10E-01	9.12E-01
Np-237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-238	0.00E+00	2.00E-01	7.24E-01	7.76E-01	1.89E-01	1.60E-01	0.00E+00	2.90E-01	0.00E+00	0.00E+00
Pu-239	0.00E+00	2.00E-01	7.24E-01	7.76E-01	1.89E-01	1.60E-01	0.00E+00	2.90E-01	0.00E+00	0.00E+00
Pu-240	0.00E+00	2.00E-01	7.24E-01	7.76E-01	1.89E-01	1.60E-01	0.00E+00	2.90E-01	0.00E+00	0.00E+00
Pu-241	0.00E+00	2.00E-01	7.24E-01	7.76E-01	1.89E-01	1.60E-01	0.00E+00	2.90E-01	0.00E+00	0.00E+00
Pu-242	0.00E+00	2.00E-01	7.24E-01	7.76E-01	1.89E-01	1.60E-01	0.00E+00	2.90E-01	0.00E+00	0.00E+00
Pu-Total	0.00E+00	2.00E-01	7.24E-01	7.76E-01	1.89E-01	1.60E-01	0.00E+00	2.90E-01	0.00E+00	0.00E+00
Am-241	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-244	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Solids Fraction Precipitated (Sheet 7)

frac. prec. solids	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3										
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	8.34E-01	9.21E-01	9.11E-01	5.51E-01	5.49E-01	0.00E+00	0.00E+00	5.47E-01	5.52E-01	5.49E-01
Ni-63	8.34E-01	9.21E-01	9.11E-01	5.51E-01	5.49E-01	0.00E+00	0.00E+00	5.47E-01	5.52E-01	5.49E-01
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-01	0.00E+00	5.54E-01	0.00E+00
Se-79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	9.80E-01	8.95E-01	9.14E-01	9.61E-01	9.89E-01	0.00E+00	0.00E+00	9.90E-01	9.96E-01	0.00E+00
Y-90	9.80E-01	8.95E-01	9.14E-01	9.61E-01	9.89E-01	0.00E+00	0.00E+00	9.90E-01	9.96E-01	0.00E+00
Zr-93	0.00E+00	0.00E+00	9.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-93m	0.00E+00	0.00E+00	9.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99										
Ru-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.94E-01	0.00E+00
Cd-113m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E-01	0.00E+00	0.00E+00	0.00E+00	4.29E-01	0.00E+00
Sn-126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Cs-134	9.99E-01	9.99E-01	9.99E-01							
Cs-137	9.99E-01	9.99E-01	9.99E-01							
Ba-137m	9.99E-01	9.99E-01	9.99E-01							
Sm-151	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-01	0.00E+00	0.00E+00	2.74E-01	8.11E-01	0.00E+00
Eu-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-01	0.00E+00	0.00E+00	2.74E-01	8.11E-01	0.00E+00
Eu-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-01	0.00E+00	0.00E+00	2.74E-01	8.11E-01	0.00E+00
Eu-155	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-01	0.00E+00	0.00E+00	2.74E-01	8.11E-01	0.00E+00
Ra-226	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ac-227	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pa-231	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-229	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-232	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
U-233	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
U-234	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
U-235	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
U-236	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
U-238	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
U-Total	9.12E-01	0.00E+00	8.84E-01	9.47E-01	9.00E-01	9.66E-01	9.65E-01	8.18E-01	9.41E-01	9.91E-01
Np-237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-238	0.00E+00	0.00E+00	7.77E-01	8.13E-01	8.20E-01	8.64E-01	8.83E-01	8.43E-01	9.09E-01	9.86E-01
Pu-239	0.00E+00	0.00E+00	7.77E-01	8.13E-01	8.20E-01	8.64E-01	8.83E-01	8.43E-01	9.09E-01	9.86E-01
Pu-240	0.00E+00	0.00E+00	7.77E-01	8.13E-01	8.20E-01	8.64E-01	8.83E-01	8.43E-01	9.09E-01	9.86E-01
Pu-241	0.00E+00	0.00E+00	7.77E-01	8.13E-01	8.20E-01	8.64E-01	8.83E-01	8.43E-01	9.09E-01	9.86E-01
Pu-242	0.00E+00	0.00E+00	7.77E-01	8.13E-01	8.20E-01	8.64E-01	8.83E-01	8.43E-01	9.09E-01	9.86E-01
Pu-Total	0.00E+00	0.00E+00	7.77E-01	8.13E-01	8.20E-01	8.64E-01	8.83E-01	8.43E-01	9.09E-01	9.86E-01
Am-241	0.00E+00	0.00E+00	0.00E+00	6.23E-01	9.29E-01	0.00E+00	3.13E-01	8.89E-01	9.72E-01	0.00E+00
Am-243	0.00E+00	0.00E+00	0.00E+00	6.23E-01	9.29E-01	0.00E+00	3.13E-01	8.89E-01	9.72E-01	0.00E+00
Cm-242	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.24E-01	0.00E+00	0.00E+00	2.19E-01	9.38E-01	0.00E+00
Cm-243	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.24E-01	0.00E+00	0.00E+00	2.19E-01	9.38E-01	0.00E+00
Cm-244	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.24E-01	0.00E+00	0.00E+00	2.19E-01	9.38E-01	0.00E+00

Solids Fraction Precipitated (Sheet 8)

frac. prec. solids	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3										
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	0.00E+00	0.00E+00	0.00E+00	5.45E-01	5.45E-01	5.45E-01	5.49E-01	0.00E+00	5.48E-01	5.48E-01
Ni-63	0.00E+00	0.00E+00	0.00E+00	5.45E-01	5.45E-01	5.45E-01	5.49E-01	0.00E+00	5.48E-01	5.48E-01
Co-60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Se-79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Sr-90	0.00E+00	0.00E+00	5.21E-01	0.00E+00	0.00E+00	0.00E+00		0.00E+00	7.95E-01	8.16E-01
Y-90	0.00E+00	0.00E+00	5.21E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.95E-01	8.16E-01
Zr-93	0.00E+00	0.00E+00	9.97E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-93m	0.00E+00	0.00E+00	9.97E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99										
Ru-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		6.93E-01	0.00E+00	0.00E+00
Cd-113m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Sn-126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
I-129	1.47E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Cs-134										
Cs-137										
Ba-137m										
Sm-151	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-154	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Eu-155	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-226	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	2.41E-03	4.32E-01
Ra-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.41E-03	4.32E-01
Ac-227	0.00E+00	6.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	1.00E+00	1.00E+00
Pa-231	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Th-229	0.00E+00	9.88E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.99E-01	9.99E-01
Th-232	0.00E+00	9.88E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	9.99E-01	9.99E-01
U-232	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01	0.00E+00	9.53E-01	9.30E-01	9.30E-01
U-233	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01	0.00E+00	9.53E-01	9.30E-01	9.30E-01
U-234	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01	0.00E+00	9.53E-01	9.30E-01	9.30E-01
U-235	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01	0.00E+00	9.53E-01	9.30E-01	9.30E-01
U-236	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01	0.00E+00	9.53E-01	9.30E-01	9.30E-01
U-238	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01	0.00E+00	9.53E-01	9.30E-01	9.30E-01
U-Total	9.58E-01	9.30E-01	9.78E-01	9.83E-01	9.61E-01	8.34E-01		9.53E-01	9.30E-01	9.30E-01
Np-237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00
Pu-238	8.53E-01	7.77E-01	9.37E-01	9.55E-01	8.20E-01	2.04E-01	9.92E-01	9.40E-01	0.00E+00	0.00E+00
Pu-239	8.53E-01	7.77E-01	9.37E-01	9.55E-01	8.20E-01	2.04E-01	9.92E-01	9.40E-01	0.00E+00	0.00E+00
Pu-240	8.53E-01	7.77E-01	9.37E-01	9.55E-01	8.20E-01	2.04E-01	9.92E-01	9.40E-01	0.00E+00	0.00E+00
Pu-241	8.53E-01	7.77E-01	9.37E-01	9.55E-01	8.20E-01	2.04E-01	9.92E-01	9.40E-01	0.00E+00	0.00E+00
Pu-242	8.53E-01	7.77E-01	9.37E-01	9.55E-01	8.20E-01	2.04E-01	9.92E-01	9.40E-01	0.00E+00	0.00E+00
Pu-Total	8.53E-01	7.77E-01	9.37E-01	9.55E-01	8.20E-01	2.04E-01	9.92E-01	9.40E-01	0.00E+00	0.00E+00
Am-241	0.00E+00	0.00E+00	9.08E-01	0.00E+00	0.00E+00	0.00E+00	9.91E-01	0.00E+00	0.00E+00	0.00E+00
Am-243	0.00E+00	0.00E+00	9.08E-01	0.00E+00	0.00E+00	0.00E+00	9.91E-01	0.00E+00	0.00E+00	0.00E+00
Cm-242	0.00E+00	0.00E+00	7.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-01	0.00E+00	0.00E+00
Cm-243	0.00E+00	0.00E+00	7.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-01	0.00E+00	0.00E+00
Cm-244	0.00E+00	0.00E+00	7.67E-01	0.00E+00	0.00E+00	0.00E+00		9.08E-01	0.00E+00	0.00E+00

Solids Fraction Precipitated (Sheet 9)

frac. prec. solids	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3										
C-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.02E-01	9.08E-02	0.00E+00	0.00E+00	5.77E-01	5.45E-01	3.84E-01	5.39E-01	7.92E-01	8.51E-01
Ni-63	7.02E-01	9.08E-02	0.00E+00	0.00E+00	5.77E-01	5.45E-01	3.84E-01	5.39E-01	7.92E-01	8.51E-01
Co-60	0.00E+00	3.75E-01	0.00E+00	5.50E-01	1.19E-01		0.00E+00	0.00E+00	3.32E-01	7.57E-01
Se-79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	9.93E-01	9.58E-01	0.00E+00	9.93E-01	5.89E-01		0.00E+00	5.71E-01	8.85E-01	9.01E-01
Y-90	9.93E-01	9.58E-01	0.00E+00	9.93E-01	5.89E-01	0.00E+00	0.00E+00	5.71E-01	8.85E-01	9.01E-01
Zr-93	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-93m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99										
Ru-106	1.14E-01	9.67E-01	7.68E-01	9.44E-01	0.00E+00		0.00E+00	0.00E+00	1.76E-03	9.99E-01
Cd-113m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-125	0.00E+00	5.30E-01	0.00E+00	4.59E-01	0.00E+00		0.00E+00	0.00E+00	0.00E+00	9.73E-01
Sn-126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	6.55E-01
Cs-134										
Cs-137										
Ba-137m										
Sm-151	4.99E-01	8.10E-01	0.00E+00	8.90E-01	3.53E-01	0.00E+00	0.00E+00	2.73E-01	2.81E-01	9.34E-01
Eu-152	4.99E-01	8.10E-01	0.00E+00	8.90E-01	3.53E-01	0.00E+00	0.00E+00	2.73E-01	2.81E-01	9.34E-01
Eu-154	4.99E-01	8.10E-01	0.00E+00	8.90E-01	3.53E-01		0.00E+00	2.73E-01	2.81E-01	9.34E-01
Eu-155	4.99E-01	8.10E-01	0.00E+00	8.90E-01	3.53E-01	0.00E+00	0.00E+00	2.73E-01	2.81E-01	9.34E-01
Ra-226	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.22E-01
Ra-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-01
Ac-227	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	1.66E-02	7.22E-01
Pa-231	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-229	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.52E-01
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	6.52E-01
U-232	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01	0.00E+00	7.60E-01	5.33E-01	7.28E-01	8.44E-01
U-233	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01	0.00E+00	7.60E-01	5.33E-01	7.28E-01	8.44E-01
U-234	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01	0.00E+00	7.60E-01	5.33E-01	7.28E-01	8.44E-01
U-235	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01	0.00E+00	7.60E-01	5.33E-01	7.28E-01	8.44E-01
U-236	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01	0.00E+00	7.60E-01	5.33E-01	7.28E-01	8.44E-01
U-238	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01	0.00E+00	7.60E-01	5.33E-01	7.28E-01	8.44E-01
U-Total	8.83E-01	8.64E-01	7.29E-01	9.76E-01	5.55E-01		7.60E-01	5.33E-01	7.28E-01	8.44E-01
Np-237	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-01		0.00E+00	0.00E+00	1.28E-01	2.86E-01
Pu-238	8.73E-01	9.14E-01	6.96E-01	9.75E-01	5.56E-01	0.00E+00	5.31E-01	5.33E-01	7.12E-01	8.41E-01
Pu-239	8.73E-01	9.14E-01	6.96E-01	9.75E-01	5.56E-01	0.00E+00	5.31E-01	5.33E-01	7.12E-01	8.41E-01
Pu-240	8.73E-01	9.14E-01	6.96E-01	9.75E-01	5.56E-01	0.00E+00	5.31E-01	5.33E-01	7.12E-01	8.41E-01
Pu-241	8.73E-01	9.14E-01	6.96E-01	9.75E-01	5.56E-01	0.00E+00	5.31E-01	5.33E-01	7.12E-01	8.41E-01
Pu-242	8.73E-01	9.14E-01	6.96E-01	9.75E-01	5.56E-01	0.00E+00	5.31E-01	5.33E-01	7.12E-01	8.41E-01
Pu-Total	8.73E-01	9.14E-01	6.96E-01	9.75E-01	5.56E-01		5.31E-01	5.33E-01	7.12E-01	8.41E-01
Am-241	9.34E-01	9.82E-01	0.00E+00	9.90E-01	5.00E-01		0.00E+00	5.49E-01	7.96E-01	9.05E-01
Am-243	9.34E-01	9.82E-01	0.00E+00	9.90E-01	5.00E-01	0.00E+00	0.00E+00	5.49E-01	7.96E-01	9.05E-01
Cm-242	7.74E-01	9.88E-01	8.99E-01	9.82E-01	3.82E-01	0.00E+00	0.00E+00	1.24E-01	3.50E-01	4.12E-01
Cm-243	7.74E-01	9.88E-01	8.99E-01	9.82E-01	3.82E-01	0.00E+00	0.00E+00	1.24E-01	3.50E-01	4.12E-01
Cm-244	7.74E-01	9.88E-01	8.99E-01	9.82E-01	3.82E-01		0.00E+00	1.24E-01	3.50E-01	4.12E-01

Solids Fraction Precipitated (Sheet 10)

frac. prec. solids	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3								
C-14	0.00E+00	0.00E+00	0.00E+00	8.51E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59	7.17E-01	1.66E-01	5.42E-01	8.02E-01	6.60E-01	7.99E-01	5.45E-01	0.00E+00
Ni-63	7.17E-01	1.66E-01	5.42E-01	8.02E-01	6.60E-01	7.99E-01	5.45E-01	0.00E+00
Co-60	3.53E-01	1.24E-01	3.50E-01	1.67E-01	9.80E-01	9.72E-01	0.00E+00	0.00E+00
Se-79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	8.85E-01	2.35E-01	8.21E-01	9.38E-01	9.98E-01	9.97E-01	0.00E+00	0.00E+00
Y-90	8.85E-01	2.35E-01	8.21E-01	9.38E-01	9.98E-01	9.97E-01	0.00E+00	0.00E+00
Zr-93	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.97E-01
Nb-93m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.97E-01
Tc-99								
Ru-106	2.69E-01	1.17E-01	1.80E-01	9.99E-01	3.39E-01	0.00E+00	9.94E-01	1.00E+00
Cd-113m	0.00E+00	0.00E+00	1.54E 01	0.00E+00	7.35E-01	5.54E-01	0.00E+00	0.00E+00
Sb-125	6.54E-01	0.00E+00	0.00E+00	1.85E-01	7.17E-01	5.02E-01	0.00E+00	0.00E+00
Sn-126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134								
Cs-137								
Ba-137m								
Sm-151	6.59E-01	0.00E+00	1.89E-01	2.51E-01	9.00E-01	8.22E-01	0.00E+00	0.00E+00
Eu-152	6.59E-01	0.00E+00	1.89E-01	2.51E-01	9.00E-01	8.22E-01	0.00E+00	0.00E+00
Eu-154	6.59E-01	0.00E+00	1.89E-01	2.51E-01	9.00E-01	8.22E-01	0.00E+00	0.00E+00
Eu-155	6.59E-01	0.00E+00	1.89E-01	2.51E-01	9.00E-01	8.22E-01	0.00E+00	0.00E+00
Ra-226	0.00E+00	0.00E+00	4.37E-02	0.00E+00	2.29E-01	0.00E+00	0.00E+00	0.00E+00
Ra-228	0.00E+00	0.00E+00	4.37E-02	0.00E+00	2.29E-01	0.00E+00	0.00E+00	0.00E+00
Ac-227	0.00E+00	0.00E+00	1.02E-01	0.00E+00	9.56E-02	0.00E+00	0.00E+00	0.00E+00
Pa-231	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-229	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-232	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
U-233	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
U-234	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
U-235	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
U-236	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
U-238	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
U-Total	5.87E-01	1.50E-01	4.29E-01	6.39E-01	9.87E-01	9.78E-01	9.47E-01	9.75E-01
Np-237	3.73E-01	1.22E-01	2.44E-01	0.00E+00	9.11E-01	8.41E-01	0.00E+00	0.00E+00
Pu-238	5.94E-01	1.49E-01	4.36E-01	6.65E-01	9.94E-01	9.89E-01	9.20E-01	8.97E-01
Pu-239	5.94E-01	1.49E-01	4.36E-01	6.65E-01	9.94E-01	9.89E-01	9.20E-01	8.97E-01
Pu-240	5.94E-01	1.49E-01	4.36E-01	6.65E-01	9.94E-01	9.89E-01	9.20E-01	8.97E-01
Pu-241	5.94E-01	1.49E-01	4.36E-01	6.65E-01	9.94E-01	9.89E-01	9.20E-01	8.97E-01
Pu-242	5.94E-01	1.49E-01	4.36E-01	6.65E-01	9.94E-01	9.89E-01	9.20E-01	8.97E-01
Pu-Total	5.94E-01	1.49E-01	4.36E-01	6.65E-01	9.94E-01	9.89E-01	9.20E-01	8.97E-01
Am-241	7.95E-01	1.83E-01	6.91E-01	8.62E-01	9.99E-01	9.98E-01	0.00E+00	6.86E-01
Am-243	7.95E-01	1.83E-01	6.91E-01	8.62E-01	9.99E-01	9.98E-01	0.00E+00	6.86E-01
Cm-242	4.47E-01	1.26E-01	3.87E-01	4.17E-01	9.99E-01	9.97E-01	0.00E+00	0.00E+00
Cm-243	4.47E-01	1.26E-01	3.87E-01	4.17E-01	9.99E-01	9.97E-01	0.00E+00	0.00E+00
Cm-244	4.47E-01	1.26E-01	3.87E-01	4.17E-01	9.99E-01	9.97E-01	0.00E+00	0.00E+00

Predicted Sludge Concentration (µg/g) (Sheet 1)

pred. sludge (µg/g)	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
Na	6.73E+04	8.19E+04	1.11E+05	1.08E+05	1.19E+05	9.97E+04	8.86E+04	7.89E+04	1.25E+05	1.40E+05
Al	0.00E+00	0.00E+00	1.15E+04	8.45E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe	3.71E+03	3.61E+03	1.40E+04	1.37E+04	2.17E+04	3.34E+04	2.95E+04	2.43E+04	4.96E+04	2.74E+04
Cr	2.74E+01	1.45E+01	1.47E+02	1.55E+02	7.46E+01	1.13E+02	1.74E+02	2.01E+02	4.23E+01	2.52E+01
Bi	9.84E+00	5.23E+00	1.26E+04	1.23E+04	2.04E+04	2.47E+04	4.33E+04	3.56E+04	9.56E+00	5.70E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E+04	1.62E+04	0.00E+00	0.00E+00
Hg	0.00E+00	4.50E+01	0.00E+00	1.05E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E+01	4.71E+01
ZrO(OH)2	0.00E+00	0.00E+00	3.12E+01	3.12E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	1.55E+01	8.21E+00	4.07E+01	4.31E+01	3.21E+01	3.53E+01	4.62E+01	5.34E+01	2.39E+01	5.37E+03
Sr	9.27E-01	1.82E+00	2.49E-03	3.79E-03	4.04E-05	4.95E-05	6.81E-07	1.42E-06	3.29E+00	2.90E+00
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.34E+03	7.68E+03	0.00E+00	0.00E+00
Ca	2.73E+03	2.65E+03	3.12E+03	3.04E+03	5.98E+03	1.20E+04	2.17E+04	1.78E+04	1.19E+04	8.77E+03
K	4.54E+00	2.41E+00	1.61E+02	1.71E+02	8.72E+01	6.29E+01	4.45E+03	5.14E+03	1.56E+02	9.81E+01
balance	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	9.92E+01	1.00E+02
density	1.80E+00	1.85E+00	1.41E+00	1.38E+00	1.45E+00	1.42E+00	1.48E+00	1.39E+00	1.78E+00	1.59E+00
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
void frac.	2.70E-01	1.45E-01	5.74E-01	5.99E-01	4.76E-01	5.26E-01	7.26E-01	7.89E-01	4.45E-01	2.34E-01
wt.% H2O	4.38E+01	4.14E+01	6.36E+01	6.51E+01	6.28E+01	6.35E+01	5.03E+01	5.68E+01	5.31E+01	5.46E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E+00	3.03E+00	1.11E-04	5.32E-01
free OH-	9.24E+01	4.82E+01	7.01E+02	6.65E+02	2.01E+02	4.41E+02	6.58E+02	7.60E+02	9.81E+00	1.67E+01
OH-	1.15E+05	1.12E+05	3.58E+04	2.95E+04	2.00E+04	3.09E+04	4.63E+04	3.83E+04	4.79E+04	2.38E+04
NO3-	1.15E+03	4.72E+02	4.40E+04	4.63E+04	2.63E+04	1.86E+04	4.22E+04	4.87E+04	1.69E+04	4.68E+03
NO2-	5.44E+02	3.93E+02	1.31E+03	1.12E+03	1.76E+00	1.12E+00	3.75E-02	6.46E-02	2.37E+04	1.82E+04
CO3--	1.32E+04	3.49E+04	4.67E+03	4.55E+03	8.95E+03	1.80E+04	3.24E+04	2.67E+04	2.05E+04	1.31E+04
PO4---	5.19E+04	5.04E+04	1.12E+05	1.10E+05	1.39E+05	1.20E+05	2.12E+04	1.79E+04	1.17E+05	8.77E+04
SO4--	4.57E+04	4.43E+04	2.90E+03	3.07E+03	1.63E+03	1.12E+03	1.42E+02	1.64E+02	4.07E+04	9.35E+04
SiO3--	1.85E+01	9.82E+00	7.42E+03	6.24E+03	7.77E+03	7.32E+03	0.00E+00	0.00E+00	0.00E+00	1.03E+04
F-	0.00E+00	0.00E+00	1.53E+03	1.62E+03	1.43E+03	9.67E+02	2.52E+03	2.92E+03	0.00E+00	6.05E+02
Cl-	1.89E+01	1.01E+01	6.71E+02	7.11E+02	3.64E+02	2.62E+02	5.01E+02	5.79E+02	8.59E+02	4.09E+02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+05	1.11E+05	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E+00	0.00E+00
butanol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.72E-01	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	8.05E-01	4.54E-01	7.64E+02	5.89E+02	2.86E-07	1.96E-07	1.73E-10	5.13E-10	1.25E+02	7.79E+01
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E+04

Predicted Sludge Concentration (µg/g) (Sheet 2)

pred. sludge (µg/g)	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
Na	1.40E+05	6.32E+04	5.55E+04	5.38E+04	7.23E+04	9.57E+04	2.16E+04	6.45E+04	1.03E+05	6.93E+04
Al	0.00E+00	7.15E+02	0.00E+00	1.12E+05	8.35E+04	1.60E+05	1.08E+05	0.00E+00	0.00E+00	0.00E+00
Fe	2.56E+04	7.12E+03	6.73E+03	3.30E+04	5.33E+04	5.80E+03	1.77E+04	1.07E+05	1.09E+05	9.11E+04
Cr	2.50E+01	1.66E+02	6.36E+01	4.05E+04	5.75E+04	6.98E+01	8.19E+01	2.31E+02	1.53E+02	1.30E+02
Bi	5.65E+00	3.72E+01	6.75E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	4.75E+01	1.81E-01	8.00E+01	1.99E+01	5.39E+01	0.00E+00	0.00E+00	1.62E+02	8.30E+01	0.00E+00
ZrO(OH)2	0.00E+00	4.93E+00	8.08E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	9.53E-01	0.00E+00	0.00E+00	0.00E+00	1.12E+04	1.89E+04	1.28E+01	8.84E+02	0.00E+00
Ni	4.84E+03	1.79E+04	1.49E+04	1.72E+03	2.44E+03	3.94E+01	4.62E+01	4.30E+03	2.23E+03	3.31E+03
Sr	5.13E+03	8.77E-01	1.65E-01	1.51E+01	8.14E+01	5.53E-03	1.12E-02	1.43E+02	1.87E+02	5.94E-03
Mn	0.00E+00	0.00E+00	0.00E+00	3.80E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	8.85E+03	2.00E+04	1.56E+04	7.74E+03	1.11E+04	4.51E+03	1.37E+04	1.91E+04	9.86E+03	1.50E+04
K	9.73E+01	4.03E+02	1.00E+02	4.18E+02	2.83E+02	3.96E+01	7.08E+01	6.81E+01	8.10E+01	1.80E+02
balance	1.00E+02	9.98E+01	1.02E+02	1.05E+02	1.08E+02	1.02E+02	1.01E+02	1.01E+02	1.01E+02	1.00E+02
density	1.58E+00	1.32E+00	1.40E+00	1.72E+00	1.79E+00	1.60E+00	1.46E+00	1.38E+00	1.51E+00	1.79E+00
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
void frac.	2.29E-01	9.16E-01	8.51E-01	6.86E-01	6.40E-01	6.90E-01	7.50E-01	7.59E-01	5.47E-01	5.56E-01
wt.% H2O	5.44E+01	6.96E+01	6.90E+01	4.08E+01	4.25E+01	3.14E+01	5.17E+01	6.26E+01	5.36E+01	4.62E+01
TOC wt.%C	2.68E-01	9.10E-01	8.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
free OH-	-3.44E+00	3.80E+02	1.04E+03	1.19E+04	1.08E+04	1.32E+02	1.75E+02	1.72E+03	1.13E+03	2.82E+02
OH-	2.69E+04	7.88E+03	1.40E+04	3.06E+05	2.82E+05	3.60E+05	2.38E+05	1.04E+05	1.06E+05	1.24E+05
NO3-	5.03E+03	4.12E+04	1.90E+04	2.88E+02	2.81E-05	2.40E+04	2.81E+04	2.92E-12	3.04E-14	5.55E+04
NO2-	1.78E+04	5.88E+04	6.00E+03	5.53E+04	4.45E+04	2.86E+04	6.90E+03	1.15E+04	1.22E+04	3.93E+02
CO3--	1.33E+04	3.40E+04	2.35E+04	1.16E+04	1.66E+04	6.76E+03	2.05E+04	2.86E+04	1.48E+04	2.24E+04
PO4---	8.85E+04	4.16E+03	3.65E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.50E+04
SO4--	9.44E+04	7.67E+03	1.25E+03	7.40E+02	1.04E+03	3.90E+02	3.02E+02	2.33E+03	6.60E+04	1.69E+03
SiO3--	1.04E+04	9.95E+01	1.86E+04	1.69E+03	1.69E+04	4.40E+03	0.00E+00	3.40E+04	3.90E+04	0.00E+00
F-	5.99E+02	1.21E+03	2.65E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl-	4.05E+02	2.02E+03	4.19E+02	1.35E+03	1.18E+03	1.65E+02	2.95E+02	2.84E+02	3.38E+02	7.52E+02
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	2.68E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
butanol	0.00E+00	9.43E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	7.27E+01	9.54E+02	4.43E+00	1.67E+03	4.13E+03	6.35E-01	2.19E-01	1.84E+03	1.50E+03	5.10E-03
NiFe(CN)6--	1.01E+04	3.42E+04	3.23E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Sludge Concentration (µg/g) (Sheet 3)

pred. sludge (µg/g)	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
Na	3.73E+04	1.95E+04	9.32E+04	6.91E+03	1.18E+04	1.88E+04	2.45E+04	3.69E+04	7.08E+04	7.08E+04
Al	1.03E+05	1.11E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E+05	0.00E+00	1.39E+04	1.39E+04
Fe	6.87E+03	1.80E+04	5.54E+03	1.18E+05	1.24E+05	1.36E+05	5.37E+04	8.01E+04	4.63E+04	4.63E+04
Cr	9.74E+01	8.35E+01	1.06E+02	1.89E+02	1.91E+02	2.16E+02	1.47E+02	1.46E+03	2.69E+02	2.69E+02
Bi	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.51E+02	0.00E+00	0.00E+00
ZrO(OH)2	0.00E+00	0.00E+00	6.68E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	1.24E+04	2.24E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E+04	0.00E+00	0.00E+00
Ni	5.50E+01	4.71E+01	5.97E+01	7.16E+03	7.50E+03	8.23E+03	3.23E+03	1.70E+02	1.76E+03	1.76E+03
Sr	7.10E-03	5.18E-03	3.88E-01	4.22E-03	1.59E-03	3.25E-04	0.00E+00	1.30E+00	2.33E+00	2.65E+00
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.66E+04	1.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	5.34E+03	1.40E+04	4.32E+03	3.19E+04	3.34E+04	3.69E+04	1.45E+04	1.42E+02	7.77E+03	7.77E+03
K	3.60E+01	5.15E+01	5.79E+03	1.77E+01	2.42E+02	1.12E+02	1.49E+02	2.51E+03	7.03E+02	7.03E+02
balance	1.02E+02	1.01E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	9.98E+01	9.99E+01
density	1.35E+00	1.43E+00	1.30E+00	1.64E+00	1.56E+00	1.42E+00	1.76E+00	1.30E+00	1.32E+00	1.32E+00
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
void frac.	8.22E-01	7.49E-01	8.55E-01	7.40E-01	7.14E-01	7.39E-01	5.23E-01	9.42E-01	8.43E-01	8.43E-01
wt.% H2O	5.74E+01	5.28E+01	6.53E+01	5.16E+01	4.85E+01	5.56E+01	2.91E+01	6.32E+01	6.35E+01	6.35E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	3.96E-01	1.47E-01	1.39E-01	0.00E+00	1.79E+00	3.66E-02	3.63E-02
free OH-	1.94E+02	1.68E+02	2.42E+03	3.16E+02	6.42E+01	5.58E+02	1.50E+03	3.23E+03	2.75E+02	2.75E+02
OH-	2.14E+05	2.39E+05	6.14E+04	1.54E+05	1.82E+05	1.35E+05	3.73E+05	9.60E+04	7.33E+04	7.33E+04
NO3-	2.59E+04	2.23E+04	1.07E+04	6.43E+03	1.07E+04	3.04E+04	4.80E+04	2.70E+04	7.10E+04	7.35E+04
NO2-	2.23E+04	6.88E+03	1.95E+03	2.39E+02	2.25E+02	2.45E+02	1.94E+02	1.63E+04	2.96E+04	2.78E+04
CO3--	7.99E+03	2.09E+04	6.46E+03	5.32E+04	6.05E+04	6.41E+04	2.50E+04	2.13E+02	1.16E+04	1.16E+04
PO4---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E+00	0.00E+00	2.91E+04	2.91E+04
SO4--	5.18E+02	3.39E+02	9.77E+01	1.74E+02	1.76E+02	2.00E+02	1.97E+02	4.70E+03	3.36E+03	3.36E+03
SiO3--	2.64E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F-	0.00E+00	0.00E+00	7.32E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.48E+03	1.48E+03
Cl-	1.50E+02	2.15E+02	1.36E+02	7.39E+01	1.12E+02	3.93E+02	9.51E+02	1.26E+03	1.45E+03	1.45E+03
C6H5O7---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.48E+03	0.00E+00	0.00E+00
EDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E+04	0.00E+00	0.00E+00
HEDTA---	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.18E+04	0.00E+00	0.00E+00
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	5.78E+03	2.14E+03	2.02E+03	0.00E+00	0.00E+00	5.34E+02	5.30E+02
butanol	0.00E+00	0.00E+00	0.00E+00	2.04E+03	7.56E+02	7.14E+02	0.00E+00	0.00E+00	1.88E+02	1.87E+02
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	6.27E-01	9.23E-02	8.63E+03	4.38E-03	1.06E-03	1.70E-04	0.00E+00	5.04E+01	1.45E+02	1.28E-02
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Sludge Concentration (µg/g) (Sheet 4)

pred. sludge (µg/g)	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
Na	1.04E+05	1.59E+05	1.83E+05	1.22E+05	9.10E+04	4.67E+03	1.70E+05	1.82E+05	1.90E+05	2.02E+05
Al	1.43E+03	1.85E+04	3.84E+04	0.00E+00	7.04E+03	0.00E+00	1.08E+02	4.32E+04	1.80E+04	4.54E+04
Fe	5.42E+04	3.29E+04	4.42E+02	5.58E+04	1.17E+04	8.21E+01	4.73E+03	6.44E+02	7.00E+02	9.37E+02
Cr	5.46E+02	2.87E+01	4.84E-03	0.00E+00	1.12E+03	3.26E+02	1.41E+02	1.44E+04	2.31E+03	1.46E+03
Bi	2.62E-01	0.00E+00	0.00E+00	0.00E+00	7.22E-01	0.00E+00	3.93E+03	3.04E-02	2.95E+01	1.39E+01
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.12E-09	1.01E-04
Hg	1.17E+02	1.35E+02	1.27E+02	6.93E+02	1.80E+01	0.00E+00	3.64E+00	1.66E+00	7.83E-01	4.55E-01
ZrO(OH)2	2.29E-03	0.00E+00	0.00E+00	0.00E+00	9.94E-02	0.00E+00	7.73E+00	4.28E-03	7.14E+00	2.28E+00
Pb	2.86E+01	8.04E+03	0.00E+00	0.00E+00	6.89E+01	0.00E+00	0.00E+00	1.19E+01	7.77E+01	5.61E+02
Ni	6.09E+03	1.25E+03	2.73E+02	0.00E+00	1.12E+04	2.11E+04	5.06E+02	6.30E+02	5.77E+02	5.98E+02
Sr	1.47E+02	1.18E+02	6.27E-01	1.72E+02	5.08E+00	0.00E+00	1.52E-02	3.17E-01	4.87E-01	1.33E+00
Mn	5.99E+00	0.00E+00	0.00E+00	0.00E+00	1.21E+01	0.00E+00	0.00E+00	4.45E+01	1.40E+01	2.58E+01
Ca	2.39E+03	2.91E+04	1.93E+02	8.87E+03	1.56E+04	3.26E+04	1.77E+03	8.78E+02	8.81E+02	8.86E+02
K	1.84E+02	2.98E+01	2.73E+02	2.76E+02	5.53E+02	2.12E+01	2.55E+02	9.92E+02	1.23E+03	1.04E+03
balance	1.01E+02	1.02E+02	1.02E+02	1.02E+02	1.02E+02	1.00E+02	1.00E+02	1.06E+02	1.03E+02	1.03E+02
density	1.34E+00	1.74E+00	1.50E+00	1.51E+00	1.31E+00	1.12E+00	1.70E+00	1.64E+00	1.63E+00	1.72E+00
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00	1.00E+00	7.96E+00	1.30E+01	4.30E+01	5.40E+01
void frac.	8.22E-01	4.80E-01	6.98E-01	7.81E-01	8.88E-01	8.77E-01	5.08E-01	8.62E-01	7.75E-01	7.08E-01
wt.% H2O	6.86E+01	5.27E+01	5.24E+01	6.22E+01	6.86E+01	8.69E+01	4.30E+01	4.02E+01	3.74E+01	2.74E+01
TOC wt.%C	0.00E+00	1.99E-02	2.90E+00	2.28E-04	3.28E-01	0.00E+00	1.01E-04	5.29E-02	7.99E-01	7.52E-01
free OH-	9.28E+02	8.51E+02	3.38E+02	1.73E+04	1.15E+04	6.84E+02	9.18E+02	3.02E+04	1.72E+04	8.95E+03
OH-	5.92E+04	7.80E+04	7.74E+04	8.20E+04	4.76E+04	1.28E+04	6.06E+03	1.53E+05	6.44E+04	1.25E+05
NO3-	4.77E-05	1.16E-06	2.03E+04	7.41E-07	5.27E+04	7.62E+03	2.77E+05	2.02E+05	2.87E+05	2.77E+05
NO2-	2.19E+04	3.58E+03	3.91E+03	1.55E+04	2.69E+04	8.66E+02	2.54E+03	5.19E+04	3.91E+04	4.80E+04
CO3--	8.62E+03	4.36E+04	7.54E+03	2.07E+04	3.07E+04	4.85E+04	5.57E+03	1.93E+03	1.22E+04	1.43E+04
PO4---	1.30E+03	0.00E+00	4.42E+02	0.00E+00	4.16E+02	0.00E+00	5.91E+04	2.58E+01	2.84E+03	2.44E+03
SO4--	4.38E+03	4.52E+02	1.97E+03	5.10E+03	6.14E+03	2.70E+03	3.40E+04	2.65E+03	1.54E+04	1.47E+04
SiO3--	5.21E+04	9.50E+04	8.78E+04	5.00E+04	1.62E+04	0.00E+00	1.92E+03	1.59E+03	6.39E+02	5.42E+02
F-	5.16E+00	0.00E+00	0.00E+00	0.00E+00	2.11E+01	0.00E+00	1.10E+03	1.83E+00	1.13E+03	8.29E+02
Cl-	4.15E+02	1.24E+02	1.14E+03	1.15E+03	1.69E+03	8.82E+01	1.25E+03	3.52E+03	3.97E+03	3.10E+03
C6H5O7---	0.00E+00	5.21E+02	1.32E+03	0.00E+00	3.54E+03	0.00E+00	0.00E+00	1.60E+02	1.52E+03	2.85E+03
EDTA----	0.00E+00	0.00E+00	2.01E+04	0.00E+00	6.87E+02	0.00E+00	0.00E+00	2.63E+02	4.59E+03	3.38E+03
HEDTA---	0.00E+00	0.00E+00	3.82E+04	0.00E+00	1.31E+03	0.00E+00	0.00E+00	5.00E+02	8.69E+03	4.25E+03
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	0.00E+00	0.00E+00	1.05E+04	0.00E+00	3.58E+02	0.00E+00	0.00E+00	1.37E+02	2.38E+03	1.16E+03
acetate-	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.06E+00	3.03E+01	1.50E+03
oxalate--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-05	3.21E-01
DBP	0.00E+00	0.00E+00	0.00E+00	3.32E+00	2.10E+03	0.00E+00	1.48E+00	1.39E+02	1.35E+03	3.19E+03
butanol	0.00E+00	0.00E+00	0.00E+00	1.17E+00	0.00E+00	0.00E+00	5.21E-01	4.89E+01	4.76E+02	1.12E+03
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	2.57E+03	2.61E+02	2.91E+00	1.95E+03	2.84E+02	0.00E+00	4.74E+02	3.68E+02	9.58E+02	3.75E+02
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Sludge Concentration (µg/g) (Sheet 5)

pred. sludge (µg/g)	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
Na	2.02E+05	2.00E+05	2.03E+05	1.99E+05	5.10E+04	3.32E+04	1.03E+04	9.17E+04
Al	2.88E+04	3.24E+04	3.06E+04	2.02E+04	6.31E+04	5.97E+04	0.00E+00	0.00E+00
Fe	6.28E+02	1.07E+02	6.76E+02	1.97E+03	7.58E+04	6.51E+04	8.32E+04	1.56E+04
Cr	4.39E+03	2.45E+03	2.56E+03	1.43E+03	2.77E+02	6.15E+02	2.77E+02	0.00E+00
Bi	1.59E+01	2.55E+01	2.02E+01	1.69E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	6.61E-04	6.71E-04	4.72E-04	3.50E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	7.94E-01	2.87E-01	8.02E-01	4.66E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ZrO(OH)2	3.64E+00	5.98E+00	4.31E+00	9.59E+00	0.00E+00	0.00E+00	0.00E+00	6.63E+04
Pb	9.91E+01	1.25E+02	1.85E+02	5.92E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	4.74E+02	1.04E+02	4.44E+02	1.27E+03	3.02E+03	4.08E+03	5.07E+03	0.00E+00
Sr	5.76E-01	5.59E-02	7.66E-01	1.97E+00	3.07E+02	1.22E+02	7.06E-04	1.60E-02
Mn	4.39E+01	2.97E+01	3.05E+01	8.04E+01	0.00E+00	0.00E+00	1.17E+04	0.00E+00
Ca	6.17E+02	1.45E+02	5.40E+02	1.80E+03	5.69E+03	1.66E+03	2.24E+04	4.28E+03
K	1.48E+03	1.78E+03	1.64E+03	3.48E+03	1.48E+02	1.13E+02	1.82E+02	5.70E+03
balance	1.05E+02	1.05E+02	1.05E+02	1.04E+02	1.01E+02	9.94E+01	1.00E+02	1.00E+02
density	1.67E+00	1.64E+00	1.67E+00	1.65E+00	1.56E+00	1.38E+00	1.28E+00	1.31E+00
vol% solids	3.61E+01	2.80E+01	1.89E+01	2.09E+01	4.43E+00	7.61E+00	2.00E+00	1.05E+01
void frac.	8.28E-01	9.03E-01	8.34E-01	8.18E-01	7.28E-01	8.37E-01	8.50E-01	8.48E-01
wt.% H2O	3.52E+01	3.78E+01	3.52E+01	3.57E+01	4.64E+01	5.71E+01	6.88E+01	6.36E+01
TOC wt.%C	1.25E+00	1.41E+00	1.59E+00	2.68E+00	0.00E+00	0.00E+00	3.27E-02	0.00E+00
free OH-	2.72E+04	3.00E+04	2.53E+04	1.93E+04	5.64E+03	4.20E+03	2.52E+02	8.68E+02
OH-	1.04E+05	1.13E+05	1.04E+05	7.29E+04	2.13E+05	1.85E+05	1.03E+05	6.81E+04
NO3-	2.36E+05	1.91E+05	1.99E+05	1.98E+05	2.68E-06	3.42E+02	1.06E+04	1.54E+04
NO2-	5.52E+04	6.40E+04	6.26E+04	4.88E+04	5.63E+04	4.49E+04	3.08E+02	5.39E+02
CO3--	1.23E+04	1.45E+04	1.82E+04	3.02E+04	8.51E+03	2.48E+03	3.77E+04	6.41E+03
PO4---	2.24E+03	3.07E+03	3.00E+03	1.90E+04	0.00E+00	0.00E+00	4.40E+03	0.00E+00
SO4--	1.23E+04	9.99E+03	2.06E+04	7.63E+03	2.49E+04	1.04E+04	2.56E+02	0.00E+00
SiO3--	6.88E+02	2.66E+02	6.47E+02	1.43E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F-	6.22E+02	9.92E+02	9.00E+02	1.89E+03	4.64E+02	3.72E+02	0.00E+00	7.26E+04
Cl-	4.70E+03	5.68E+03	5.17E+03	4.91E+03	6.18E+02	4.71E+02	1.09E+02	1.07E+02
C6H5O7---	2.90E+03	3.15E+03	3.68E+03	3.33E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA----	7.17E+03	8.08E+03	9.01E+03	1.70E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA---	1.34E+04	1.52E+04	1.61E+04	3.16E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate-	3.67E+03	4.15E+03	4.39E+03	8.64E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate-	1.65E+02	1.55E+02	7.51E+02	4.87E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate--	2.09E+00	2.13E+00	1.50E+00	1.11E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	1.82E+03	2.13E+03	2.90E+03	2.41E+03	0.00E+00	0.00E+00	4.77E+02	0.00E+00
butanol	6.43E+02	7.53E+02	1.02E+03	8.50E+02	0.00E+00	0.00E+00	1.68E+02	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	7.22E+02	1.01E+03	7.84E+02	3.67E+03	6.39E+03	1.50E+03	1.73E-04	8.49E+03
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Sludge Concentration (µCi/g) (Sheet 1)

pred. sludge (µCi/g)	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3 (µCi/g)	1.74E-03	2.03E-03	1.19E-03	2.64E-03	2.75E-08	6.59E-07	8.49E-11	8.53E-09	1.53E-03	9.14E-04
C-14 (µCi/g)	8.24E-05	4.14E-04	3.89E-05	3.50E-05	1.90E-06	2.08E-06	1.90E-07	3.53E-07	5.94E-05	3.54E-05
Ni-59 (µCi/g)	1.25E-05	1.08E-05	7.85E-06	1.15E-05	4.98E-07	5.43E-07	4.96E-08	9.21E-08	1.55E-05	8.44E-04
Ni-63 (µCi/g)	1.06E-03	9.50E-04	1.15E-03	1.59E-03	4.25E-05	4.79E-05	4.23E-06	8.14E-06	1.35E-03	7.38E-02
Co-60 (µCi/g)	2.26E-05	3.78E-05	4.53E-05	1.38E-04	9.03E-07	1.91E-06	8.99E-08	3.24E-07	4.62E-05	2.76E-05
Se-79 (µCi/g)	2.13E-06	1.87E-06	8.31E-07	1.15E-06	8.51E-08	9.43E-08	8.47E-09	1.60E-08	2.68E-06	1.60E-06
Sr-90 (µCi/g)	4.14E+01	8.16E+01	1.11E-01	1.69E-01	1.80E-03	2.21E-03	3.05E-05	6.37E-05	1.47E+02	1.30E+02
Y-90 (µCi/g)	4.15E+01	8.16E+01	1.11E-01	1.69E-01	1.80E-03	2.21E-03	3.05E-05	6.37E-05	1.47E+02	1.30E+02
Zr-93 (µCi/g)	5.77E-07	5.00E-07	1.11E-03	1.43E-03	5.18E-05	5.67E-05	0.00E+00	0.00E+00	7.20E-07	4.30E-07
Nb-93m (µCi/g)	5.19E-07	4.38E-07	9.99E-04	1.26E-03	4.66E-05	4.97E-05	0.00E+00	0.00E+00	6.36E-07	3.80E-07
Tc-99 (µCi/g)	1.03E-03	9.04E-04	6.26E-05	8.76E-05	1.02E-06	1.13E-06	1.72E-08	3.24E-08	9.34E-04	5.57E-04
Ru-106 (µCi/g)	2.26E-17	7.94E-16	1.76E-14	5.71E-13	1.62E-15	7.20E-14	4.03E-16	3.06E-14	7.93E-16	4.73E-16
Cd-113m (µCi/g)	5.01E-05	6.16E-05	3.48E-05	6.99E-05	2.00E-06	3.11E-06	1.99E-07	5.27E-07	8.05E-05	4.80E-05
Sb-125 (µCi/g)	6.56E-07	2.16E-06	5.53E-07	2.01E-06	2.62E-08	1.09E-07	2.61E-09	1.85E-08	2.39E-06	1.43E-06
Sn-126 (µCi/g)	7.69E-06	7.19E-06	3.00E-06	4.49E-06	3.07E-07	3.63E-07	3.06E-08	6.16E-08	1.01E-05	6.04E-06
I-129 (µCi/g)	4.56E-07	1.03E-06	3.08E-08	7.65E-07	4.50E-10	0.00E+00	7.59E-12	0.00E+00	1.20E-06	7.15E-07
Cs-134 (µCi/g)	2.82E-09	2.47E-08	1.71E-10	2.34E-09	2.78E-12	3.07E-11	4.70E-14	8.84E-13	2.55E-08	1.48E-06
Cs-137 (µCi/g)	2.10E+00	2.07E+00	1.28E-01	1.98E-01	2.07E-03	2.58E-03	3.50E-05	7.42E-05	2.87E+00	1.67E+02
Ba-137m (µCi/g)	1.98E+00	1.95E+00	1.20E-01	1.87E-01	1.96E-03	2.43E-03	3.30E-05	7.01E-05	2.71E+00	1.57E+02
Sm-151 (µCi/g)	8.06E-02	6.86E-02	6.95E-02	9.18E-02	1.79E-02	1.92E-02	5.93E-03	1.09E-02	9.94E-02	5.93E-02
Eu-152 (µCi/g)	9.98E-07	3.28E-06	8.61E-07	5.03E-06	2.21E-07	9.19E-07	7.35E-08	5.20E-07	3.63E-06	2.17E-06
Eu-154 (µCi/g)	9.67E-05	2.41E-04	8.34E-05	3.52E-04	2.14E-05	6.75E-05	7.12E-06	3.82E-05	2.76E-04	1.65E-04
Eu-155 (µCi/g)	7.84E-05	1.32E-04	6.76E-05	1.60E-04	1.74E-05	3.71E-05	5.77E-06	2.10E-05	1.61E-04	9.64E-05
Ra-226 (µCi/g)	1.88E-07	1.01E-07	6.09E-09	3.79E-09	6.25E-10	3.40E-10	6.22E-11	5.77E-11	1.28E-08	7.63E-09
Ra-228 (µCi/g)	6.31E-13	5.97E-13	2.04E-14	2.46E-14	2.10E-15	2.00E-15	2.09E-16	3.40E-16	5.98E-14	3.57E-14
Ac-227 (µCi/g)	6.42E-07	2.73E-07	1.82E-08	1.15E-08	5.32E-09	2.96E-09	2.65E-09	2.51E-09	6.19E-08	3.70E-08
Pa-231 (µCi/g)	6.23E-10	2.92E-10	3.78E-07	2.51E-07	1.12E-07	6.64E-08	5.57E-08	5.64E-08	5.33E-10	3.18E-10
Th-229 (µCi/g)	2.50E-12	1.90E-12	1.41E-11	1.71E-11	4.15E-12	3.98E-12	2.07E-12	3.38E-12	2.86E-12	1.70E-12
Th-232 (µCi/g)	2.10E-14	1.62E-14	1.18E-13	1.44E-13	3.47E-14	3.39E-14	1.73E-14	2.87E-14	2.42E-14	1.44E-14
U-232 (µCi/g)	7.45E-07	1.27E-06	4.21E-09	6.03E-09	7.71E-12	9.08E-12	2.86E-14	5.74E-14	2.54E-08	1.87E-08
U-233 (µCi/g)	6.60E-08	9.96E-08	3.72E-10	4.56E-10	6.82E-13	7.13E-13	2.53E-15	4.50E-15	2.07E-09	1.52E-09
U-234 (µCi/g)	8.53E-02	8.32E-02	4.66E-04	3.33E-04	8.82E-07	5.96E-07	3.27E-09	3.76E-09	2.04E-03	1.50E-03
U-235 (µCi/g)	3.85E-03	3.68E-03	2.10E-05	1.47E-05	3.98E-08	2.64E-08	1.48E-10	1.67E-10	9.09E-05	6.70E-05
U-236 (µCi/g)	7.28E-04	1.13E-03	3.98E-06	4.94E-06	7.53E-09	8.09E-09	2.79E-11	5.11E-11	2.33E-05	1.72E-05
U-238 (µCi/g)	8.68E-02	8.50E-02	4.74E-04	3.40E-04	8.97E-07	6.08E-07	3.33E-09	3.84E-09	2.08E-03	1.53E-03
U-Total (µg/g)	2.60E+05	2.55E+05	1.42E+03	1.02E+03	2.69E+00	1.82E+00	9.97E-03	1.15E-02	6.22E+03	4.58E+03
Np-237 (µCi/g)	5.81E-06	5.20E-06	1.42E-06	2.02E-06	4.13E-07	4.67E-07	2.05E-07	3.96E-07	7.41E-06	4.42E-06
Pu-238 (µCi/g)	2.09E-06	5.02E-05	2.41E-04	8.93E-04	4.79E-05	1.95E-04	7.88E-06	6.00E-04	5.29E-06	3.15E-06
Pu-239 (µCi/g)	6.05E-04	5.66E-03	6.97E-02	8.78E-02	1.38E-02	2.20E-02	2.28E-03	6.77E-02	7.41E-04	4.42E-04
Pu-240 (µCi/g)	4.08E-05	7.18E-04	4.71E-03	1.24E-02	9.34E-04	2.79E-03	1.54E-04	8.58E-03	7.98E-05	4.76E-05
Pu-241 (µCi/g)	3.95E-05	1.58E-03	4.55E-03	2.87E-02	9.03E-04	6.14E-03	1.49E-04	1.88E-02	1.56E-04	9.29E-05
Pu-242 (µCi/g)	1.85E-10	1.15E-08	2.13E-08	2.17E-07	4.22E-09	4.46E-08	6.95E-10	1.37E-07	1.09E-09	6.52E-10
Pu-Total (µg/g)	9.92E-03	9.44E-02	1.14E+00	1.47E+00	2.27E-01	3.68E-01	3.74E-02	1.13E+00	1.23E-02	7.33E-03
Am-241 (µCi/g)	1.26E-04	3.64E-04	4.25E-05	2.25E-04	8.95E-06	3.27E-05	4.45E-06	2.77E-05	4.09E-04	2.44E-04
Am-243 (µCi/g)	5.45E-09	5.64E-08	1.33E-09	2.59E-08	3.87E-10	5.06E-09	1.93E-10	4.29E-09	5.78E-08	3.45E-08
Cm-242 (µCi/g)	9.54E-09	9.70E-08	2.33E-09	4.46E-08	6.78E-10	8.71E-09	3.37E-10	7.39E-09	9.96E-08	5.95E-08
Cm-243 (µCi/g)	5.64E-11	1.17E-09	1.38E-11	5.42E-10	4.01E-12	1.05E-10	1.99E-12	8.93E-11	1.18E-09	7.04E-10
Cm-244 (µCi/g)	1.32E-09	2.75E-08	3.23E-10	1.27E-08	9.40E-11	2.47E-09	4.67E-11	2.10E-09	2.77E-08	1.66E-08

Predicted Sludge Concentration (µCi/g) (Sheet 2)

pred. sludge (uCi/g)	PFeCN2	TFeCN	ICFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3 (µCi/g)	9.06E-04	4.37E-03	1.48E-04	1.10E-02	5.59E-02	6.65E-02	1.44E-01	2.14E-03	4.26E-03	6.52E-04
C-14 (µCi/g)	3.51E-05	1.52E-04	1.68E-04	6.03E-04	3.49E-04	7.30E-04	9.79E-04	1.35E-03	1.08E-03	6.27E-06
Ni-59 (µCi/g)	7.61E-04	2.20E-03	2.81E-04	2.85E-03	9.78E-03	8.78E-04	7.13E-03	2.46E-02	2.80E-02	5.91E-05
Ni-63 (µCi/g)	6.65E-02	2.06E-01	2.53E-02	2.57E-01	9.25E-01	8.56E-02	6.83E-01	2.29E+00	2.69E+00	5.70E-03
Co-60 (µCi/g)	2.73E-05	2.09E-04	3.86E-05	8.14E-04	4.83E-03	4.03E-03	1.32E-01	6.80E-03	5.04E-01	4.22E-05
Se-79 (µCi/g)	1.59E-06	6.05E-06	1.35E-06	2.79E-05	7.53E-05	3.08E-07	5.20E-07	1.32E-04	1.96E-04	2.63E-07
Sr-90 (µCi/g)	1.42E+02	3.92E+01	7.37E+00	7.78E+02	4.19E+03	2.84E-01	5.77E-01	7.79E+03	1.02E+04	3.24E-01
Y-90 (µCi/g)	1.42E+02	3.92E+01	7.38E+00	7.79E+02	4.19E+03	2.85E-01	5.77E-01	7.79E+03	1.02E+04	3.24E-01
Zr-93 (µCi/g)	4.26E-07	2.01E-04	2.67E-02	1.67E-03	4.50E-03	1.84E-05	3.12E-05	7.86E-03	1.17E-02	1.56E-05
Nb-93m (µCi/g)	3.76E-07	1.78E-04	2.30E-02	1.44E-03	3.63E-03	1.58E-05	2.50E-05	6.53E-03	9.20E-03	1.17E-05
Tc-99 (µCi/g)	5.52E-04	2.01E-03	9.67E-05	1.06E-02	2.82E-02	1.34E-04	2.24E-04	4.14E-02	6.12E-02	1.12E-04
Ru-106 (µCi/g)	4.69E-16	1.62E-13	3.51E-12	2.23E-11	1.34E-08	5.49E-13	9.32E-11	2.07E-09	3.30E-06	1.72E-09
Cd-113m (µCi/g)	4.76E-05	2.02E-04	4.62E-05	1.15E-03	4.49E-03	8.47E-04	1.76E-03	6.95E-03	1.35E-02	2.32E-05
Sb-125 (µCi/g)	1.41E-06	5.48E-06	2.69E-06	7.10E-05	1.08E-02	8.35E-06	1.20E-05	1.03E-03	1.12E-01	2.05E-05
Sn-126 (µCi/g)	5.98E-06	2.28E-05	4.87E-06	1.13E-04	3.05E-04	1.24E-06	2.08E-06	5.46E-04	8.17E-04	1.13E-06
I-129 (µCi/g)	7.08E-07	4.42E-06	9.33E-07	1.70E-05	4.36E-05	1.89E-07	3.15E-07	2.47E-06	3.68E-06	0.00E+00
Cs-134 (µCi/g)	1.49E-06	1.57E-06	1.13E-07	1.58E-06	1.00E-04	2.62E-08	6.17E-07	3.90E-05	3.63E-04	2.91E-06
Cs-137 (µCi/g)	1.68E+02	1.78E+02	9.16E+00	3.00E+01	9.61E+01	3.36E-01	6.71E-01	1.57E+02	2.62E+02	3.81E-01
Ba-137m (µCi/g)	1.59E+02	1.68E+02	8.65E+00	2.83E+01	9.07E+01	3.17E-01	6.34E-01	1.48E+02	2.48E+02	3.60E-01
Sm-151 (µCi/g)	5.88E-02	2.45E-01	1.20E-01	1.17E+00	1.12E+02	1.29E-02	2.18E-02	9.54E+01	3.17E+02	1.03E-02
Eu-152 (µCi/g)	2.15E-06	8.69E-06	2.00E-06	1.19E-04	3.04E-02	1.45E-06	5.25E-06	1.42E-02	7.32E-02	6.58E-06
Eu-154 (µCi/g)	1.63E-04	6.62E-04	2.50E-04	8.03E-03	2.02E+00	9.63E-05	3.50E-04	1.06E+00	5.86E+00	4.73E-04
Eu-155 (µCi/g)	9.55E-05	3.87E-04	3.31E-04	3.30E-03	8.46E-01	4.00E-05	1.75E-04	4.83E-01	3.24E+00	1.74E-04
Ra-226 (µCi/g)	7.56E-09	2.91E-08	6.89E-09	1.60E-09	4.62E-09	5.38E-10	6.13E-10	5.20E-09	8.65E-09	2.27E-11
Ra-228 (µCi/g)	3.54E-14	1.34E-13	2.76E-14	9.01E-15	3.98E-14	4.97E-15	8.87E-15	3.20E-14	7.08E-14	2.29E-08
Ac-227 (µCi/g)	3.66E-08	1.37E-07	2.18E-08	6.88E-09	1.91E-08	2.56E-09	2.78E-09	2.32E-08	4.00E-08	6.06E-08
Pa-231 (µCi/g)	3.15E-10	1.51E-07	5.02E-07	1.02E-08	2.79E-08	5.43E-09	6.60E-09	3.30E-08	6.12E-08	9.41E-08
Th-229 (µCi/g)	1.69E-12	1.30E-11	1.84E-11	3.38E-11	2.50E-11	7.41E-13	9.24E-13	8.65E-11	5.24E-11	1.42E-08
Th-232 (µCi/g)	1.43E-14	1.10E-13	1.65E-13	9.68E-15	4.09E-14	6.09E-15	1.13E-14	3.30E-14	7.36E-14	1.82E-08
U-232 (µCi/g)	1.89E-08	8.62E-11	1.83E-08	9.39E-08	1.88E-07	8.53E-08	4.85E-07	1.02E-07	2.20E-07	1.03E-02
U-233 (µCi/g)	1.54E-09	6.94E-12	1.37E-09	4.62E-07	5.35E-07	4.36E-09	1.65E-08	7.21E-07	3.99E-07	6.12E-01
U-234 (µCi/g)	1.51E-03	6.87E-06	1.84E-03	2.31E-03	2.47E-03	2.26E-03	9.53E-03	1.50E-03	2.82E-03	4.45E-02
U-235 (µCi/g)	6.76E-05	3.07E-07	8.29E-05	9.93E-05	9.35E-05	9.60E-05	3.62E-04	6.40E-05	1.18E-04	1.71E-03
U-236 (µCi/g)	1.73E-05	7.71E-08	1.65E-05	4.77E-05	7.14E-05	4.63E-05	2.68E-04	3.30E-05	7.23E-05	1.95E-03
U-238 (µCi/g)	1.54E-03	7.00E-06	1.87E-03	2.36E-03	1.72E-03	2.20E-03	6.64E-03	1.53E-03	2.75E-03	2.99E-02
U-Total (µg/g)	4.62E+03	2.10E+01	5.61E+03	7.08E+03	5.18E+03	6.61E+03	1.99E+04	4.59E+03	8.24E+03	8.99E+04
Np-237 (µCi/g)	4.38E-06	1.63E-05	2.29E-06	7.71E-05	6.94E-05	8.90E-07	1.46E-06	2.26E-04	1.65E-04	2.36E-07
Pu-238 (µCi/g)	3.13E-06	1.80E-05	1.59E-03	5.43E-03	2.90E-02	3.91E-03	2.29E-02	2.23E-02	4.05E-02	1.01E+00
Pu-239 (µCi/g)	4.38E-04	2.40E-03	4.39E-01	2.86E-01	4.24E-01	2.46E-01	8.97E-01	9.04E-01	8.43E-01	8.91E+00
Pu-240 (µCi/g)	4.72E-05	2.68E-04	2.98E-02	5.55E-02	9.94E-02	4.67E-02	1.97E-01	1.82E-01	2.07E-01	3.12E+00
Pu-241 (µCi/g)	9.21E-05	5.46E-04	3.85E-02	1.93E-01	7.53E-01	1.72E-01	1.27E+00	7.96E-01	1.84E+00	5.90E+01
Pu-242 (µCi/g)	6.46E-10	3.88E-09	1.10E-07	1.69E-06	5.73E-06	1.39E-06	8.36E-06	5.67E-06	1.50E-05	5.32E-04
Pu-Total (µg/g)	7.27E-03	3.98E-02	7.20E+00	4.85E+00	7.29E+00	4.17E+00	1.53E+01	1.54E+01	1.45E+01	1.58E+02
Am-241 (µCi/g)	2.42E-04	9.42E-04	5.97E-05	1.45E-01	1.63E+00	2.76E-03	7.55E-02	1.77E+00	3.86E+00	4.18E-04
Am-243 (µCi/g)	3.42E-08	1.25E-07	1.46E-09	5.28E-05	1.41E-03	3.01E-08	1.40E-06	8.14E-04	2.06E-03	4.00E-07
Cm-242 (µCi/g)	5.89E-08	2.15E-07	2.68E-09	4.35E-06	2.54E-03	5.15E-08	1.72E-07	3.61E-04	3.46E-03	6.67E-07
Cm-243 (µCi/g)	6.98E-10	2.55E-09	1.22E-11	7.79E-08	1.97E-04	9.46E-10	6.20E-09	7.07E-06	2.07E-04	7.20E-08
Cm-244 (µCi/g)	1.64E-08	5.99E-08	3.42E-10	1.92E-06	4.33E-03	2.31E-08	1.69E-07	1.87E-04	4.86E-03	1.76E-06

Predicted Sludge Concentration (µCi/g) (Sheet 3)

pred. sludge (µCi/g)	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3 (µCi/g)	1.01E-01	8.81E-02	1.07E-01	1.35E-04	6.01E-05	3.57E-05	0.00E+00	2.37E-04	1.74E-04	5.44E-04
C-14 (µCi/g)	9.56E-04	5.62E-04	2.32E-03	1.90E-04	3.38E-05	2.64E-05	0.00E+00	1.03E-04	7.27E-08	7.50E-08
Ni-59 (µCi/g)	3.76E-03	4.12E-03	1.16E-04	8.73E-05	2.93E-05	4.86E-06	0.00E+00	2.11E-03	3.61E-05	3.72E-05
Ni-63 (µCi/g)	3.52E-01	3.97E-01	1.01E-02	8.12E-03	2.82E-03	4.68E-04	0.00E+00	1.99E-01	3.07E-03	3.24E-03
Co-60 (µCi/g)	7.46E-03	1.09E-02	4.56E-03	1.19E-05	7.56E-06	2.31E-06	0.00E+00	1.50E-02	5.32E-06	8.28E-06
Se-79 (µCi/g)	3.96E-07	2.54E-07	3.02E-06	2.30E-07	7.64E-08	1.44E-08	0.00E+00	1.27E-05	1.24E-05	1.28E-05
Sr-90 (µCi/g)	3.87E-01	2.83E-01	2.12E+01	2.30E-01	8.65E-02	1.77E-02	0.00E+00	7.08E+01	1.27E+02	1.44E+02
Y-90 (µCi/g)	3.87E-01	2.83E-01	2.12E+01	2.30E-01	8.65E-02	1.77E-02	0.00E+00	7.08E+01	1.27E+02	1.44E+02
Zr-93 (µCi/g)	2.36E-05	1.46E-05	3.11E-03	1.37E-05	4.54E-06	8.55E-07	0.00E+00	7.55E-04	3.30E-04	3.40E-04
Nb-93m (µCi/g)	1.98E-05	1.15E-05	2.40E-03	1.14E-05	3.58E-06	6.41E-07	0.00E+00	6.13E-04	2.58E-04	2.56E-04
Tc-99 (µCi/g)	1.73E-04	1.06E-04	6.83E-03	1.00E-04	3.31E-05	6.12E-06	0.00E+00	3.97E-03	1.40E-03	1.44E-03
Ru-106 (µCi/g)	2.34E-12	3.72E-10	1.29E-08	3.61E-12	3.49E-11	9.44E-11	0.00E+00	5.90E-06	3.68E-10	3.72E-09
Cd-113m (µCi/g)	1.27E-03	1.06E-03	2.94E-04	1.21E-05	5.25E-06	1.27E-06	0.00E+00	7.59E-04	6.51E-04	7.82E-04
Sb-125 (µCi/g)	2.77E-06	1.11E-05	4.04E-04	1.79E-06	2.16E-06	1.12E-06	0.00E+00	3.31E-03	2.92E-04	6.71E-04
Sn-126 (µCi/g)	1.63E-06	1.05E-06	1.43E-05	9.50E-07	3.19E-07	6.21E-08	0.00E+00	5.26E-05	4.06E-05	4.19E-05
I-129 (µCi/g)	2.08E-04	9.17E-05	1.06E-05	6.67E-05	2.22E-05	2.36E-05	0.00E+00	2.37E-07	1.32E-07	1.36E-07
Cs-134 (µCi/g)	7.47E-08	7.13E-07	3.31E-04	6.79E-08	1.41E-07	1.59E-07	0.00E+00	1.26E-05	8.89E-06	2.71E-05
Cs-137 (µCi/g)	4.59E-01	3.31E-01	2.34E+01	2.73E-01	1.02E-01	2.08E-02	0.00E+00	1.59E+01	6.67E+00	7.39E+00
Ba-137m (µCi/g)	4.33E-01	3.13E-01	2.21E+01	2.58E-01	9.65E-02	1.97E-02	0.00E+00	1.50E+01	6.30E+00	6.98E+00
Sm-151 (µCi/g)	1.67E-02	1.04E-02	8.88E-02	9.74E-03	3.29E-03	5.62E-04	0.00E+00	1.43E+01	1.41E-01	1.49E-01
Eu-152 (µCi/g)	2.29E-06	2.70E-06	1.29E-04	1.45E-06	7.59E-07	3.60E-07	0.00E+00	2.88E-03	3.98E-05	4.81E-05
Eu-154 (µCi/g)	1.66E-04	2.07E-04	8.76E-03	1.08E-04	6.08E-05	2.59E-05	0.00E+00	2.26E-01	1.59E-03	2.10E-03
Eu-155 (µCi/g)	7.22E-05	1.14E-04	1.14E-03	4.94E-05	3.36E-05	9.50E-06	0.00E+00	1.20E-01	5.67E-04	9.24E-04
Ra-226 (µCi/g)	5.21E-10	1.21E-09	9.31E-10	9.06E-12	3.78E-12	1.24E-12	0.00E+00	5.26E-10	4.17E-08	6.52E-07
Ra-228 (µCi/g)	5.58E-15	9.35E-06	3.68E-14	5.57E-17	1.81E-09	1.26E-09	0.00E+00	3.75E-15	1.83E-04	1.99E-03
Ac-227 (µCi/g)	2.54E-09	1.99E-05	5.58E-09	4.04E-11	5.95E-09	3.32E-09	0.00E+00	2.39E-09	1.16E-02	1.14E-02
Pa-231 (µCi/g)	5.59E-09	9.49E-07	1.43E-08	5.75E-11	8.78E-09	5.15E-09	0.00E+00	3.52E-09	8.46E-04	8.74E-04
Th-229 (µCi/g)	8.75E-13	9.43E-05	4.14E-12	1.51E-13	1.54E-09	7.77E-10	0.00E+00	6.10E-12	3.01E-03	2.67E-03
Th-232 (µCi/g)	6.92E-15	4.30E-04	4.91E-14	5.75E-17	1.69E-09	9.95E-10	0.00E+00	3.88E-15	3.31E-03	3.42E-03
U-232 (µCi/g)	9.66E-08	4.44E-04	1.15E-06	2.17E-06	1.57E-03	1.14E-03	0.00E+00	9.95E-07	1.33E-02	1.41E-02
U-233 (µCi/g)	4.57E-09	2.66E-02	1.74E-08	1.52E-05	9.97E-02	6.75E-02	0.00E+00	4.20E-06	8.47E-01	8.39E-01
U-234 (µCi/g)	2.06E-03	3.69E-03	4.66E-03	3.16E-02	1.60E-02	4.92E-03	0.00E+00	1.36E-02	6.42E-03	6.63E-03
U-235 (µCi/g)	8.78E-05	1.44E-04	2.16E-04	1.35E-03	6.35E-04	1.89E-04	0.00E+00	5.73E-04	2.28E-08	2.35E-08
U-236 (µCi/g)	4.69E-05	9.07E-05	3.27E-04	6.98E-04	3.90E-04	2.15E-04	0.00E+00	3.24E-04	3.97E-09	4.10E-09
U-238 (µCi/g)	2.11E-03	3.31E-03	3.26E-03	3.24E-02	1.49E-02	3.30E-03	0.00E+00	1.36E-02	3.55E-16	3.67E-16
U-Total (µg/g)	6.33E+03	9.93E+03	9.80E+03	9.71E+04	4.45E+04	9.93E+03	0.00E+00	4.07E+04	9.08E+01	9.00E+01
Np-237 (µCi/g)	1.16E-06	7.02E-07	4.99E-06	3.94E-07	6.42E-08	1.29E-08	0.00E+00	1.68E-05	1.55E-10	1.60E-10
Pu-238 (µCi/g)	4.73E-03	1.02E-02	5.31E-02	1.48E-01	6.42E-02	9.30E-03	1.04E+00	1.96E-01	2.64E-08	2.80E-08
Pu-239 (µCi/g)	2.68E-01	4.24E-01	5.22E-01	5.98E+00	1.33E+00	8.24E-02	1.62E+01	6.02E+00	1.34E-12	1.38E-12
Pu-240 (µCi/g)	5.58E-02	1.00E-01	2.02E-01	1.20E+00	3.27E-01	2.88E-02	4.06E+00	1.30E+00	9.22E-14	9.52E-14
Pu-241 (µCi/g)	2.42E-01	7.23E-01	4.12E+00	5.27E+00	2.91E+00	5.45E-01	6.54E+01	7.95E+00	3.55E-13	4.25E-13
Pu-242 (µCi/g)	1.74E-06	5.08E-06	3.90E-05	3.76E-05	2.37E-05	4.92E-06	4.04E-04	6.11E-05	7.54E-19	7.78E-19
Pu-Total (µg/g)	4.57E+00	7.28E+00	9.36E+00	1.02E+02	2.30E+01	1.46E+00	2.79E+02	1.03E+02	1.57E-09	1.66E-09
Am-241 (µCi/g)	4.00E-03	2.92E-03	4.84E-01	5.81E-05	3.35E-05	2.29E-05	1.72E+01	2.06E-01	5.13E-14	5.13E-14
Am-243 (µCi/g)	4.45E-08	7.77E-08	5.05E-05	2.67E-08	1.79E-08	2.19E-08	0.00E+00	1.03E-04	1.83E-19	1.89E-19
Cm-242 (µCi/g)	7.54E-08	1.21E-07	7.76E-05	4.55E-08	3.11E-08	3.65E-08	0.00E+00	9.59E-03	3.45E-19	1.04E-19
Cm-243 (µCi/g)	1.41E-09	6.35E-09	2.18E-05	8.92E-10	1.87E-09	3.94E-09	0.00E+00	5.13E-04	6.94E-21	7.70E-21
Cm-244 (µCi/g)	3.68E-08	1.96E-07	4.69E-04	2.36E-08	4.38E-08	9.65E-08	0.00E+00	1.21E-02	1.51E-19	1.75E-19

Predicted Sludge Concentration (µCi/g) (Sheet 4)

pred. sludge (µCi/g)	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3 (µCi/g)	6.50E-03	4.50E-03	7.80E-04	3.96E-03	1.34E-02	0.00E+00	1.45E-03	3.89E-02	1.78E-02	3.18E-02
C-14 (µCi/g)	1.18E-03	2.83E-04	5.67E-05	3.60E-04	2.57E-03	0.00E+00	8.49E-05	1.51E-03	2.34E-03	3.74E-03
Ni-59 (µCi/g)	3.13E-02	1.27E-02	2.42E-04	2.96E-03	7.35E-02	0.00E+00	2.05E-04	3.39E-03	6.67E-03	2.21E-02
Ni-63 (µCi/g)	2.97E+00	1.23E+00	2.29E-02	2.79E-01	6.99E+00	0.00E+00	2.11E-02	3.21E-01	6.39E-01	2.12E+00
Co-60 (µCi/g)	1.14E-02	1.66E+00	3.10E-03	7.56E-01	2.63E-01	0.00E+00	9.78E-05	8.42E-03	2.67E-02	7.79E-02
Se-79 (µCi/g)	1.42E-04	6.56E-05	1.22E-05	6.94E-05	3.06E-04	0.00E+00	3.27E-06	1.42E-04	2.08E-04	2.56E-04
Sr-90 (µCi/g)	8.01E+03	6.44E+03	3.42E+01	9.40E+03	2.73E+02	0.00E+00	6.81E-01	1.65E+01	2.59E+01	2.15E+01
Y-90 (µCi/g)	8.01E+03	6.44E+03	3.42E+01	9.40E+03	2.73E+02	0.00E+00	6.81E-01	1.65E+01	2.59E+01	2.15E+01
Zr-93 (µCi/g)	8.43E-03	3.90E-03	7.25E-04	4.13E-03	1.82E-02	0.00E+00	3.03E-04	8.48E-03	1.24E-02	1.52E-02
Nb-93m (µCi/g)	6.83E-03	2.93E-03	5.48E-04	3.15E-03	1.47E-02	0.00E+00	2.69E-04	6.97E-03	1.01E-02	1.22E-02
Tc-99 (µCi/g)	4.43E-02	2.01E-02	3.74E-03	2.14E-02	9.74E-02	0.00E+00	9.82E-04	5.26E-02	6.87E-02	8.12E-02
Ru-106 (µCi/g)	1.89E-07	1.74E-04	8.93E-06	2.19E-05	2.75E-08	0.00E+00	2.13E-13	1.69E-08	2.44E-08	6.11E-08
Cd-113m (µCi/g)	8.61E-03	5.78E-03	1.04E-03	5.66E-03	1.90E-02	0.00E+00	1.10E-04	7.85E-03	1.33E-02	1.90E-02
Sb-125 (µCi/g)	2.60E-03	1.13E+00	1.15E-03	1.93E-01	4.50E-03	0.00E+00	3.03E-06	1.67E-03	3.29E-03	9.19E-03
Sn-126 (µCi/g)	5.88E-04	2.83E-04	5.23E-05	2.96E-04	1.27E-03	0.00E+00	1.23E-05	5.75E-04	8.61E-04	1.06E-03
I-129 (µCi/g)	2.36E-05	1.24E-06	2.29E-07	1.31E-06	5.75E-05	0.00E+00	1.36E-06	8.12E-05	7.53E-05	5.97E-04
Cs-134 (µCi/g)	1.49E-04	4.37E-05	0.00E+00	6.07E-04	8.26E-06	0.00E+00	2.41E-08	1.19E-04	1.53E-04	7.80E-05
Cs-137 (µCi/g)	1.79E+02	5.71E+00	0.00E+00	9.75E+01	1.02E+01	0.00E+00	2.86E+00	1.57E+02	1.26E+02	6.76E+01
Ba-137m (µCi/g)	1.69E+02	5.39E+00	0.00E+00	9.20E+01	9.61E+00	0.00E+00	2.70E+00	1.48E+02	1.19E+02	6.38E+01
Sm-151 (µCi/g)	1.37E+02	8.65E+02	1.69E+00	8.83E+02	2.50E+02	0.00E+00	1.50E-01	9.52E+00	5.82E+00	9.64E+00
Eu-152 (µCi/g)	2.57E-02	5.55E-01	5.31E-04	2.18E-01	4.64E-02	0.00E+00	5.09E-06	1.61E-03	1.09E-03	1.90E-03
Eu-154 (µCi/g)	2.00E+00	3.99E+01	3.98E-02	1.67E+01	3.46E+00	0.00E+00	3.89E-04	1.09E-01	7.99E-02	1.43E-01
Eu-155 (µCi/g)	1.03E+00	1.46E+01	1.79E-02	8.19E+00	1.60E+00	0.00E+00	2.28E-04	4.55E-02	3.65E-02	6.86E-02
Ra-226 (µCi/g)	6.11E-09	3.80E-09	6.86E-10	3.75E-09	1.42E-08	0.00E+00	1.59E-08	8.46E-09	2.81E-08	3.34E-08
Ra-228 (µCi/g)	3.60E-07	5.23E-14	9.15E-15	4.72E-14	6.63E-07	0.00E+00	7.21E-14	3.35E-07	3.34E-06	4.03E-05
Ac-227 (µCi/g)	4.03E-08	1.84E-08	3.31E-09	1.79E-08	8.44E-08	0.00E+00	7.14E-08	4.12E-08	1.79E-07	9.95E-07
Pa-231 (µCi/g)	8.47E-08	2.99E-08	5.36E-09	2.88E-08	2.28E-07	0.00E+00	2.22E-07	6.34E-07	9.28E-06	9.70E-05
Th-229 (µCi/g)	2.39E-09	1.79E-11	3.56E-12	2.23E-11	3.68E-09	0.00E+00	1.30E-11	9.60E-10	8.05E-09	1.23E-07
Th-232 (µCi/g)	6.08E-09	5.50E-14	9.61E-15	4.96E-14	1.02E-08	0.00E+00	1.10E-13	3.43E-09	2.90E-08	4.70E-07
U-232 (µCi/g)	1.18E-05	2.85E-06	2.48E-07	1.03E-06	2.50E-05	0.00E+00	3.11E-09	5.49E-07	2.27E-06	1.70E-05
U-233 (µCi/g)	7.22E-04	1.04E-06	5.08E-07	3.14E-06	1.54E-03	0.00E+00	2.48E-10	3.25E-05	1.35E-04	1.03E-03
U-234 (µCi/g)	1.88E-03	9.95E-03	1.97E-03	1.09E-02	1.06E-03	0.00E+00	2.31E-04	6.92E-05	4.47E-05	6.71E-05
U-235 (µCi/g)	7.91E-05	4.30E-04	8.35E-05	4.60E-04	4.42E-05	0.00E+00	1.03E-05	2.80E-06	1.85E-06	2.50E-06
U-236 (µCi/g)	4.51E-05	4.89E-04	5.93E-05	2.87E-04	2.87E-05	0.00E+00	2.71E-06	1.73E-06	1.04E-06	1.71E-06
U-238 (µCi/g)	1.87E-03	7.49E-03	1.85E-03	1.06E-02	9.93E-04	0.00E+00	2.36E-04	5.95E-05	4.06E-05	5.50E-05
U-Total (µg/g)	5.60E+03	2.25E+04	5.54E+03	3.18E+04	2.98E+03	0.00E+00	7.06E+02	1.78E+02	1.22E+02	1.65E+02
Np-237 (µCi/g)	1.83E-04	5.92E-05	1.15E-05	6.94E-05	9.97E-03	0.00E+00	8.36E-06	2.10E-04	3.12E-04	3.64E-04
Pu-238 (µCi/g)	2.81E-02	6.70E-01	5.04E-02	2.12E-01	2.08E-02	0.00E+00	3.32E-04	1.14E-03	6.71E-04	1.04E-03
Pu-239 (µCi/g)	8.41E-01	5.93E+00	8.97E-01	5.00E+00	4.87E-01	0.00E+00	4.36E-02	2.93E-02	1.86E-02	2.64E-02
Pu-240 (µCi/g)	1.83E-01	2.08E+00	2.29E-01	1.16E+00	1.13E-01	0.00E+00	4.94E-03	6.22E-03	3.90E-03	6.31E-03
Pu-241 (µCi/g)	1.16E+00	3.93E+01	2.58E+00	9.81E+00	9.39E-01	0.00E+00	9.93E-03	3.54E-02	3.20E-02	5.95E-02
Pu-242 (µCi/g)	8.96E-06	3.54E-04	2.21E-05	8.07E-05	7.73E-06	0.00E+00	7.16E-08	2.86E-07	2.57E-07	4.82E-07
Pu-Total (µg/g)	1.44E+01	1.05E+02	1.55E+01	8.58E+01	8.35E+00	0.00E+00	7.24E-01	4.99E-01	3.17E-01	4.53E-01
Am-241 (µCi/g)	2.29E+00	4.28E+01	3.58E-02	1.68E+01	5.19E-01	0.00E+00	4.63E-04	4.11E-02	3.70E-02	6.12E-02
Am-243 (µCi/g)	1.14E-03	4.09E-02	2.59E-05	1.03E-02	2.93E-04	0.00E+00	6.11E-08	2.26E-05	2.01E-05	2.44E-05
Cm-242 (µCi/g)	1.44E-03	6.86E-02	4.97E-03	1.38E-02	1.21E-03	0.00E+00	1.05E-07	2.34E-05	2.44E-05	2.31E-05
Cm-243 (µCi/g)	6.62E-05	7.40E-03	4.63E-04	1.09E-03	3.69E-05	0.00E+00	1.24E-09	9.87E-07	9.27E-07	8.09E-07
Cm-244 (µCi/g)	1.58E-03	1.81E-01	1.13E-02	2.65E-02	9.20E-04	0.00E+00	2.91E-08	2.25E-05	2.24E-05	2.01E-05

Predicted Sludge Concentration (µCi/g) (Sheet 5)

pred. sludge (µCi/g)	S1SltCk	S2SltStr	A1SltCk	A2SltStr	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (µCi/g)	1.40E-02	1.60E-02	1.53E-02	1.22E-02	2.72E-01	2.22E-01	7.03E-04	1.03E-01
C-14 (µCi/g)	3.30E-03	3.82E-03	4.30E-03	4.93E-03	8.49E-04	6.14E-04	4.68E-06	1.24E-03
Ni-59 (µCi/g)	3.00E-03	8.14E-04	6.52E-03	3.67E-03	5.43E-02	2.44E-02	5.88E-06	2.56E-05
Ni-63 (µCi/g)	2.86E-01	7.78E-02	6.22E-01	3.50E-01	5.25E+00	2.38E+00	5.70E-04	2.46E-03
Co-60 (µCi/g)	3.22E-02	2.04E-02	5.17E-02	2.54E-02	1.65E+01	7.86E+00	4.16E-05	8.30E-03
Se-79 (µCi/g)	3.12E-04	3.56E-04	3.85E-04	2.83E-04	4.19E-04	3.14E-04	2.90E-08	6.57E-07
Sr-90 (µCi/g)	3.08E+01	2.98E+00	3.62E+01	1.07E+02	2.12E+04	8.43E+03	4.87E-02	1.11E+00
Y-90 (µCi/g)	3.08E+01	2.98E+00	3.62E+01	1.07E+02	2.12E+04	8.43E+03	4.88E-02	1.11E+00
Zr-93 (µCi/g)	1.86E-02	2.12E-02	2.29E-02	1.69E-02	2.53E-02	1.90E-02	1.75E-06	6.89E-04
Nb-93m (µCi/g)	1.51E-02	1.72E-02	1.85E-02	1.36E-02	1.42E-02	1.01E-02	9.65E-07	3.80E-04
Tc-99 (µCi/g)	1.03E-01	1.17E-01	1.24E-01	9.28E-02	1.24E-01	9.27E-02	1.19E-05	3.58E-03
Ru-106 (µCi/g)	5.44E-08	4.25E-08	6.01E-08	1.31E-04	4.78E-01	1.20E-01	3.42E-04	1.47E-03
Cd-113m (µCi/g)	1.93E-02	2.22E-02	4.57E-02	1.67E-02	1.72E+00	5.30E-01	5.30E-06	1.24E-04
Sb-125 (µCi/g)	1.13E-02	2.79E-03	3.54E-03	9.91E-03	2.49E+01	1.12E+01	9.44E-05	5.20E 03
Sn-126 (µCi/g)	1.29E-03	1.47E-03	1.60E-03	1.18E-03	1.87E-03	1.37E-03	1.29E-07	2.92E-06
I-129 (µCi/g)	9.75E-05	1.15E-04	1.28E-04	1.09E-04	1.10E-05	8.10E-06	1.17E-05	2.37E-05
Cs-134 (µCi/g)	1.38E-04	1.80E-04	2.53E-04	5.20E-03	5.12E-01	6.53E-01	4.43E-05	1.34E-02
Cs-137 (µCi/g)	1.26E+02	1.59E+02	1.59E+02	1.20E+02	7.92E+02	6.15E+02	5.55E-02	1.67E+01
Ba-137m (µCi/g)	1.19E+02	1.50E+02	1.50E+02	1.13E+02	7.48E+02	5.80E+02	5.24E-02	1.58E+01
Sm-151 (µCi/g)	1.26E+01	2.75E+00	6.47E+00	6.48E+00	4.63E+02	1.66E+02	1.17E-03	2.65E-02
Eu-152 (µCi/g)	2.30E-03	5.08E-04	1.33E-03	1.55E-03	6.34E-01	2.04E-01	1.54E-06	3.50E-05
Eu-154 (µCi/g)	1.69E-01	3.73E-02	9.92E-02	1.17E-01	7.46E+01	2.59E+01	1.86E-04	4.22E-03
Eu-155 (µCi/g)	7.67E-02	1.70E-02	4.62E-02	5.48E-02	5.06E+01	2.39E+01	1.42E-04	3.23E-03
Ra-226 (µCi/g)	2.44E-08	3.24E-08	3.98E-08	2.43E-08	2.93E-07	2.56E-08	2.51E-12	2.64E-10
Ra-228 (µCi/g)	3.18E-06	4.09E-06	1.88E-05	9.89E-06	1.67E-11	1.70E-12	1.51E-16	2.05E-14
Ac-227 (µCi/g)	1.49E-07	1.97E-07	3.06E-07	1.42E-07	7.11E-07	1.32E-07	1.26E-11	1.27E-09
Pa-231 (µCi/g)	7.67E-06	1.03E-05	4.71E-05	3.14E-05	4.12E-07	3.24E-07	2.90E-11	5.39E-09
Th-229 (µCi/g)	7.55E-09	9.75E-09	1.72E-08	1.20E-08	2.46E-10	1.70E-10	1.66E-14	1.42E-12
Th-232 (µCi/g)	2.59E-08	3.40E-08	6.25E-08	4.35E-08	2.42E-12	1.99E-12	1.73E-16	3.43E-14
U-232 (µCi/g)	7.79E-07	3.38E-07	3.08E-06	1.71E-06	5.77E-06	1.91E-06	3.46E-06	7.92E-07
U-233 (µCi/g)	4.69E-05	2.03E-05	1.85E-04	1.02E-04	1.85E-06	5.89E-07	1.10E-06	9.69E-09
U-234 (µCi/g)	2.97E-05	1.03E-05	3.23E-05	7.19E-05	1.66E-02	6.35E-03	1.05E-02	4.19E-03
U-235 (µCi/g)	1.24E-06	4.29E-07	1.31E-06	2.84E-06	6.23E-04	2.53E-04	4.01E-04	1.61E-04
U-236 (µCi/g)	7.36E-07	2.49E-07	8.47E-07	4.87E-06	1.58E-03	6.27E-04	1.01E-03	4.05E-04
U-238 (µCi/g)	2.79E-05	9.59E-06	2.90E-05	5.63E-05	1.15E-02	4.37E-03	7.22E-03	2.89E-03
U-Total (µg/g)	8.36E+01	2.87E+01	8.71E+01	1.69E+02	3.44E+04	1.31E+04	2.17E+04	8.69E+03
Np-237 (µCi/g)	6.65E-04	3.97E-04	7.01E-04	1.97E-04	6.85E-02	2.37E-02	1.68E-07	3.81E-06
Pu-238 (µCi/g)	5.04E-04	1.68E-04	6.10E-04	2.24E-03	1.19E+00	4.09E-01	2.32E-01	3.19E-02
Pu-239 (µCi/g)	1.40E-02	4.69E-03	1.45E-02	3.03E-02	1.13E+01	4.12E+00	2.24E+00	3.14E-01
Pu-240 (µCi/g)	3.05E-03	1.01E-03	3.37E-03	7.86E-03	3.24E+00	1.13E+00	6.32E-01	8.85E-02
Pu-241 (µCi/g)	2.25E-02	7.70E-03	3.03E-02	1.59E-01	9.67E+01	3.28E+01	1.87E+01	2.62E+00
Pu-242 (µCi/g)	1.87E-07	6.30E-08	2.51E-07	8.31E-07	4.18E-04	1.35E-04	7.97E-05	1.12E-05
Pu-Total (µg/g)	2.39E-01	8.01E-02	2.49E-01	5.24E-01	1.97E+02	7.18E+01	3.91E+01	5.48E+00
Am-241 (µCi/g)	4.38E-02	6.90E-03	4.96E-02	1.21E-01	9.27E+01	4.12E+01	2.22E-04	1.10E-01
Am-243 (µCi/g)	2.64E-05	4.01E-06	3.07E-05	7.94E-05	2.91E-02	9.20E-03	6.18E-08	1.10E-05
Cm-242 (µCi/g)	3.90E-05	1.88E-05	4.79E-05	3.33E-05	5.39E-02	1.67E-02	1.14E-07	2.57E-06
Cm-243 (µCi/g)	1.37E-06	6.75E-07	1.91E-06	1.94E-06	8.32E-03	2.40E-03	1.72E-08	3.91E-07
Cm-244 (µCi/g)	3.35E-05	1.64E-05	4.69E-05	4.80E-05	2.16E-01	5.95E-02	4.41E-07	1.00E-05

Predicted Supernatant Concentration (µg/g) (Sheet 1)

pred. su (µg/g)	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
Na	3.98E+04	3.99E+04	5.07E+04	5.00E+04	3.96E+04	2.81E+04	3.40E+04	3.40E+04	7.66E+04	7.52E+04
Al	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fe	9.50E+01	9.50E+01	9.28E+01	9.29E+01	9.55E+01	9.82E+01	9.59E+01	9.59E+01	8.64E+01	8.67E+01
Cr	1.66E+02	1.68E+02	3.18E+02	3.18E+02	2.07E+02	2.87E+02	3.25E+02	3.25E+02	1.39E+02	1.42E+02
Bi	5.95E+01	6.04E+01	8.51E+01	8.52E+01	8.76E+01	9.00E+01	8.79E+01	8.79E+01	3.15E+01	3.22E+01
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-01	1.27E-01	0.00E+00	0.00E+00
Hg	0.00E+00	2.94E-01	0.00E+00	2.88E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-01	2.69E-01
Zr	0.00E+00	0.00E+00	2.38E+01	2.38E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	9.35E+01	9.50E+01	8.84E+01	8.84E+01	8.88E+01	8.95E+01	8.64E+01	8.64E+01	7.87E+01	8.87E+01
Sr	5.03E-02	5.03E-02	5.39E-03	7.76E-03	1.12E-04	1.26E-04	1.27E-06	2.30E-06	4.57E-02	1.85E-02
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.79E+01	2.79E+01	0.00E+00	0.00E+00
Ca	1.36E+02	1.36E+02	1.33E+02	1.33E+02	1.37E+02	1.41E+02	1.38E+02	1.38E+02	1.24E+02	1.24E+02
K	2.75E+01	2.79E+01	3.49E+02	3.50E+02	2.41E+02	1.59E+02	8.32E+03	8.32E+03	5.16E+02	5.54E+02
balance	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
density	1.10E+00	1.10E+00	1.13E+00	1.13E+00	1.10E+00	1.07E+00	1.09E+00	1.09E+00	1.21E+00	1.21E+00
vol% solids	1.20E+01	1.20E+01	1.37E+01	1.43E+01	6.80E+00	3.40E+00	1.80E+00	2.34E+00	2.80E+00	4.25E+00
void frac.	2.70E-01	1.45E-01	5.74E-01	5.99E-01	4.76E-01	5.26E-01	7.26E-01	7.89E-01	4.45E-01	2.34E-01
wt.% H2O	8.96E+01	8.96E+01	8.29E+01	8.32E+01	8.70E+01	9.10E+01	8.68E+01	8.68E+01	7.36E+01	7.37E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-02	1.10E-02	3.66E-04	0.00E+00
species										
OH	5.58E+02	5.58E+02	1.52E+03	1.36E+03	5.57E+02	1.12E+03	1.23E+03	1.23E+03	3.24E+01	9.45E+01
NO3	1.05E+04	1.03E+04	9.56E+04	9.50E+04	7.27E+04	4.71E+04	7.88E+04	7.88E+04	1.53E+05	1.64E+05
NO2	6.94E+02	9.59E+02	2.73E+03	2.15E+03	3.30E+00	1.86E+00	4.06E-02	5.84E-02	6.16E+03	4.76E+02
CO3	3.40E+04	3.41E+04	2.00E+02	2.00E+02	2.05E+02	2.11E+02	2.06E+02	2.06E+02	9.31E+03	1.86E+02
PO4	6.09E+03	6.08E+03	5.94E+03	5.95E+03	6.12E+03	6.29E+03	2.83E+03	2.83E+03	5.53E+03	5.56E+03
SO4	1.08E+04	1.08E+04	6.29E+03	6.29E+03	4.51E+03	2.85E+03	2.65E+02	2.65E+02	9.82E+03	9.86E+03
Si	1.12E+02	1.14E+02	2.62E+02	2.63E+02	2.70E+02	2.78E+02	0.00E+00	0.00E+00	0.00E+00	2.45E+02
F	0.00E+00	0.00E+00	3.33E+03	3.33E+03	3.95E+03	2.45E+03	4.72E+03	4.72E+03	0.00E+00	3.42E+03
Cl	1.14E+02	1.16E+02	1.46E+03	1.46E+03	1.01E+03	6.65E+02	9.37E+02	9.37E+02	2.83E+03	2.31E+03
C6H5O7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E+02	4.03E+02	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.34E+00	0.00E+00
butanol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	1.11E+00	2.12E+00	1.76E+03	1.28E+03	3.72E-06	1.78E-06	5.03E-10	1.04E-09	5.72E+00	3.41E-02
NiFe(CN)6–	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Concentration (µg/g) (Sheet 2)

pred. su (µg/g)	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
Na	7.52E+04	6.96E+04	2.86E+04	1.01E+05	1.00E+05	7.39E+04	3.88E+04	1.61E+04	2.56E+04	6.47E+04
Al	0.00E+00	2.32E+02	0.00E+00	1.81E+04	2.15E+04	3.12E+04	1.57E+04	0.00E+00	0.00E+00	0.00E+00
Fe	8.67E+01	7.94E+01	9.85E+01	8.28E+01	8.38E+01	9.03E+01	9.67E+01	1.01E+02	9.94E+01	8.91E+01
Cr	1.42E+02	2.01E+02	9.83E+01	2.28E+03	2.31E+03	1.40E+02	1.47E+02	4.05E+02	4.02E+02	3.57E+02
Bi	3.22E+01	4.50E+01	9.03E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	2.69E-01	2.19E-01	3.05E-01	2.56E-01	2.60E-01	0.00E+00	0.00E+00	3.14E-01	3.08E-01	0.00E+00
Zr	0.00E+00	5.98E+00	2.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	0.00E+00	1.16E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+02	1.38E+02	2.25E+01	1.42E+02	0.00E+00
Ni	8.86E+01	9.01E+01	1.01E+02	8.46E+01	8.57E+01	7.89E+01	8.30E+01	1.04E+02	1.02E+02	9.10E+01
Sr	5.94E+00	3.43E-03	6.12E-04	3.81E-02	3.86E-02	1.11E-02	2.01E-02	4.41E-02	4.32E-02	1.63E-02
Mn	0.00E+00	0.00E+00	0.00E+00	2.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	1.24E+02	1.27E+02	1.41E+02	1.19E+02	1.20E+02	1.30E+02	1.39E+02	1.46E+02	1.43E+02	1.28E+02
K	5.54E+02	4.88E+02	1.55E+02	8.27E+02	6.33E+02	7.93E+01	1.27E+02	1.20E+02	2.13E+02	4.94E+02
balance	1.00E+02	1.00E+02	1.00E+02	9.91E+01	9.87E+01	9.63E+01	9.82E+01	1.00E+02	1.00E+02	1.00E+02
density	1.21E+00	1.19E+00	1.06E+00	1.26E+00	1.25E+00	1.16E+00	1.08E+00	1.03E+00	1.05E+00	1.18E+00
vol% solids	4.25E+00	3.00E+00	3.00E+00	4.50E+00	3.00E+00	8.10E+00	2.90E+00	2.20E+00	3.90E+00	2.20E+00
void frac.	2.29E-01	9.16E-01	8.51E-01	6.86E-01	6.40E-01	6.90E-01	7.50E-01	7.59E-01	5.47E-01	5.56E-01
wt.% H2O	7.37E+01	7.60E+01	9.17E+01	7.01E+01	7.15E+01	7.50E+01	8.62E+01	9.53E+01	9.24E+01	7.68E+01
TOC wt.%C	0.00E+00	9.55E-04	1.76E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
species										
OH	-1.96E+01	4.60E+02	1.61E+03	2.36E+04	2.41E+04	2.63E+02	3.14E+02	3.03E+03	2.98E+03	7.73E+02
NO3	1.65E+05	1.39E+05	3.19E+04	1.10E+05	6.45E+04	4.82E+04	5.07E+04	1.05E+04	7.06E+03	1.52E+05
NO2	9.12E+01	4.81E+03	7.39E+03	2.80E+04	5.18E+04	5.71E+04	1.22E+04	1.23E+04	2.69E+04	8.33E+02
CO3	1.86E+02	5.10E+03	3.11E+02	1.78E+02	1.80E+02	1.94E+02	2.08E+02	2.18E+02	2.14E+02	1.91E+02
PO4	5.56E+03	5.04E+03	6.31E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.70E+03
SO4	9.86E+03	9.29E+03	1.94E+03	1.46E+03	2.33E+03	7.80E+02	5.42E+02	4.09E+03	1.13E+04	4.62E+03
Si	2.45E+02	1.21E+02	2.78E+02	2.34E+02	2.37E+02	2.55E+02	0.00E+00	2.87E+02	2.81E+02	0.00E+00
F	3.42E+03	1.47E+03	4.09E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cl	2.31E+03	2.45E+03	6.47E+02	2.68E+03	2.64E+03	3.30E+02	5.30E+02	4.99E+02	8.88E+02	2.06E+03
C6H5O7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	3.24E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
butanol	0.00E+00	1.14E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	1.25E-03	3.74E+02	6.91E-03	1.29E+02	5.00E+02	2.74E+00	6.98E-01	1.39E+02	4.96E+02	4.40E-02
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Concentration (µg/g) (Sheet 3)

pred. su (µg/g)	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
Na	4.96E+04	3.48E+04	1.29E+04	1.48E+04	2.45E+04	3.36E+04	6.98E+04	4.71E+04	6.94E+04	6.94E+04
Al	2.09E+04	1.58E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.78E+03	0.00E+00	7.26E+03	7.26E+03
Fe	9.50E+01	9.77E+01	1.01E+02	1.01E+02	9.91E+01	9.69E+01	8.87E+01	2.49E+03	8.84E+01	8.84E+01
Cr	1.45E+02	1.49E+02	1.55E+02	4.04E+02	3.94E+02	3.86E+02	4.19E+02	3.68E+02	3.54E+02	3.54E+02
Bi	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-01	0.00E+00	0.00E+00
Zr	0.00E+00	0.00E+00	2.60E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pb	1.35E+02	1.39E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.20E+02	0.00E+00	0.00E+00
Ni	8.21E+01	8.38E+01	8.76E+01	1.04E+02	1.01E+02	9.91E+01	9.06E+01	2.17E+02	9.04E+01	9.04E+01
Sr	1.06E-02	9.22E-03	4.40E-02	9.04E-03	3.28E-03	5.80E-04	0.00E+00	1.66E+00	3.84E-02	3.84E-02
Mn	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.89E+01	2.82E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ca	1.36E+02	1.40E+02	1.45E+02	1.46E+02	1.42E+02	1.39E+02	1.27E+02	1.82E+02	1.27E+02	1.27E+02
K	5.37E+01	9.16E+01	8.49E+03	3.80E+01	5.00E+02	2.00E+02	4.23E+02	3.21E+03	9.25E+02	9.25E+02
balance	9.75E+01	9.81E+01	1.00E+02	1.00E+02	1.00E+02	1.00E+02	9.95E+01	1.00E+02	9.92E+01	9.92E+01
density	1.10E+00	1.07E+00	1.03E+00	1.03E+00	1.06E+00	1.08E+00	1.18E+00	1.08E+00	1.19E+00	1.19E+00
vol% solids	8.10E+00	2.90E+00	1.05E+01	1.10E+00	1.10E+00	1.10E+00	2.30E+00	1.20E+00	5.80E+00	5.80E+00
void frac.	8.22E-01	7.49E-01	8.55E-01	7.40E-01	7.14E-01	7.39E-01	5.23E-01	9.42E-01	8.43E-01	8.43E-01
wt.% H2O	8.30E+01	8.77E+01	9.39E+01	9.41E+01	9.23E+01	8.88E+01	7.65E+01	8.22E+01	7.53E+01	7.53E+01
TOC wt.%C	0.00E+00	0.00E+00	0.00E+00	8.47E-01	3.04E-01	2.47E-01	0.00E+00	2.29E+00	4.81E-02	4.78E-02
species										
OH	2.89E+02	2.98E+02	3.55E+03	6.77E+02	1.33E+02	9.96E+02	4.28E+03	4.12E+03	3.62E+02	3.62E+02
NO3	3.88E+04	3.98E+04	1.76E+04	1.38E+04	2.22E+04	5.42E+04	1.36E+05	4.58E+04	1.41E+05	1.42E+05
NO2	3.32E+04	1.22E+04	1.38E+03	4.83E+02	4.53E+02	4.32E+02	5.52E+02	1.24E+04	3.61E+03	3.24E+03
CO3	2.04E+02	2.10E+02	2.18E+02	1.20E+04	2.19E+04	1.61E+04	9.53E+03	2.72E+02	1.90E+02	1.90E+02
PO4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E+01	0.00E+00	5.67E+03	5.66E+03
SO4	7.73E+02	6.04E+02	1.43E+02	3.73E+02	3.64E+02	3.56E+02	5.59E+02	5.99E+03	4.42E+03	4.42E+03
Si	2.68E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F	0.00E+00	0.00E+00	5.03E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.94E+03	1.94E+03
Cl	2.24E+02	3.82E+02	1.99E+02	1.58E+02	2.32E+02	7.02E+02	2.70E+03	1.61E+03	1.91E+03	1.91E+03
C6H5O7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E+03	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.13E+04	0.00E+00	0.00E+00
HEDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.79E+04	0.00E+00	0.00E+00
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	0.00E+00	0.00E+00	0.00E+00	1.24E+04	4.44E+03	3.61E+03	0.00E+00	0.00E+00	7.03E+02	6.97E+02
butanol	0.00E+00	0.00E+00	0.00E+00	4.36E+03	1.56E+03	1.27E+03	0.00E+00	0.00E+00	2.48E+02	2.46E+02
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	1.40E+00	2.94E-01	1.29E+04	1.66E-02	4.26E-03	5.54E-04	0.00E+00	5.68E+01	1.82E+00	1.44E+00
NiFe(CN)6–	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Concentration (µg/g) (Sheet 4)

pred. su (µg/g)	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
Na	2.91E+04	1.39E+04	7.71E+04	6.75E+04	8.01E+04	4.45E+03	9.03E+04	1.68E+05	1.64E+05	1.69E+05
Al	5.54E+02	2.04E+03	6.44E+03	0.00E+00	8.71E+03	0.00E+00	2.87E+02	3.15E+04	2.55E+04	3.13E+04
Fe	9.81E+01	1.02E+02	8.70E+02	9.14E+01	8.79E+01	1.04E+02	8.34E+01	6.99E+01	7.06E+01	6.95E+01
Cr	8.34E+02	1.02E+02	9.53E-03	0.00E+00	1.38E+03	4.13E+02	3.75E+02	1.92E+03	1.94E+03	1.91E+03
Bi	4.01E-01	0.00E+00	0.00E+00	0.00E+00	8.93E-01	0.00E+00	7.64E+01	3.87E-02	4.18E+01	2.25E+01
La	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-08	1.63E-04
Hg	3.04E-01	3.17E-01	2.96E-01	2.83E-01	2.72E-01	0.00E+00	2.58E-01	2.16E-01	2.19E-01	2.15E-01
Zr	3.50E-03	0.00E+00	0.00E+00	0.00E+00	1.23E-01	0.00E+00	2.06E+01	5.45E-03	1.01E+01	3.68E+00
Pb	4.38E+01	1.46E+02	0.00E+00	0.00E+00	8.53E+01	0.00E+00	0.00E+00	1.51E+01	1.00E+02	9.89E+01
Ni	1.00E+02	1.04E+02	5.38E+02	0.00E+00	8.98E+01	1.06E+02	8.52E+01	7.14E+01	7.21E+01	7.10E+01
Sr	4.26E-02	4.44E-02	1.24E+00	3.97E-02	3.87E-02	0.00E+00	4.05E-02	3.19E-02	3.15E-02	1.02E-01
Mn	9.16E+00	0.00E+00	0.00E+00	0.00E+00	1.49E+01	0.00E+00	0.00E+00	2.04E+01	1.98E+01	2.02E+01
Ca	1.41E+02	1.47E+02	3.81E+02	1.31E+02	1.26E+02	3.57E+02	1.20E+02	1.00E+02	1.01E+02	9.97E+01
K	2.82E+02	1.06E+02	5.38E+02	4.65E+02	6.84E+02	2.68E+01	6.78E+02	1.26E+03	1.74E+03	1.67E+03
balance	1.00E+02	9.99E+01	9.93E+01	1.01E+02	9.97E+01	1.00E+02	1.00E+02	9.83E+01	9.82E+01	9.70E+01
density	1.07E+00	1.02E+00	1.09E+00	1.15E+00	1.19E+00	1.01E+00	1.26E+00	1.50E+00	1.48E+00	1.51E+00
vol% solids	3.10E+00	5.00E-01	1.00E+00	2.60E+00	1.00E+00	1.00E+00	7.96E+00	1.30E+01	4.30E+01	5.40E+01
void frac.	8.22E-01	4.80E-01	6.98E-01	7.81E-01	8.88E-01	8.77E-01	5.08E-01	8.62E-01	7.75E-01	7.08E-01
wt.% H2O	9.11E+01	9.58E+01	6.97E+01	8.61E+01	7.62E+01	9.83E+01	6.96E+01	5.19E+01	4.99E+01	4.62E+01
TOC wt.%C	0.00E+00	7.05E-02	5.71E+00	3.84E-04	4.66E-01	0.00E+00	2.69E-04	6.73E-02	1.13E+00	1.21E+00
species										
OH	1.42E+03	3.02E+03	6.66E+02	2.91E+04	1.42E+04	8.64E+02	2.44E+03	3.84E+04	2.44E+04	1.44E+04
NO3	1.74E+04	1.58E+04	4.37E+04	2.53E+04	6.52E+04	9.64E+03	1.73E+05	1.45E+05	1.46E+05	1.44E+05
NO2	2.06E+04	9.96E+02	4.91E+03	7.39E+03	3.32E+04	1.10E+03	6.77E+03	6.60E+04	5.55E+04	7.73E+04
CO3	7.93E+03	2.20E+02	1.49E+04	1.27E+04	9.29E+03	1.17E+02	7.93E+03	9.34E+02	1.55E+04	2.10E+04
PO4	1.99E+03	0.00E+00	8.71E+02	0.00E+00	5.15E+02	0.00E+00	5.34E+03	3.28E+01	4.03E+03	3.92E+03
SO4	6.69E+03	1.60E+03	3.87E+03	8.60E+03	7.59E+03	3.81E+02	9.48E+03	3.37E+03	8.03E+03	7.90E+03
Si	2.77E+02	2.89E+02	7.71E+01	2.58E+02	2.48E+02	0.00E+00	2.36E+02	1.98E+02	1.99E+02	1.96E+02
F	7.88E+00	0.00E+00	0.00E+00	0.00E+00	2.61E+01	0.00E+00	2.93E+03	2.33E+00	1.61E+03	1.34E+03
Cl	6.34E+02	4.41E+02	2.24E+03	1.94E+03	2.09E+03	1.12E+02	3.33E+03	4.48E+03	5.63E+03	4.98E+03
C6H5O7	0.00E+00	1.85E+03	2.60E+03	0.00E+00	4.37E+03	0.00E+00	0.00E+00	2.04E+02	2.15E+03	4.59E+03
EDTA	0.00E+00	0.00E+00	3.96E+04	0.00E+00	8.49E+02	0.00E+00	0.00E+00	3.35E+02	6.50E+03	5.44E+03
HEDTA	0.00E+00	0.00E+00	7.54E+04	0.00E+00	1.63E+03	0.00E+00	0.00E+00	6.36E+02	1.23E+04	6.83E+03
NTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	0.00E+00	0.00E+00	2.06E+04	0.00E+00	4.42E+02	0.00E+00	0.00E+00	1.74E+02	3.37E+03	1.87E+03
acetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E+00	4.30E+01	2.42E+03
oxalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.20E-05	5.16E-01
DBP	0.00E+00	0.00E+00	0.00E+00	5.60E+00	2.60E+03	0.00E+00	3.93E+00	1.76E+02	1.91E+03	5.13E+03
butanol	0.00E+00	0.00E+00	0.00E+00	1.98E+00	9.17E+02	0.00E+00	1.39E+00	6.22E+01	6.75E+02	1.81E+03
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	2.82E+02	6.16E-01	1.02E+01	3.51E+01	3.51E+02	0.00E+00	1.26E+03	4.69E+02	1.36E+03	6.03E+02
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Concentration (µg/g) (Sheet 5)

pred. su (µg/g)	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
Na	1.89E+05	1.91E+05	1.96E+05	1.91E+05	7.60E+04	4.68E+04	1.49E+04	1.17E+04
Al	3.02E+04	3.00E+04	2.97E+04	2.64E+04	6.33E+03	4.26E+02	0.00E+00	0.00E+00
Fe	6.70E+01	6.64E+01	6.58E+01	6.81E+01	8.93E+01	9.41E+01	1.01E+02	1.01E+02
Cr	1.84E+03	1.83E+03	1.81E+03	1.87E+03	5.07E+02	9.08E+02	4.03E+02	0.00E+00
Bi	2.06E+01	2.94E+01	2.53E+01	2.21E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La	8.54E-04	7.73E-04	5.92E-04	4.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hg	2.07E-01	2.06E-01	2.04E-01	2.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr	4.70E+00	6.88E+00	5.41E+00	1.25E+01	0.00E+00	0.00E+00	0.00E+00	2.60E+01
Pb	9.54E+01	9.46E+01	9.37E+01	7.73E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni	6.84E+01	6.79E+01	6.73E+01	6.96E+01	9.12E+01	9.61E+01	1.03E+02	0.00E+00
Sr	2.97E-02	2.95E-02	3.30E-02	2.98E-02	3.06E-02	3.22E-02	1.03E-03	2.39E-02
Mn	1.95E+01	1.94E+01	1.92E+01	1.98E+01	0.00E+00	0.00E+00	2.95E+01	0.00E+00
Ca	9.61E+01	9.54E+01	9.45E+01	9.77E+01	1.28E+02	1.35E+02	1.45E+02	1.46E+02
K	1.91E+03	2.05E+03	2.06E+03	4.55E+03	2.72E+02	1.67E+02	2.65E+02	8.50E+03
balance	9.82E+01	9.82E+01	9.81E+01	9.82E+01	9.98E+01	1.00E+02	1.00E+02	1.00E+02
density	1.56E+00	1.58E+00	1.59E+00	1.54E+00	1.17E+00	1.11E+00	1.04E+00	1.03E+00
vol% solids	3.61E+01	2.80E+01	1.89E+01	2.09E+01	4.43E+00	7.61E+00	2.00E+00	1.05E+01
void frac.	8.28E-01	9.03E-01	8.34E-01	8.18E-01	7.28E-01	8.37E-01	8.50E-01	8.48E-01
wt.% H2O	4.42E+01	4.36E+01	4.15E+01	3.93E+01	7.78E+01	8.54E+01	9.54E+01	9.37E+01
TOC wt.%C	1.61E+00	1.62E+00	1.99E+00	3.50E+00	0.00E+00	0.00E+00	4.75E-02	0.00E+00
species								
OH	3.52E+04	3.46E+04	3.18E+04	2.52E+04	1.03E+04	6.20E+03	3.66E+02	1.30E+03
NO3	1.39E+05	1.38E+05	1.36E+05	1.41E+05	4.18E+04	5.76E+04	1.54E+04	2.33E+04
NO2	7.13E+04	7.36E+04	7.86E+04	6.37E+04	7.18E+04	2.39E+04	4.46E+02	5.83E+02
CO3	1.49E+04	1.66E+04	2.20E+04	2.44E+04	1.92E+02	2.02E+02	6.14E+03	2.18E+02
PO4	2.90E+03	3.54E+03	3.77E+03	4.36E+03	0.00E+00	0.00E+00	6.39E+03	0.00E+00
SO4	7.61E+03	7.55E+03	7.49E+03	7.74E+03	9.31E+03	1.08E+04	3.72E+02	0.00E+00
Si	1.89E+02	1.88E+02	1.86E+02	1.87E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F	8.04E+02	1.14E+03	1.13E+03	2.46E+03	8.49E+02	5.50E+02	0.00E+00	5.04E+03
Cl	6.08E+03	6.54E+03	6.49E+03	6.41E+03	1.13E+03	6.96E+02	1.58E+02	1.60E+02
C6H5O7	3.74E+03	3.63E+03	4.61E+03	4.35E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	9.28E+03	9.30E+03	1.13E+04	2.22E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HEDTA	1.73E+04	1.74E+04	2.01E+04	4.13E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
glycolate	4.75E+03	4.77E+03	5.51E+03	1.13E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
acetate	2.13E+02	1.78E+02	9.42E+02	6.36E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
oxalate	2.71E+00	2.45E+00	1.88E+00	1.45E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DBP	2.36E+03	2.46E+03	3.64E+03	3.15E+03	0.00E+00	0.00E+00	6.93E+02	0.00E+00
butanol	8.32E+02	8.66E+02	1.28E+03	1.11E+03	0.00E+00	0.00E+00	2.44E+02	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NH3	9.34E+02	1.16E+03	9.84E+02	4.79E+03	9.34E+02	1.30E+02	3.48E-04	1.29E+04
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Predicted Supernatant Concentration (µCi/g) (Sheet 1)

pred. su (µCi/g)	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3 (µCi/g)	1.05E-02	2.35E-02	2.58E-03	5.42E-03	7.61E-08	1.67E-06	1.59E-10	1.38E-08	5.05E-03	5.16E-03
C-14 (µCi/g)	2.81E-04	3.91E-04	8.44E-05	7.18E-05	5.27E-06	5.28E-06	3.54E-07	5.71E-07	1.96E-04	2.00E-04
Ni-59 (µCi/g)	7.54E-05	1.24E-04	1.70E-05	2.36E-05	1.38E-06	1.38E-06	9.27E-08	1.49E-07	5.11E-05	3.39E-06
Ni-63 (µCi/g)	6.43E-03	1.10E-02	2.49E-03	3.27E-03	1.18E-04	1.22E-04	7.90E-06	1.32E-05	4.47E-03	2.96E-04
Co-60 (µCi/g)	1.37E-04	4.37E-04	9.84E-05	2.82E-04	2.50E-06	4.84E-06	1.68E-07	5.24E-07	1.52E-04	1.56E-04
Se-79 (µCi/g)	1.29E-05	2.16E-05	1.80E-06	2.36E-06	2.35E-07	2.39E-07	1.58E-08	2.59E-08	8.84E-06	9.03E-06
Sr-90 (µCi/g)	2.25E+00	2.25E+00	2.41E-01	3.47E-01	5.00E-03	5.61E-03	5.69E-05	1.03E-04	2.04E+00	8.29E-01
Y-90 (µCi/g)	2.25E+00	2.25E+00	2.41E-01	3.47E-01	5.00E-03	5.62E-03	5.69E-05	1.03E-04	2.05E+00	8.29E-01
Zr-93 (µCi/g)	3.49E-06	5.78E-06	8.48E-04	1.10E-03	1.43E-04	1.44E-04	0.00E+00	0.00E+00	2.37E-06	2.43E-06
Nb-93m (µCi/g)	3.14E-06	5.07E-06	7.63E-04	9.63E-04	1.29E-04	1.26E-04	0.00E+00	0.00E+00	2.10E-06	2.15E-06
Tc-99 (µCi/g)	6.23E-03	1.05E-02	1.36E-04	1.80E-04	2.81E-06	2.86E-06	3.21E-08	5.24E-08	3.08E-03	3.15E-03
Ru-106 (µCi/g)	1.36E-16	9.18E-15	3.83E-14	1.17E-12	4.49E-15	1.83E-13	7.54E-16	4.94E-14	2.61E-15	2.67E-15
Cd-113m (µCi/g)	3.03E-04	7.12E-04	7.55E-05	1.43E-04	5.54E-06	7.88E-06	3.72E-07	8.54E-07	2.65E-04	2.71E-04
Sb-125 (µCi/g)	3.97E-06	2.50E-05	1.20E-06	4.12E-06	7.25E-08	2.77E-07	4.87E-09	2.99E-08	7.88E-06	8.06E-06
Sn-126 (µCi/g)	4.65E-05	8.32E-05	6.50E-06	9.20E-06	8.49E-07	9.21E-07	5.71E-08	9.97E-08	3.33E-05	3.41E-05
I-129 (µCi/g)	2.76E-06	1.19E-05	6.69E-08	1.57E-06	1.25E-09	0.00E+00	1.42E-11	0.00E+00	3.95E-06	4.04E-06
Cs-134 (µCi/g)	1.71E-08	2.85E-07	3.72E-10	4.81E-09	7.71E-12	7.80E-11	8.78E-14	1.43E-12	8.40E-08	6.90E-11
Cs-137 (µCi/g)	1.27E+01	2.39E+01	2.77E-01	4.06E-01	5.73E-03	6.54E-03	6.53E-05	1.20E-04	9.45E+00	7.76E-03
Ba-137m (µCi/g)	1.20E+01	2.26E+01	2.61E-01	3.84E-01	5.41E-03	6.18E-03	6.17E-05	1.13E-04	8.93E+00	7.33E-03
Sm-151 (µCi/g)	4.87E-01	7.94E-01	1.51E-01	1.88E-01	4.95E-02	4.88E-02	1.11E-02	1.76E-02	3.28E-01	3.35E-01
Eu-152 (µCi/g)	6.03E-06	3.79E-05	1.87E-06	1.03E-05	6.13E-07	2.33E-06	1.37E-07	8.41E-07	1.20E-05	1.22E-05
Eu-154 (µCi/g)	5.85E-04	2.78E-03	1.81E-04	7.21E-04	5.94E-05	1.71E-04	1.33E-05	6.18E-05	9.09E-04	9.29E-04
Eu-155 (µCi/g)	4.74E-04	1.53E-03	1.47E-04	3.27E-04	4.82E-05	9.41E-05	1.08E-05	3.40E-05	5.32E-04	5.44E-04
Ra-226 (µCi/g)	5.63E-08	5.62E-08	1.32E-08	7.78E-09	1.73E-09	8.62E-10	1.16E-10	9.34E-11	4.22E-08	4.31E-08
Ra-228 (µCi/g)	1.89E-13	3.32E-13	4.43E-14	5.05E-14	5.80E-15	5.09E-15	3.90E-16	5.51E-16	1.97E-13	2.02E-13
Ac-227 (µCi/g)	3.27E-07	3.27E-07	3.95E-08	2.36E-08	1.47E-08	7.52E-09	4.95E-09	4.07E-09	2.04E-07	2.09E-07
Pa-231 (µCi/g)	3.76E-09	3.38E-09	8.21E-07	5.15E-07	3.10E-07	1.68E-07	1.04E-07	9.12E-08	1.76E-09	1.80E-09
Th-229 (µCi/g)	1.51E-11	2.19E-11	3.05E-11	3.50E-11	1.15E-11	1.01E-11	3.86E-12	5.46E-12	9.41E-12	9.62E-12
Th-232 (µCi/g)	1.27E-13	1.87E-13	2.55E-13	2.95E-13	9.62E-14	8.59E-14	3.23E-14	4.65E-14	7.97E-14	8.15E-14
U-232 (µCi/g)	2.48E-09	4.30E-09	8.13E-11	1.63E-10	2.13E-11	2.30E-11	5.34E-14	9.28E-14	1.04E-10	1.05E-10
U-233 (µCi/g)	2.19E-10	3.38E-10	7.20E-12	1.23E-11	1.89E-12	1.81E-12	4.73E-15	7.29E-15	8.51E-12	8.55E-12
U-234 (µCi/g)	2.83E-04	2.82E-04	9.01E-06	8.99E-06	2.44E-06	1.51E-06	6.11E-09	6.09E-09	8.37E-06	8.41E-06
U-235 (µCi/g)	1.28E-05	1.25E-05	4.07E-07	3.96E-07	1.10E-07	6.69E-08	2.76E-10	2.70E-10	3.74E-07	3.75E-07
U-236 (µCi/g)	2.42E-06	3.83E-06	7.70E-08	1.33E-07	2.09E-08	2.05E-08	5.22E-11	8.27E-11	9.57E-08	9.62E-08
U-238 (µCi/g)	2.88E-04	2.88E-04	9.17E-06	9.18E-06	2.48E-06	1.54E-06	6.22E-09	6.21E-09	8.53E-06	8.57E-06
U-Total (µg/g)	8.64E+02	8.63E+02	2.75E+01	2.75E+01	7.45E+00	4.62E+00	1.86E-02	1.86E-02	2.56E+01	2.57E+01
Np-237 (µCi/g)	3.51E-05	6.01E-05	3.08E-06	4.13E-06	1.14E-06	1.18E-06	3.84E-07	6.40E-07	2.44E-05	2.50E-05
Pu-238 (µCi/g)	1.26E-05	4.18E-05	1.62E-05	4.67E-05	1.67E-05	4.32E-05	1.47E-05	4.22E-05	1.74E-05	1.78E-05
Pu-239 (µCi/g)	3.66E-03	4.72E-03	4.68E-03	4.60E-03	4.82E-03	4.88E-03	4.26E-03	4.76E-03	2.44E-03	2.50E-03
Pu-240 (µCi/g)	2.47E-04	5.98E-04	3.16E-04	6.51E-04	3.25E-04	6.18E-04	2.87E-04	6.03E-04	2.63E-04	2.69E-04
Pu-241 (µCi/g)	2.39E-04	1.31E-03	3.06E-04	1.50E-03	3.15E-04	1.36E-03	2.78E-04	1.32E-03	5.13E-04	5.25E-04
Pu-242 (µCi/g)	1.12E-09	9.55E-09	1.43E-09	1.14E-08	1.47E-09	9.87E-09	1.30E-09	9.63E-09	3.60E-09	3.68E-09
Pu-Total (µg/g)	6.00E-02	7.87E-02	7.68E-02	7.69E-02	7.90E-02	8.13E-02	6.99E-02	7.93E-02	4.05E-02	4.14E-02
Am-241 (µCi/g)	7.62E-04	4.21E-03	9.22E-05	4.62E-04	2.48E-05	8.30E-05	8.32E-06	4.49E-05	1.35E-03	1.38E-03
Am-243 (µCi/g)	3.29E-08	6.52E-07	2.88E-09	5.31E-08	1.07E-09	1.28E-08	3.60E-10	6.94E-09	1.91E-07	1.95E-07
Cm-242 (µCi/g)	5.77E-08	1.12E-06	5.05E-09	9.14E-08	1.88E-09	2.21E-08	6.30E-10	1.20E-08	3.28E-07	3.36E-07
Cm-243 (µCi/g)	3.41E-10	1.36E-08	2.98E-11	1.11E-09	1.11E-11	2.67E-10	3.73E-12	1.44E-10	3.89E-09	3.98E-09
Cm-244 (µCi/g)	8.00E-09	3.19E-07	7.00E-10	2.61E-08	2.60E-10	6.28E-09	8.74E-11	3.39E-09	9.15E-08	9.35E-08

Predicted Supernatant Concentration (µCi/g) (Sheet 2)

pred. su (µCi/g)	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3 (µCi/g)	5.16E-03	5.30E-03	2.29E-04	2.19E-02	1.25E-01	1.33E-01	2.59E-01	3.77E-03	1.12E-02	1.79E-03
C-14 (µCi/g)	2.00E-04	1.84E-04	2.59E-04	1.19E-03	7.80E-04	1.46E-03	1.76E-03	2.37E-03	2.83E-03	1.72E-05
Ni-59 (µCi/g)	8.68E-06	6.28E-06	1.09E-06	1.40E-04	3.43E-04	1.76E-03	1.28E-02	5.94E-04	1.27E-03	1.63E-06
Ni-63 (µCi/g)	7.58E-04	5.85E-04	9.76E-05	1.27E-02	3.24E-02	1.71E-01	1.23E+00	5.52E-02	1.22E-01	1.57E-04
Co-60 (µCi/g)	1.56E-04	2.53E-04	5.97E-05	1.61E-03	1.08E-02	8.07E-03	2.22E-02	1.20E-02	2.28E-02	1.16E-04
Se-79 (µCi/g)	9.03E-06	7.34E-06	2.08E-06	5.52E-05	1.69E-04	6.16E-07	9.34E-07	2.32E-04	5.15E-04	7.21E-07
Sr-90 (µCi/g)	1.65E-01	1.53E-01	2.74E-02	1.96E+00	1.99E+00	5.69E-01	1.04E+00	2.40E+00	2.35E+00	8.86E-01
Y-90 (µCi/g)	1.65E-01	1.53E-01	2.74E-02	1.96E+00	1.99E+00	5.69E-01	1.04E+00	2.40E+00	2.35E+00	8.86E-01
Zr-93 (µCi/g)	2.43E-06	2.43E-04	8.37E-05	3.30E-03	1.01E-02	3.69E-05	5.60E-05	1.38E-02	3.07E-02	4.28E-05
Nb-93m (µCi/g)	2.14E-06	2.16E-04	7.21E-05	2.84E-03	8.12E-03	3.16E-05	4.49E-05	1.15E-02	2.42E-02	3.21E-05
Tc-99 (µCi/g)	3.15E-03	2.44E-03	1.50E-04	2.10E-02	6.31E-02	2.68E-04	4.02E-04	7.27E-02	1.61E-01	3.06E-04
Ru-106 (µCi/g)	2.67E-15	1.96E-13	5.43E-12	4.40E-11	3.00E-08	1.10E-12	1.67E-10	3.64E-09	4.85E-08	4.72E-09
Cd-113m (µCi/g)	2.71E-04	2.45E-04	7.13E-05	2.27E-03	1.00E-02	1.70E-03	3.16E-03	1.22E-02	3.54E-02	6.34E-05
Sb-125 (µCi/g)	8.06E-06	6.64E-06	4.15E-06	1.40E-04	2.64E-03	1.67E-05	2.15E-05	1.80E-03	8.29E-03	5.61E-05
Sn-126 (µCi/g)	3.41E-05	2.76E-05	7.53E-06	2.24E-04	6.82E-04	2.49E-06	3.74E-06	9.58E-04	2.15E-03	3.10E-06
I-129 (µCi/g)	4.04E-06	5.35E-06	1.44E-06	3.36E-05	9.76E-05	3.78E-07	5.65E-07	4.33E-06	9.67E-06	0.00E+00
Cs-134 (µCi/g)	6.90E-11	6.96E-11	2.87E-12	3.13E-06	2.25E-04	5.25E-08	1.11E-06	6.85E-05	9.54E-04	7.96E-06
Cs-137 (µCi/g)	7.76E-03	7.89E-03	2.32E-04	5.93E+01	2.15E+02	6.72E-01	1.20E+00	2.75E+02	6.90E+02	1.04E+00
Ba-137m (µCi/g)	7.33E-03	7.45E-03	2.19E-04	5.60E+01	2.03E+02	6.34E-01	1.14E+00	2.60E+02	6.51E+02	9.84E-01
Sm-151 (µCi/g)	3.35E-01	2.97E-01	1.86E-01	2.32E+00	2.14E+00	2.58E-02	3.92E-02	7.13E+00	4.19E+00	2.81E-02
Eu-152 (µCi/g)	1.22E-05	1.05E-05	3.09E-06	2.35E-04	5.83E-04	2.89E-06	9.42E-06	1.06E-03	9.67E-04	1.80E-05
Eu-154 (µCi/g)	9.29E-04	8.02E-04	3.87E-04	1.59E-02	3.87E-02	1.93E-04	6.29E-04	7.91E-02	7.74E-02	1.29E-03
Eu-155 (µCi/g)	5.44E-04	4.69E-04	5.12E-04	6.53E-03	1.62E-02	8.00E-05	3.15E-04	3.61E-02	4.29E-02	4.75E-04
Ra-226 (µCi/g)	4.31E-08	3.52E-08	1.06E-08	3.17E-09	1.03E-08	1.08E-09	1.10E-09	9.14E-09	2.27E-08	6.21E-11
Ra-228 (µCi/g)	2.02E-13	1.63E-13	4.27E-14	1.78E-14	8.92E-14	9.94E-15	1.59E-14	5.62E-14	1.86E-13	6.28E-08
Ac-227 (µCi/g)	2.09E-07	1.67E-07	3.37E-08	1.36E-08	4.28E-08	5.12E-09	4.99E-09	4.07E-08	1.05E-07	1.66E-07
Pa-231 (µCi/g)	1.80E-09	1.83E-07	7.77E-07	2.02E-08	6.26E-08	1.09E-08	1.18E-08	5.80E-08	1.61E-07	2.58E-07
Th-229 (µCi/g)	9.62E-12	1.58E-11	2.85E-11	6.69E-11	5.61E-11	1.48E-12	1.66E-12	1.52E-10	1.38E-10	3.88E-08
Th-232 (µCi/g)	8.15E-14	1.33E-13	2.55E-13	1.92E-14	9.15E-14	1.22E-14	2.04E-14	5.79E-14	1.93E-13	4.97E-08
U-232 (µCi/g)	1.05E-10	1.04E-10	9.53E-11	3.25E-10	9.03E-10	3.45E-10	6.96E-10	6.70E-10	7.84E-10	3.03E-06
U-233 (µCi/g)	8.55E-12	8.41E-12	7.10E-12	1.60E-09	2.56E-09	1.76E-11	2.36E-11	4.72E-09	1.42E-09	1.79E-04
U-234 (µCi/g)	8.41E-06	8.33E-06	9.57E-06	7.99E-06	1.18E-05	9.14E-06	1.37E-05	9.78E-06	1.01E-05	1.31E-05
U-235 (µCi/g)	3.75E-07	3.72E-07	4.31E-07	3.44E-07	4.49E-07	3.88E-07	5.19E-07	4.18E-07	4.20E-07	5.03E-07
U-236 (µCi/g)	9.62E-08	9.34E-08	8.60E-08	1.65E-07	3.42E-07	1.87E-07	3.85E-07	2.16E-07	2.58E-07	5.72E-07
U-238 (µCi/g)	8.57E-06	8.49E-06	9.73E-06	8.18E-06	8.27E-06	8.92E-06	9.53E-06	1.00E-05	9.82E-06	8.77E-06
U-Total (µg/g)	2.57E+01	2.54E+01	2.92E+01	2.45E+01	2.48E+01	2.67E+01	2.86E+01	3.01E+01	2.94E+01	2.64E+01
Np-237 (µCi/g)	2.50E-05	1.98E-05	3.54E-06	1.53E-04	1.55E-04	1.78E-06	2.61E-06	3.98E-04	4.33E-04	6.47E-07
Pu-238 (µCi/g)	1.78E-05	2.18E-05	1.80E-05	7.67E-05	2.77E-04	7.01E-05	1.20E-04	1.22E-04	2.30E-04	4.69E-04
Pu-239 (µCi/g)	2.50E-03	2.90E-03	4.97E-03	4.04E-03	4.04E-03	4.41E-03	4.68E-03	4.94E-03	4.78E-03	4.16E-03
Pu-240 (µCi/g)	2.69E-04	3.24E-04	3.38E-04	7.84E-04	9.46E-04	8.37E-04	1.03E-03	9.93E-04	1.17E-03	1.45E-03
Pu-241 (µCi/g)	5.25E-04	6.61E-04	4.36E-04	2.72E-03	7.17E-03	3.08E-03	6.65E-03	4.35E-03	1.04E-02	2.75E-02
Pu-242 (µCi/g)	3.68E-09	4.70E-09	1.24E-09	2.38E-08	5.46E-08	2.48E-08	4.36E-08	3.10E-08	8.47E-08	2.48E-07
Pu-Total (µg/g)	4.14E-02	4.82E-02	8.16E-02	6.85E-02	6.94E-02	7.47E-02	8.00E-02	8.40E-02	8.23E-02	7.37E-02
Am-241 (µCi/g)	1.38E-03	1.14E-03	9.22E-05	5.32E-03	5.39E-03	5.53E-03	6.21E-03	6.52E-03	6.39E-03	1.14E-03
Am-243 (µCi/g)	1.95E-07	1.51E-07	2.26E-09	1.94E-06	4.66E-06	6.02E-08	1.15E-07	3.00E-06	3.40E-06	1.09E-06
Cm-242 (µCi/g)	3.36E-07	2.60E-07	4.14E-09	8.61E-06	9.00E-06	1.03E-07	3.09E-07	3.59E-05	1.30E-05	1.83E-06
Cm-243 (µCi/g)	3.98E-09	3.09E-09	1.88E-11	1.54E-07	6.98E-07	1.89E-09	1.11E-08	7.02E-07	7.77E-07	1.97E-07
Cm-244 (µCi/g)	9.35E-08	7.26E-08	5.28E-10	3.81E-06	1.54E-05	4.63E-08	3.03E-07	1.86E-05	1.82E-05	4.83E-06

Predicted Supernatant Concentration (µCi/g) (Sheet 3)

pred. su (µCi/g)	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3 (µCi/g)	1.51E-01	1.57E-01	1.58E-01	2.89E-04	1.24E-04	6.37E-05	0.00E+00	3.03E-04	2.29E-04	7.16E-04
C-14 (µCi/g)	1.43E-03	1.00E-03	3.40E-03	4.06E-04	7.00E-05	4.71E-05	0.00E+00	1.31E-04	9.56E-08	9.87E-08
Ni-59 (µCi/g)	5.62E-03	7.32E-03	1.71E-04	1.26E-06	3.96E-07	5.84E-08	0.00E+00	2.70E-03	1.86E-06	1.92E-06
Ni-63 (µCi/g)	5.25E-01	7.06E-01	1.48E-02	1.18E-04	3.81E-05	5.63E-06	0.00E+00	2.55E-01	1.58E-04	1.67E-04
Co-60 (µCi/g)	1.11E-02	1.93E-02	6.69E-03	2.54E-05	1.56E-05	4.12E-06	0.00E+00	1.91E-02	7.00E-06	1.09E-05
Se-79 (µCi/g)	5.91E-07	4.51E-07	4.43E-06	4.92E-07	1.58E-07	2.57E-08	0.00E+00	1.62E-05	1.63E-05	1.68E-05
Sr-90 (µCi/g)	5.78E-01	5.03E-01	2.40E+00	4.93E-01	1.79E-01	3.16E-02	0.00E+00	9.04E+01	2.09E+00	2.09E+00
Y-90 (µCi/g)	5.78E-01	5.03E-01	2.40E+00	4.93E-01	1.79E-01	3.16E-02	0.00E+00	9.04E+01	2.09E+00	2.09E+00
Zr-93 (µCi/g)	3.53E-05	2.60E-05	1.21E-06	2.93E-05	9.41E-06	1.52E-06	0.00E+00	9.64E-04	4.34E-04	4.48E-04
Nb-93m (µCi/g)	2.96E-05	2.04E-05	9.35E-07	2.44E-05	7.42E-06	1.14E-06	0.00E+00	7.82E-04	3.40E-04	3.37E-04
Tc-99 (µCi/g)	2.58E-04	1.88E-04	1.00E-02	2.14E-04	6.86E-05	1.09E-05	0.00E+00	5.07E-03	1.84E-03	1.90E-03
Ru-106 (µCi/g)	3.50E-12	6.61E-10	1.89E-08	7.73E-12	7.23E-11	1.68E-10	0.00E+00	3.76E-08	4.84E-10	4.89E-09
Cd-113m (µCi/g)	1.90E-03	1.88E-03	4.31E-04	2.59E-05	1.09E-05	2.26E-06	0.00E+00	9.69E-04	8.57E-04	1.03E-03
Sb-125 (µCi/g)	4.14E-06	1.97E-05	5.93E-04	3.83E-06	4.46E-06	2.00E-06	0.00E+00	4.23E-03	3.84E-04	8.83E-04
Sn-126 (µCi/g)	2.43E-06	1.86E-06	2.10E-05	2.03E-06	6.59E-07	1.11E-07	0.00E+00	6.71E-05	5.34E-05	5.51E-05
I-129 (µCi/g)	2.54E-04	1.63E-04	1.56E-05	1.43E-04	4.60E-05	4.21E-05	0.00E+00	3.03E-07	1.73E-07	1.79E-07
Cs-134 (µCi/g)	1.12E-07	1.27E-06	4.85E-04	1.45E-07	2.93E-07	2.84E-07	0.00E+00	1.61E-05	1.17E-05	3.56E-05
Cs-137 (µCi/g)	6.85E-01	5.89E-01	3.43E+01	5.84E-01	2.12E-01	3.72E-02	0.00E+00	2.03E+01	8.78E+00	9.72E+00
Ba-137m (µCi/g)	6.47E-01	5.56E-01	3.23E+01	5.52E-01	2.00E-01	3.51E-02	0.00E+00	1.92E+01	8.29E+00	9.18E+00
Sm-151 (µCi/g)	2.50E-02	1.86E-02	1.30E-01	2.08E-02	6.81E-03	1.00E-03	0.00E+00	1.82E+01	1.85E-01	1.96E-01
Eu-152 (µCi/g)	3.42E-06	4.80E-06	1.90E-04	3.11E-06	1.57E-06	6.42E-07	0.00E+00	3.67E-03	5.24E-05	6.33E-05
Eu-154 (µCi/g)	2.48E-04	3.68E-04	1.28E-02	2.31E-04	1.26E-04	4.61E-05	0.00E+00	2.89E-01	2.09E-03	2.77E-03
Eu-155 (µCi/g)	1.08E-04	2.04E-04	1.67E-03	1.06E-04	6.96E-05	1.69E-05	0.00E+00	1.53E-01	7.45E-04	1.22E-03
Ra-226 (µCi/g)	7.78E-10	2.15E-09	1.37E-09	1.94E-11	7.83E-12	2.21E-12	0.00E+00	6.72E-10	5.23E-08	5.23E-08
Ra-228 (µCi/g)	8.32E-15	1.66E-05	5.40E-14	1.19E-16	3.75E-09	2.24E-09	0.00E+00	4.78E-15	2.30E-04	1.59E-04
Ac-227 (µCi/g)	3.79E-09	3.36E-07	8.19E-09	8.64E-11	1.23E-08	5.92E-09	0.00E+00	3.05E-09	3.04E-07	3.04E-07
Pa-231 (µCi/g)	8.34E-09	1.69E-06	2.10E-08	1.23E-10	1.82E-08	9.18E-09	0.00E+00	4.50E-09	1.11E-03	1.15E-03
Th-229 (µCi/g)	1.31E-12	4.56E-08	6.08E-12	3.23E-13	3.19E-09	1.38E-09	0.00E+00	7.79E-12	1.71E-07	1.47E-07
Th-232 (µCi/g)	1.03E-14	2.08E-07	7.20E-14	1.23E-16	3.51E-09	1.77E-09	0.00E+00	4.95E-15	1.88E-07	1.88E-07
U-232 (µCi/g)	4.30E-10	1.29E-06	3.50E-09	6.69E-10	1.03E-06	3.29E-06	0.00E+00	7.01E-10	6.45E-05	6.86E-05
U-233 (µCi/g)	2.03E-11	7.74E-05	5.31E-11	4.71E-09	6.56E-05	1.95E-04	0.00E+00	2.96E-09	4.11E-03	4.07E-03
U-234 (µCi/g)	9.14E-06	1.08E-05	1.42E-05	9.77E-06	1.05E-05	1.42E-05	0.00E+00	9.57E-06	3.11E-05	3.21E-05
U-235 (µCi/g)	3.90E-07	4.18E-07	6.59E-07	4.18E-07	4.18E-07	5.47E-07	0.00E+00	4.04E-07	1.10E-10	1.14E-10
U-236 (µCi/g)	2.09E-07	2.64E-07	1.00E-06	2.16E-07	2.57E-07	6.22E-07	0.00E+00	2.29E-07	1.93E-11	1.99E-11
U-238 (µCi/g)	9.39E-06	9.65E-06	9.96E-06	1.00E-05	9.78E-06	9.54E-06	0.00E+00	9.57E-06	1.72E-18	1.78E-18
U-Total (µg/g)	2.81E+01	2.89E+01	3.00E+01	3.00E+01	2.93E+01	2.87E+01	0.00E+00	2.87E+01	4.41E-01	4.37E-01
Np-237 (µCi/g)	1.73E-06	1.25E-06	7.33E-06	8.44E-07	1.33E-07	2.31E-08	0.00E+00	2.14E-05	2.04E-10	2.11E-10
Pu-238 (µCi/g)	8.14E-05	1.14E-04	4.76E-04	1.22E-04	2.29E-04	5.10E-04	2.73E-04	1.80E-04	3.48E-08	3.68E-08
Pu-239 (µCi/g)	4.61E-03	4.71E-03	4.68E-03	4.93E-03	4.76E-03	4.52E-03	4.27E-03	5.52E-03	1.76E-12	1.82E-12
Pu-240 (µCi/g)	9.62E-04	1.11E-03	1.81E-03	9.92E-04	1.17E-03	1.58E-03	1.07E-03	1.19E-03	1.21E-13	1.25E-13
Pu-241 (µCi/g)	4.17E-03	8.03E-03	3.69E-02	4.35E-03	1.04E-02	2.99E-02	1.72E-02	7.29E-03	4.67E-13	5.59E-13
Pu-242 (µCi/g)	2.99E-08	5.64E-08	3.49E-07	3.10E-08	8.44E-08	2.70E-07	1.06E-07	5.61E-08	9.92E-19	1.02E-18
Pu-Total (µg/g)	7.86E-02	8.09E-02	8.38E-02	8.39E-02	8.19E-02	8.02E-02	7.34E-02	9.43E-02	2.06E-09	2.18E-09
Am-241 (µCi/g)	5.97E-03	5.19E-03	6.51E-03	1.24E-04	6.94E-05	4.08E-05	5.70E-03	2.63E-01	6.75E-14	6.75E-14
Am-243 (µCi/g)	6.64E-08	1.38E-07	6.79E-07	5.72E-08	3.70E-08	3.90E-08	0.00E+00	1.31E-04	2.40E-19	2.48E-19
Cm-242 (µCi/g)	1.13E-07	2.16E-07	3.07E-06	9.75E-08	6.44E-08	6.51E-08	0.00E+00	1.41E-05	4.54E-19	1.37E-19
Cm-243 (µCi/g)	2.11E-09	1.13E-08	8.66E-07	1.91E-09	3.86E-09	7.03E-09	0.00E+00	7.52E-07	9.13E-21	1.01E-20
Cm-244 (µCi/g)	5.49E-08	3.49E-07	1.86E-05	5.05E-08	9.06E-08	1.72E-07	0.00E+00	1.78E-05	1.99E-19	2.31E-19

Predicted Supernatant Concentration (µCi/g) (Sheet 4)

pred_su (µCi/g)	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3 (µCi/g)	9.94E-03	1.60E-02	1.54E-03	6.67E-03	1.65E-02	0.00E+00	3.86E-03	4.95E-02	2.52E-02	5.13E-02
C-14 (µCi/g)	1.81E-03	1.00E-03	1.12E-04	6.07E-04	3.17E-03	0.00E+00	2.26E-04	1.93E-03	3.32E-03	6.03E-03
Ni-59 (µCi/g)	5.16E-04	1.06E-03	4.76E-04	4.98E-03	5.89E-04	0.00E+00	3.45E-05	3.84E-04	8.34E-04	2.63E-03
Ni-63 (µCi/g)	4.88E-02	1.03E-01	4.52E-02	4.71E-01	5.60E-02	0.00E+00	3.55E-03	3.64E-02	7.99E-02	2.52E-01
Co-60 (µCi/g)	1.74E-02	2.34E-02	6.11E-03	2.09E-02	2.01E-02	0.00E+00	2.60E-04	1.07E-02	1.62E-02	1.59E-02
Se-79 (µCi/g)	2.17E-04	2.33E-04	2.40E-05	1.17E-04	3.78E-04	0.00E+00	8.69E-06	1.80E-04	2.95E-04	4.12E-04
Sr-90 (µCi/g)	2.32E+00	2.42E+00	6.74E+01	2.16E+00	2.08E+00	0.00E+00	1.81E+00	1.66E+00	1.67E+00	1.65E+00
Y-90 (µCi/g)	2.32E+00	2.42E+00	6.74E+01	2.17E+00	2.08E+00	0.00E+00	1.81E+00	1.66E+00	1.67E+00	1.65E+00
Zr-93 (µCi/g)	1.29E-02	1.39E-02	1.43E-03	6.96E-03	2.25E-02	0.00E+00	8.05E-04	1.08E-02	1.76E-02	2.44E-02
Nb-93m (µCi/g)	1.04E-02	1.04E-02	1.08E-03	5.32E-03	1.82E-02	0.00E+00	7.16E-04	8.87E-03	1.43E-02	1.97E-02
Tc-99 (µCi/g)	6.78E-02	7.14E-02	7.37E-03	3.60E-02	1.20E-01	0.00E+00	2.61E-03	6.70E-02	9.74E-02	1.31E-01
Ru-106 (µCi/g)	4.79E-08	4.99E-08	3.71E-08	4.46E-08	3.40E-08	0.00E+00	5.66E-13	2.15E-08	3.44E-08	2.24E-11
Cd-113m (µCi/g)	1.32E-02	2.05E-02	2.05E-03	9.53E-03	2.35E-02	0.00E+00	2.93E-04	9.99E-03	1.88E-02	3.05E-02
Sb-125 (µCi/g)	3.97E-03	8.53E-03	2.28E-03	7.63E-03	5.56E-03	0.00E+00	8.06E-06	2.13E-03	4.66E-03	1.87E-04
Sn-126 (µCi/g)	8.99E-04	1.00E-03	1.03E-04	5.00E-04	1.57E-03	0.00E+00	3.27E-05	7.32E-04	1.22E-03	1.71E-03
I-129 (µCi/g)	3.60E-05	4.39E-06	4.52E-07	2.20E-06	7.11E-05	0.00E+00	3.62E-06	1.03E-04	1.07E-04	1.86E-04
Cs-134 (µCi/g)	2.28E-04	1.55E-04	0.00E+00	1.02E-03	1.02E-05	0.00E+00	6.41E-08	1.51E-04	2.18E-04	1.26E-04
Cs-137 (µCi/g)	2.73E+02	2.03E+01	0.00E+00	1.64E+02	1.26E+01	0.00E+00	7.61E+00	1.99E+02	1.79E+02	1.09E+02
Ba-137m (µCi/g)	2.58E+02	1.91E+01	0.00E+00	1.55E+02	1.19E+01	0.00E+00	7.19E+00	1.88E+02	1.69E+02	1.03E+02
Sm-151 (µCi/g)	5.25E+00	1.73E+00	3.33E+00	3.75E+00	4.96E+00	0.00E+00	4.00E-01	2.83E+00	4.01E+00	4.83E-01
Eu-152 (µCi/g)	9.85E-04	1.11E-03	1.05E-03	9.28E-04	9.20E-04	0.00E+00	1.36E-05	4.79E-04	7.49E-04	9.50E-05
Eu-154 (µCi/g)	7.65E-02	7.97E-02	7.85E-02	7.12E-02	6.85E-02	0.00E+00	1.04E-03	3.22E-02	5.50E-02	7.16E-03
Eu-155 (µCi/g)	3.93E-02	2.93E-02	3.52E-02	3.48E-02	3.16E-02	0.00E+00	6.06E-04	1.35E-02	2.51E-02	3.43E-03
Ra-226 (µCi/g)	9.34E-09	1.35E-08	1.35E-09	6.32E-09	1.76E-08	0.00E+00	4.23E-08	1.08E-08	3.99E-08	4.11E-08
Ra-228 (µCi/g)	5.51E-07	1.86E-13	1.80E-14	7.96E-14	8.19E-07	0.00E+00	1.92E-13	4.26E-07	4.73E-06	4.97E-05
Ac-227 (µCi/g)	6.16E-08	6.52E-08	6.51E-09	3.02E-08	1.04E-07	0.00E+00	1.90E-07	5.24E-08	2.43E-07	2.39E-07
Pa-231 (µCi/g)	1.29E-07	1.06E-07	1.06E-08	4.85E-08	2.82E-07	0.00E+00	5.90E-07	8.07E-07	1.32E-05	1.56E-04
Th-229 (µCi/g)	3.65E-09	6.36E-11	7.01E-12	3.76E-11	4.55E-09	0.00E+00	3.47E-11	1.22E-09	1.14E-08	3.87E-08
Th-232 (µCi/g)	9.30E-09	1.95E-13	1.89E-14	8.35E-14	1.27E-08	0.00E+00	2.92E-13	4.36E-09	4.12E-08	1.48E-07
U-232 (µCi/g)	6.12E-08	3.83E-09	1.27E-09	8.73E-10	2.18E-07	0.00E+00	1.08E-10	6.37E-08	3.89E-07	2.12E-06
U-233 (µCi/g)	3.75E-06	1.40E-09	2.60E-09	2.67E-09	1.35E-05	0.00E+00	8.66E-12	3.77E-06	2.32E-05	1.28E-04
U-234 (µCi/g)	9.74E-06	1.34E-05	1.01E-05	9.25E-06	9.26E-06	0.00E+00	8.08E-06	8.02E-06	7.67E-06	8.36E-06
U-235 (µCi/g)	4.10E-07	5.77E-07	4.28E-07	3.92E-07	3.87E-07	0.00E+00	3.60E-07	3.24E-07	3.18E-07	3.11E-07
U-236 (µCi/g)	2.34E-07	6.57E-07	3.03E-07	2.44E-07	2.51E-07	0.00E+00	9.47E-08	2.01E-07	1.78E-07	2.13E-07
U-238 (µCi/g)	9.69E-06	1.01E-05	9.45E-06	9.03E-06	8.68E-06	0.00E+00	8.23E-06	6.90E-06	6.97E-06	6.85E-06
U-Total (µg/g)	2.91E+01	3.03E+01	2.83E+01	2.71E+01	2.60E+01	0.00E+00	2.47E+01	2.07E+01	2.09E+01	2.06E+01
Np-237 (µCi/g)	2.79E-04	2.10E-04	2.26E-05	1.17E-04	3.93E-04	0.00E+00	2.23E-05	2.67E-04	3.16E-04	3.11E-04
Pu-238 (µCi/g)	1.59E-04	5.39E-04	3.03E-04	1.87E-04	1.81E-04	0.00E+00	3.16E-05	1.32E-04	1.24E-04	1.32E-04
Pu-239 (µCi/g)	4.75E-03	4.77E-03	5.39E-03	4.41E-03	4.24E-03	0.00E+00	4.15E-03	3.39E-03	3.42E-03	3.34E-03
Pu-240 (µCi/g)	1.03E-03	1.67E-03	1.38E-03	1.02E-03	9.81E-04	0.00E+00	4.71E-04	7.21E-04	7.18E-04	8.01E-04
Pu-241 (µCi/g)	6.55E-03	3.16E-02	1.55E-02	8.65E-03	8.18E-03	0.00E+00	9.46E-04	4.11E-03	5.90E-03	7.54E-03
Pu-242 (µCi/g)	5.07E-08	2.85E-07	1.33E-07	7.12E-08	6.73E-08	0.00E+00	6.82E-09	3.31E-08	4.74E-08	6.12E-08
Pu-Total (µg/g)	8.12E-02	8.46E-02	9.32E-02	7.57E-02	7.28E-02	0.00E+00	6.90E-02	5.79E-02	5.84E-02	5.75E-02
Am-241 (µCi/g)	6.31E-03	6.57E-03	7.05E-02	5.87E-03	5.65E-03	0.00E+00	1.23E-03	4.49E-03	4.53E-03	4.46E-03
Am-243 (µCi/g)	3.14E-06	6.28E-06	5.11E-05	3.59E-06	3.18E-06	0.00E+00	1.62E-07	2.47E-06	2.47E-06	1.78E-06
Cm-242 (µCi/g)	1.64E-05	7.09E-06	7.74E-06	8.75E-06	2.12E-05	0.00E+00	2.80E-07	1.33E-05	1.40E-05	1.46E-05
Cm-243 (µCi/g)	7.53E-07	7.65E-07	7.20E-07	6.93E-07	6.46E-07	0.00E+00	3.30E-09	5.62E-07	5.35E-07	5.12E-07
Cm-244 (µCi/g)	1.80E-05	1.87E-05	1.75E-05	1.68E-05	1.61E-05	0.00E+00	7.76E-08	1.28E-05	1.29E-05	1.27E-05

Predicted Supernatant Concentration (µCi/g) (Sheet 5)

pred. su (µCi/g)	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (µCi/g)	1.81E-02	1.84E-02	1.91E-02	1.60E-02	4.98E-01	3.28E-01	1.02E-03	1.54E-01
C-14 (µCi/g)	4.26E-03	4.40E-03	5.39E-03	4.23E-03	1.55E-03	9.07E-04	6.80E-06	1.86E-03
Ni-59 (µCi/g)	4.34E-04	5.30E-04	9.89E-04	2.01E-04	1.64E-03	5.75E-04	1.20E-07	3.82E-05
Ni-63 (µCi/g)	4.13E-02	5.06E-02	9.43E-02	1.92E-02	1.59E-01	5.61E-02	1.16E-05	3.67E-03
Co-60 (µCi/g)	1.53E-02	1.52E-02	1.51E-02	1.56E-02	2.05E-02	2.16E-02	6.05E-05	1.24E-02
Se-79 (µCi/g)	4.03E-04	4.09E-04	4.82E-04	3.70E-04	7.66E-04	4.63E-04	4.21E-08	9.81E-07
Sr-90 (µCi/g)	1.59E+00	1.57E+00	1.56E+00	1.61E+00	2.11E+00	2.23E+00	7.09E-02	1.65E+00
Y-90 (µCi/g)	1.59E+00	1.57E+00	1.56E+00	1.61E+00	2.11E+00	2.23E+00	7.09E-02	1.65E+00
Zr-93 (µCi/g)	2.41E-02	2.44E-02	2.87E-02	2.20E-02	4.63E-02	2.81E-02	2.55E-06	2.70E-07
Nb-93m (µCi/g)	1.95E-02	1.98E-02	2.32E-02	1.78E-02	2.61E-02	1.49E-02	1.40E-06	1.49E-07
Tc-99 (µCi/g)	1.33E-01	1.35E-01	1.56E-01	1.21E-01	2.26E-01	1.37E-01	1.73E-05	5.35E-03
Ru-106 (µCi/g)	3.27E-08	3.24E-08	3.21E-08	3.32E-08	5.23E-02	1.77E-01	4.93E-08	4.95E-08
Cd-113m (µCi/g)	2.50E-02	2.55E-02	2.71E-02	2.19E-02	3.67E-02	3.86E-02	7.70E-06	1.85E-04
Sb-125 (µCi/g)	2.11E-03	3.22E-03	4.44E-03	5.68E-03	5.78E-01	9.97E-01	1.37E-04	7.76E-03
Sn-126 (µCi/g)	1.67E-03	1.69E-03	2.00E-03	1.54E-03	3.43E-03	2.03E-03	1.87E-07	4.36E-06
I-129 (µCi/g)	1.26E-04	1.32E-04	1.61E-04	1.43E-04	2.01E-05	1.20E-05	1.71E-05	3.54E-05
Cs-134 (µCi/g)	1.78E-04	2.07E-04	3.17E-04	6.79E-03	9.37E-01	9.64E-01	6.44E-05	1.99E-02
Cs-137 (µCi/g)	1.62E+02	1.83E+02	1.99E+02	1.56E+02	1.45E+03	9.08E+02	8.07E-02	2.50E+01
Ba-137m (µCi/g)	1.53E+02	1.73E+02	1.88E+02	1.48E+02	1.37E+03	8.57E+02	7.62E-02	2.36E+01
Sm-151 (µCi/g)	2.30E+00	3.17E+00	3.34E+00	2.93E+00	3.06E+00	3.39E+00	1.70E-03	3.96E-02
Eu-152 (µCi/g)	4.21E-04	5.85E-04	6.87E-04	7.01E-04	4.20E-03	4.17E-03	2.24E-06	5.22E-05
Eu-154 (µCi/g)	3.09E-02	4.29E-02	5.13E-02	5.31E-02	4.94E-01	5.28E-01	2.70E-04	6.30E-03
Eu-155 (µCi/g)	1.41E-02	1.96E-02	2.39E-02	2.48E-02	3.35E-01	4.89E-01	2.07E-04	4.82E-03
Ra-226 (µCi/g)	3.16E-08	3.73E-08	3.90E-08	3.17E-08	5.29E-08	3.78E-08	3.65E-12	3.94E-10
Ra-228 (µCi/g)	4.11E-06	4.70E-06	1.84E-05	1.29E-05	3.01E-12	2.51E-12	2.20E-16	3.07E-14
Ac-227 (µCi/g)	1.93E-07	2.27E-07	2.26E-07	1.86E-07	3.07E-07	1.95E-07	1.83E-11	1.89E-09
Pa-231 (µCi/g)	9.91E-06	1.19E-05	5.91E-05	4.10E-05	7.54E-07	4.78E-07	4.22E-11	8.04E-09
Th-229 (µCi/g)	9.76E-09	1.12E-08	2.16E-08	1.57E-08	4.51E-10	2.51E-10	2.41E-14	2.12E-12
Th-232 (µCi/g)	3.35E-08	3.91E-08	7.84E-08	5.68E-08	4.43E-12	2.94E-12	2.52E-16	5.11E-14
U-232 (µCi/g)	1.85E-07	2.32E-07	6.89E-07	2.03E-07	4.43E-09	4.05E-09	4.78E-09	2.74E-09
U-233 (µCi/g)	1.11E-05	1.39E-05	4.14E-05	1.21E-05	1.42E-09	1.25E-09	1.51E-09	3.35E-11
U-234 (µCi/g)	7.03E-06	7.04E-06	7.22E-06	8.57E-06	1.28E-05	1.35E-05	1.44E-05	1.45E-05
U-235 (µCi/g)	2.94E-07	2.94E-07	2.92E-07	3.39E-07	4.78E-07	5.36E-07	5.54E-07	5.56E-07
U-236 (µCi/g)	1.74E-07	1.70E-07	1.90E-07	5.81E-07	1.22E-06	1.33E-06	1.39E-06	1.40E-06
U-238 (µCi/g)	6.61E-06	6.56E-06	6.50E-06	6.72E-06	8.80E-06	9.27E-06	9.96E-06	1.00E-05
U-Total (µg/g)	1.98E+01	1.97E+01	1.95E+01	2.02E+01	2.64E+01	2.79E+01	2.99E+01	3.00E+01
Np-237 (µCi/g)	3.00E-04	2.98E-04	2.95E-04	2.57E-04	4.00E-04	4.21E-04	2.44E-07	5.70E-06
Pu-238 (µCi/g)	1.17E-04	1.16E-04	1.33E-04	2.41E-04	4.48E-04	4.44E-04	4.97E-04	4.89E-04
Pu-239 (µCi/g)	3.24E-03	3.22E-03	3.17E-03	3.25E-03	4.23E-03	4.47E-03	4.79E-03	4.81E-03
Pu-240 (µCi/g)	7.06E-04	6.92E-04	7.37E-04	8.44E-04	1.21E-03	1.22E-03	1.35E-03	1.36E-03
Pu-241 (µCi/g)	5.22E-03	5.29E-03	6.62E-03	1.71E-02	3.62E-02	3.56E-02	4.01E-02	4.02E-02
Pu-242 (µCi/g)	4.33E-08	4.33E-08	5.48E-08	8.93E-08	1.56E-07	1.47E-07	1.70E-07	1.71E-07
Pu-Total (µg/g)	5.54E-02	5.50E-02	5.45E-02	5.63E-02	7.39E-02	7.79E-02	8.37E-02	8.40E-02
Am-241 (µCi/g)	4.30E-03	4.27E-03	4.23E-03	4.37E-03	5.74E-03	6.05E-03	3.23E-04	6.52E-03
Am-243 (µCi/g)	2.59E-06	2.48E-06	2.61E-06	2.87E-06	1.80E-06	1.35E-06	8.99E-08	6.53E-07
Cm-242 (µCi/g)	1.43E-05	1.39E-05	1.23E-05	8.65E-06	4.08E-06	4.85E-06	1.66E-07	3.84E-06
Cm-243 (µCi/g)	5.03E-07	5.00E-07	4.92E-07	5.05E-07	6.30E-07	6.96E-07	2.50E-08	5.83E-07
Cm-244 (µCi/g)	1.23E-05	1.22E-05	1.21E-05	1.25E-05	1.64E-05	1.72E-05	6.41E-07	1.49E-05

Supernatant Volumes to Evaporator (kgal) (Sheet 1)

salt cake inputs (kgal)	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
BT	6.01E+02	0.00E+00	9.05E+03	6.10E+03	3.65E+02	2.30E+02	0.00E+00		1.31E+04	1.72E+02
BT'										
BY	3.08E+00	2.99E-01	9.10E+01	1.28E+02	3.02E+00	3.10E+01	1.14E+01	5.00E+00	4.45E+02	1.56E+02
BY'										
A1	1.40E-02	1.03E-04	2.08E+00	2.58E+01	1.88E-02	1.38E+00	3.27E+00	0.00E+00	2.38E+01	1.33E-01
A1'										
Org	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E+00	0.00E+00	0.00E+00
Org'										
R	1.04E-04	5.04E-10	2.51E-03	1.83E-03	5.84E-04	8.34E-03	0.00E+00		1.76E-02	3.88E-03
R'										
T2	1.06E+02	1.21E+01	1.21E+02	8.84E+02	5.90E-02	1.77E102	1.24E-03		2.52E+03	2.73E+02
T2'										
S1	4.77E+00	2.27E-01	2.15E+01	6.79E+01	1.10E-01	8.14E+01	1.42E+02	0.00E+00	3.50E+01	1.11E+00
S1'										
S2	2.10E+00	2.96E-03	7.36E+00	1.02E+01	4.65E-03	2.01E+00	1.09E+01		1.30E-01	1.09E-02
S2'										
A2	4.13E-03	1.73E-03	5.62E-01	1.32E+00	6.58E-03	5.95E+01	5.71E+00	0.00E+00	7.83E+01	3.58E-02
A2'										
CSR in	5.28E-01	3.71E-11	3.48E-01	3.97E-02	3.14E-01	8.03E+01	0.00E+00	0.00E+00	9.51E+01	5.68E-01
AR in	1.29E-03	0.00E+00	5.26E-01	2.68E-01	7.06E-02	1.34E+01	0.00E+00	0.00E+00	2.60E+01	2.42E+00
			9.30E+03	7.22E+03	3.68E+02	5.82E+02	1.73E+02	7.00E+00	1.62E+04	6.03E+02
fr.su left			1.00E+00	1.00E+00	1.00E+00	9.95E-01	1.00E+00	1.00E+00	9.95E-01	1.00E+00
frac NO3- left in su	9.18E-01	8.88E-01	9.97E-01	9.97E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.48E-01	9.96E-01
frac. NO2 to NH3 in su	2.05E-03	2.84E-03	7.29E-05	8.35E-05	1.47E-06	1.28E-06	1.67E-08	2.40E-08	1.27E-03	9.38E-05
frac NO3- left in sl	6.66E-01	5.30E-01	9.98E-01	9.98E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.64E-01	1.61E-01
frac. NO2 to NH3 in sl	9.73E-03	1.51E-02	4.19E-05	5.01E-05	6.99E-07	6.71E-07	1.21E-08	1.89E-08	2.40E-02	4.29E-02
5.00E-02	mol NO2/mol NO3/Ci/yr.									
2.49E+00	gal TBP lost *per ton fuel*									
1.20E-03	mol NH3/mol NO2/Ci/yr.									
su ionic strength	1.71E+00	1.72E+00	1.68E+00	1.67E+00	1.48E+00	1.26E+00	1.41E+00	1.41E+00	2.15E+00	2.08E+00
complexability	8.90E-01	8.92E-01	2.19E-01	2.19E-01	1.96E-01	1.77E-01	7.20E-02	7.20E-02	4.54E-01	2.69E-01

Supernatant Volumes to Evaporator (kgal) (Sheet 2)

salt cake inputs (kgal)	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
BT	0.00E+00	0.00E+00	5.73E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BT'										
BY	9.74E+02	5.77E+02	0.00E+00	5.32E-03	3.80E+00	4.05E-01	1.40E-01	7.28E+02	8.35E+02	1.66E+02
BY'										
A1	3.31E+00	3.86E+00	4.29E-03	4.81E-01	2.55E-01	1.36E+00	1.97E-01	1.74E+02	8.56E+01	1.89E+01
A1'										
Org	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Org'										
R	1.94E-03	7.15E-03	0.00E+00	7.60E+03	5.23E+03	4.40E+02	1.60E+02	3.82E-02	2.08E-01	1.53E+00
R'										
T2	3.54E+00	1.23E+00	1.80E+02	4.27E+03	2.28E+03	1.53E+03	2.02E+03	2.13E+03	1.09E+03	9.80E+01
T2'										
S1	3.38E+00	1.24E+01	5.17E-01	8.49E+03	2.83E+02	9.77E+02	1.03E+02	2.15E+02	1.02E+02	1.53E+02
S1'										
S2	3.82E-02	9.50E-03	6.68E-03	1.13E+02	1.90E+00	7.64E+01	9.67E-01	6.67E-01	1.54E+00	1.20E+00
S2'										
A2	5.54E-01	4.72E-01	9.47E-03	5.09E-01	7.17E-01	1.55E-01	1.39E-01	9.45E-01	2.84E+00	2.15E+00
A2'										
CSR in	2.64E+00	1.47E+00	0.00E+00	3.32E+03	2.28E+03	8.68E+00	2.39E+00	2.03E+04	5.95E+03	6.25E+02
AR in	0.00E+00	2.61E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E+03	1.16E+03	1.45E+02
	9.85E+02	5.95E+02	7.53E+02	2.05E+04	7.79E+03	3.03E+03	2.29E+03	3.25E+03	2.11E+03	4.40E+02
fr.su left	1.00E+00	1.00E+00	1.00E+00	7.86E-01	6.56E-01	9.57E-01	9.74E-01	1.30E-01	2.48E-01	3.75E-01
				1.88E+03	2.05E+03	3.09E+00	2.73E+00	9.78E+02	1.49E+03	6.23E-01
frac NO3- left in su	9.99E-01	9.99E-01	1.00E+00	7.45E-01	4.80E-01	9.95E-01	9.94E-01	3.97E-01	1.66E-01	9.96E-01
frac. NO2 to NH3 in su	1.79E-05	1.64E-05	2.52E-06	7.03E-03	1.75E-02	1.26E-04	1.51E-04	2.19E-02	4.22E-02	9.29E-05
frac NO3- left in sl	1.74E-01	3.58E-01	9.21E-01	5.16E-03	9.76E-10	9.96E-01	9.95E-01	4.87E-16	1.13E-17	9.98E-01
frac. NO2 to NH3 in sl	4.11E-02	2.43E-02	1.98E-03	1.19E-01	3.92E-01	8.69E-05	1.13E-04	5.71E-01	6.08E-01	5.16E-05
5.00E-02										
2.49E+00										
1.20E-03										
su ionic strength	2.08E+00	2.01E+00	1.26E+00	2.41E+00	2.40E+00	1.94E+00	1.37E+00	9.79E-01	1.31E+00	1.91E+00
complexability	2.69E-01	3.42E-01	1.68E-01	2.30E-02	3.41E-02	1.32E-02	9.87E-03	4.77E-02	1.28E-01	2.02E-01

Supernatant Volumes to Evaporator (kgal) (Sheet 3)

salt cake inputs (kgal)	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
BT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BT'										
BY	4.75E+03	1.68E+04	4.14E-01	5.05E+02	4.16E+01	5.28E+03	0.00E+00	7.78E+02	4.15E+02	6.83E+02
BY'										
A1	5.28E+01	2.82E+02	3.55E-02	3.03E+01	9.34E+01	2.43E+02	1.74E-02	3.17E+01	8.06E-02	3.26E+01
A1'										
Org	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Org'										
R	2.79E-01	1.63E+02	0.00E+00	5.27E-02	1.03E-04	1.69E+02	0.00E+00	4.46E-01	5.88E-03	5.12E+00
R'										
T2	1.34E+02	2.53E+03	5.89E+02	3.54E+02	9.76E+02	1.50E+03	1.76E+03	2.42E+01	1.95E+00	1.53E+02
T2'										
S1	1.47E+02	5.46E+02	9.54E+00	5.30E+01	3.06E+01	1.70E+02	1.55E+01	1.06E+02	3.69E-01	7.86E+00
S1'										
S2	6.25E-01	5.96E+00	4.71E-02	1.31E-01	2.78E-01	1.76E+00	3.64E+01	8.52E-02	4.44E-03	3.71E-02
S2'										
A2	9.50E+00	3.18E+01	8.02E-03	6.09E-01	1.70E-01	2.46E+01	1.22E+03	3.98E+00	5.28E-02	5.68E+00
A2'										
CSR in	2.16E+02	1.20E+03	0.00E+00	3.09E+03	7.96E+03	5.42E+02	0.00E+00	1.19E-01	1.10E-02	9.63E-02
AR in	1.99E+01	1.89E+02	0.00E+00	4.65E+02	1.69E+03	1.53E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.09E+03	2.03E+04	5.99E+02	9.43E+02	1.14E+03	7.38E+03	3.03E+03	9.44E+02	4.17E+02	8.87E+02
fr.su left	9.62E-01	9.36E-01	1.00E+00	2.18E-01	1.27E-01	9.14E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
	6.12E+00	1.50E+01	8.81E+01	8.31E-01	3.85E-01	3.30E-01	0.00E+00	2.05E+01	3.44E+00	7.32E+00
frac NO3- left in su	9.95E-01	9.97E-01	9.25E-01	9.96E-01	9.99E-01	1.00E+00	1.00E+00	7.39E-01	9.70E-01	9.74E-01
frac. NO2 to NH3 in su	1.12E-04	6.44E-05	1.88E-03	8.61E-05	2.45E-05	3.41E-06	0.00E+00	7.23E-03	7.26E-04	6.42E-04
frac NO3- left in sl	9.96E-01	9.98E-01	8.87E-01	9.97E-01	9.99E-01	1.00E+00	1.00E+00	7.52E-01	6.62E-01	6.83E-01
frac. NO2 to NH3 in sl	9.23E-05	4.82E-05	2.87E-03	6.37E-05	1.75E-05	2.52E-06	0.00E+00	6.81E-03	9.84E-03	9.11E-03
5.00E-02										
2.49E+00										
1.20E-03										
su ionic strength	1.56E+00	1.29E+00	9.31E-01	9.76E-01	1.26E+00	1.39E+00	1.96E+00	1.88E+00	1.98E+00	1.98E+00
complexability	1.26E-02	1.05E-02	5.29E-03	2.71E-01	4.13E-01	3.13E-01	1.95E-01	2.80E+00	2.04E-01	2.04E-01

Supernatant Volumes to Evaporator (kgal) (Sheet 4)

salt cake inputs (kgal)	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
BT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.89E+00				
BT'							1.76E+04			
BY	2.20E+01	5.34E+02	5.92E+02	0.00E+00	6.75E+03	3.91E+02	8.16E+02	3.54E+00	2.40E+02	
BY'										7.64E+03
A1	7.20E+02	2.38E+02	8.70E+02	1.08E+03	1.23E+03	2.73E+01	2.80E+01	4.26E+00	1.99E+01	2.14E+03
A1'										
Org	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Org'										
R	0.00E+00	2.90E+00	6.83E+01	0.00E+00	3.50E+02	3.88E-01	1.03E-01	2.40E+01		
R'								6.75E+03		
T2	1.25E+02	1.97E+02	2.40E+03	9.64E+02	5.56E+03	6.01E+03	4.81E+03	1.06E+03		5.68E+02
T2'									1.27E+04	
S1	4.18E+02	6.30E+01	3.17E+03	8.56E+02	1.03E+04	1.45E+03	3.10E+02	2.46E+03	6.30E+03	3.72E+02
S1'										
S2	4.77E+00	1.12E+00	4.03E+01	9.86E+00	1.72E+02	2.41E+01	9.42E+00	1.69E+01	2.67E+03	6.56E+00
S2'										
A2	1.10E+00	3.10E+01	5.08E+03	6.82E+01	4.75E+02	2.57E+03	6.98E+01	4.14E+00	9.94E+02	3.70E+02
A2'										
CSR in	4.09E+03	5.36E+03	5.77E+02	5.37E+01	8.77E+02	5.76E+02	1.43E+02	1.81E+03	9.35E+02	1.18E+02
AR in	1.58E+02	4.79E+03	1.17E+00	4.20E+01	5.80E+01	9.60E+01	1.84E+01	0.00E+00	0.00E+00	0.00E+00
	1.29E+03	1.07E+03	1.22E+04	2.98E+03	2.48E+04	1.05E+04	2.37E+04	1.03E+04	2.29E+04	1.11E+04
fr.su left	2.67E-01	1.21E-01	9.60E-01	9.71E-01	9.65E-01	9.46E-01	9.91E-01	7.32E-01	9.26E-01	9.85E-01
	4.11E+02	3.85E+02	4.20E+02	4.94E+02	1.38E+04	0.00E+00	2.00E+02	1.63E+03	3.67E+03	2.58E+03
frac NO3- left in su	5.97E-01	9.55E-01	8.79E-01	7.29E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
frac. NO2 to NH3 in su	1.23E-02	1.09E-03	3.10E-03	7.56E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
frac NO3- left in sl	4.18E-09	2.60E-10	9.14E-01	4.93E-11	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
frac. NO2 to NH3 in sl	3.71E-01	4.11E-01	2.17E-03	4.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.00E-02										
2.49E+00										
1.20E-03										
su ionic strength	1.36E+00	8.47E-01	2.49E+00	1.96E+00	2.17E+00	5.12E-01	2.35E+00	3.37E+00	3.48E+00	3.55E+00
complexability	2.60E-01	8.10E-02	5.84E+00	3.45E-01	5.99E-01	5.97E-03	4.31E-01	1.51E-01	1.96E+00	2.01E+00

Supernatant Volumes to Evaporator (kgal) (Sheet 5)

salt cake inputs (kgal)	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
BT								
BT'								
BY								
BY'								
A1	8.15E+02	3.46E+03						
A1'			6.89E+03					
Org	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Org'								
R								
R'								
T2								
T2'								
S1								
S1'	1.58E+04							
S2	6.02E+03							
S2'		8.08E+03						
A2	4.61E+02	4.22E+02	5.36E+03	0.00E+00	7.65E+00	0.00E+00	9.83E+03	4.49E+03
A2'				1.04E+04				
CSR in	0.00E+00	0.00E+00	8.02E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AR in	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.31E+04	1 20E+04	1.22E+04	1.04E+04	7.65E+00	0.00E+00	9.83E+03	4.49E+03
fr.su left	1.00E+00	1.00E+00	9.88E-01		1.00E+00	1.00E+00	1.00E+00	1.00E+00
	7.95E+03	4.68E+03	5.18E+03	0.00E+00	9.53E+02	5.11E+02	7.66E-01	1.04E+02
frac NO3- left in su	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.21E-01	6.80E-01	1.00E+00	9.85E-01
frac. NO2 to NH3 in su	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-02	9.21E-03	2.10E-06	3.67E-04
frac NO3- left in sl	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.17E-10	8.77E-03	1.00E+00	9.87E-01
frac. NO2 to NH3 in sl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.22E-01	1.07E-01	1.78E-06	3.11E-04
5.00E-02								
2.49E+00								
1.20E-03								
su ionic strength	3.82E+00	3.86E+00	3.96E+00	3.97E+00	2.22E+00	1.73E+00	1.02E+00	8.91E-01
complexability	2.62E+00	2.70E+00	3.32E+00	5.38E+00	1.17E-01	1.29E-01	2.53E-01	3.75E-03

Radionuclide Partition Fractions (Sheet 1)

Rad. partition fr.	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1
H-3	9.98E-01	9.90E-01	1.88E-03	9.85E-03	4.44E-06	7.17E-05	1.38E-08	5.47E-07	5.70E-01	5.70E-01
C-14	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Ni-59	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Ni-63	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Co-60	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Se-79	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Sr-90	9.83E-01	9.83E-01	1.64E-02	1.64E-02	2.73E-04	2.73E-04	4.63E-06	4.63E-06	1.00E+00	1.00E+00
Y-90	9.83E-01	9.83E-01	1.64E-02	1.64E-02	2.73E-04	2.73E-04	4.63E-06	4.63E-06	1.00E+00	1.00E+00
Zr-93	3.94E-03	3.94E-03	8.96E-01	8.96E-01	9.96E-02	9.96E-02	0.00E+00	0.00E+00	1.00E+00	1.00E+00
Nb-93m	3.94E-03	3.94E-03	8.96E-01	8.96E-01	9.96E-02	9.96E-02	0.00E+00	0.00E+00	1.00E+00	1.00E+00
Tc-99	9.83E-01	9.83E-01	1.64E-02	1.64E-02	2.73E-04	2.73E-04	4.63E-06	4.63E-06	7.20E-01	7.20E-01
Ru-106	3.94E-03	3.94E-03	8.96E-01	8.96E-01	7.97E-02	7.97E-02	1.99E-02	1.99E-02	1.00E+00	1.00E+00
Cd-113m	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Sb-125	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Sn-126	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
I-129	9.83E-01	8.80E-01	1.64E-02	1.20E-01	2.73E-04	0.00E+00	4.63E-06	0.00E+00	1.00E+00	1.00E+00
Cs-134	9.83E-01	9.83E-01	1.64E-02	1.64E-02	2.73E-04	2.73E-04	4.63E-06	4.63E-06	1.00E+00	1.00E+00
Cs-137	9.83E-01	9.83E-01	1.64E-02	1.64E-02	2.73E-04	2.73E-04	4.63E-06	4.63E-06	1.00E+00	1.00E+00
Ba-137m	9.83E-01	9.83E-01	1.64E-02	1.64E-02	2.73E-04	2.73E-04	4.63E-06	4.63E-06	1.00E+00	1.00E+00
Sm-151	7.50E-01	7.50E-01	1.88E-01	1.88E-01	4.69E-02	4.69E-02	1.56E-02	1.56E-02	1.00E+00	1.00E+00
Eu-152	7.50E-01	7.50E-01	1.88E-01	1.88E-01	4.69E-02	4.69E-02	1.56E-02	1.56E-02	1.00E+00	1.00E+00
Eu-154	7.50E-01	7.50E-01	1.88E-01	1.88E-01	4.69E-02	4.69E-02	1.56E-02	1.56E-02	1.00E+00	1.00E+00
Eu-155	7.50E-01	7.50E-01	1.88E-01	1.88E-01	4.69E-02	4.69E-02	1.56E-02	1.56E-02	1.00E+00	1.00E+00
Ra-226	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Ra-228	8.89E-01	8.89E-01	1.00E-01	1.00E-01	1.00E-02	1.00E-02	1.00E-03	1.00E-03	1.00E+00	1.00E+00
Ac-227	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00
Pa-231	3.94E-03	3.94E-03	6.97E-01	6.97E-01	1.99E-01	1.99E-01	9.98E-02	9.98E-02	1.00E+00	1.00E+00
Th-229	3.00E-01	3.00E-01	4.90E-01	4.90E-01	1.40E-01	1.40E-01	7.01E-02	7.01E-02	1.00E+00	1.00E+00
Th-232	3.00E-01	3.00E-01	4.90E-01	4.90E-01	1.40E-01	1.40E-01	7.01E-02	7.01E-02	1.00E+00	1.00E+00
U-232	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
U-233	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
U-234	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
U-235	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
U-236	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
U-238	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
U-Total	9.97E-01	9.97E-01	3.23E-03	3.23E-03	8.06E-05	8.06E-05	3.00E-07	3.00E-07	1.00E-02	1.00E-02
Np-237	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00
Pu-238	1.52E-01	1.52E-01	5.35E-01	5.35E-01	1.52E-01	1.52E-01	1.62E-01	1.62E-01	1.00E+00	1.00E+00
Pu-239	1.52E-01	1.52E-01	5.35E-01	5.35E-01	1.52E-01	1.52E-01	1.62E-01	1.62E-01	1.00E+00	1.00E+00
Pu-240	1.52E-01	1.52E-01	5.35E-01	5.35E-01	1.52E-01	1.52E-01	1.62E-01	1.62E-01	1.00E+00	1.00E+00
Pu-241	1.52E-01	1.52E-01	5.35E-01	5.35E-01	1.52E-01	1.52E-01	1.62E-01	1.62E-01	1.00E+00	1.00E+00
Pu-242	1.52E-01	1.52E-01	5.35E-01	5.35E-01	1.52E-01	1.52E-01	1.62E-01	1.62E-01	1.00E+00	1.00E+00
Pu-Total	1.52E-01	1.52E-01	5.35E-01	5.35E-01	1.52E-01	1.52E-01	1.62E-01	1.62E-01	1.00E+00	1.00E+00
Am-241	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00
Am-243	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00
Cm-242	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00
Cm-243	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00
Cm-244	9.09E-01	9.09E-01	6.36E-02	6.36E-02	1.82E-02	1.82E-02	9.09E-03	9.09E-03	1.00E+00	1.00E+00

Radionuclide Partition Fractions (Sheet 2)

Rad. partition fr.	PFeCN2	TFeCN	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1
H-3	5.70E-01	1.00E+00	9.85E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.87E-01	9.87E-01	1.07E-02
C-14	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	9.71E-01	9.71E-01	1.62E-03
Ni-59	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Ni-63	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Co-60	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Se-79	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Sr-90	1.00E+00	1.00E+00	1.64E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Y-90	1.00E+00	1.00E+00	1.64E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Zr-93	1.00E+00	1.00E+00	8.96E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Nb-93m	1.00E+00	1.00E+00	8.96E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Tc-99	7.20E-01	1.00E+00	1.64E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.17E-04
Ru-106	1.00E+00	1.00E+00	8.96E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Cd-113m	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Sb-125	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Sn-126	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
I-129	1.00E+00	1.00E+00	1.20E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	0.00E+00
Cs-134	1.00E+00	1.00E+00	1.64E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Cs-137	1.00E+00	1.00E+00	1.64E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Ba-137m	1.00E+00	1.00E+00	1.64E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Sm-151	1.00E+00	1.00E+00	1.88E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Eu-152	1.00E+00	1.00E+00	1.88E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Eu-154	1.00E+00	1.00E+00	1.88E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Eu-155	1.00E+00	1.00E+00	1.88E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Ra-226	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Ra-228	1.00E+00	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Ac-227	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Pa-231	1.00E+00	1.00E+00	6.97E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Th-229	1.00E+00	1.00E+00	4.90E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Th-232	1.00E+00	1.00E+00	4.90E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
U-232	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
U-233	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
U-234	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
U-235	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
U-236	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
U-238	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
U-Total	1.00E-02	1.00E+00	3.23E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.57E-01	3.57E-01	4.79E-01
Np-237	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Pu-238	1.00E+00	1.00E+00	5.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	6.26E-01	3.36E-01
Pu-239	1.00E+00	1.00E+00	5.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	6.26E-01	3.36E-01
Pu-240	1.00E+00	1.00E+00	5.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	6.26E-01	3.36E-01
Pu-241	1.00E+00	1.00E+00	5.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	6.26E-01	3.36E-01
Pu-242	1.00E+00	1.00E+00	5.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	6.26E-01	3.36E-01
Pu-Total	1.00E+00	1.00E+00	5.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	6.26E-01	3.36E-01
Am-241	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Am-243	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Cm-242	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Cm-243	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04
Cm-244	1.00E+00	1.00E+00	6.36E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.00E-04

Radionuclide Partition Fractions (Sheet 3)

Rad. partition fr.	CWP1	CWP2	CWZr1	OWW1	OWW2	OWW3	Z	HS	TH1	TH2
H-3	1.00E+00	1.00E+00	1.00E+00	1.30E-02	1.30E-02	2.32E-03	1.00E+00	1.00E+00	1.00E+00	1.00E+00
C-14	1.00E+00	1.00E+00	1.00E+00	2.86E-02	2.86E-02	2.70E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ni-59	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ni-63	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Co-60	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Se-79	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Sr-90	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E-01	1.00E+00	1.00E+00
Y-90	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E-01	1.00E+00	1.00E+00
Zr-93	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Nb-93m	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tc-99	1.00E+00	1.00E+00	1.00E+00	5.07E-04	5.07E-04	9.03E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ru-106	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cd-113m	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Sb-125	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Sn-126	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
I-129	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cs-134	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cs-137	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ba-137m	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Sm-151	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Eu-152	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Eu-154	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Eu-155	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ra-226	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ra-228	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ac-227	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pa-231	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-229	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Th-232	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-232	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-233	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-234	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-235	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-236	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-238	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
U-Total	1.00E+00	1.00E+00	1.00E+00	6.43E-01	6.43E-01	1.64E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Np-237	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-238	1.00E+00	1.00E+00	1.00E+00	3.74E-01	3.74E-01	3.80E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-239	1.00E+00	1.00E+00	1.00E+00	3.74E-01	3.74E-01	3.80E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-240	1.00E+00	1.00E+00	1.00E+00	3.74E-01	3.74E-01	3.80E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-241	1.00E+00	1.00E+00	1.00E+00	3.74E-01	3.74E-01	3.80E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-242	1.00E+00	1.00E+00	1.00E+00	3.74E-01	3.74E-01	3.80E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Pu-Total	1.00E+00	1.00E+00	1.00E+00	3.74E-01	3.74E-01	3.80E-02	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Am-241	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Am-243	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cm-242	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cm-243	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cm-244	1.00E+00	1.00E+00	1.00E+00	3.65E-04	3.65E-04	6.50E-05	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Radionuclide Partition Fractions (Sheet 4)

Rad. partition fr.	AR	B	BL	SRR	CSR	DW	BT-SltCk	RSltCk	T2SltCk	BYSltCk
H-3	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.55E-01		5.43E-01	4.18E-01	2.05E-01	1.31E-01
C-14	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Ni-59	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Ni-63	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Co-60	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Se-79	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Sr-90	1.00E+00	2.00E-01	4.50E-01	2.00E-01	1.00E+00					
Y-90	1.00E+00	2.00E-01	4.50E-01	2.00E-01	1.00E+00					
Zr-93	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Nb-93m	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Tc-99	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Ru-106	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Cd-113m	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Sb-125	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Sn-126	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
I-129	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Cs-134	1.00E+00	6.00E-02	0.00E+00	1.00E+00	3.00E-02					
Cs-137	1.00E+00	6.00E-02	0.00E+00	1.00E+00	3.00E-02					
Ba-137m	1.00E+00	6.00E-02	0.00E+00	1.00E+00	3.00E-02					
Sm-151	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Eu-152	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Eu-154	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Eu-155	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Ra-226	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Ra-228	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Ac-227	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pa-231	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Th-229	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Th-232	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-232	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-233	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-234	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-235	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-236	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-238	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
U-Total	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Np-237	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pu-238	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pu-239	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pu-240	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pu-241	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pu-242	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Pu-Total	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Am-241	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Am-243	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Cm-242	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Cm-243	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00					
Cm-244	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00		1.00E+00	1.00E+00	1.00E+00	1.00E+00

Radionuclide Partition Fractions (Sheet 5)

Rad. partition fr.	S1SltCk	S2SltSlr	A1SltCk	A2SltSlr	P3AZ1	P3AZ2	PL2	CWZr2
H-3	3.36E-01	7.79E-01	5.15E-01	2.45E-01	9.87E-01	9.87E-01	1.30E-02	1.00E+00
C-14					9.71E-01	9.71E-01	2.86E-02	1.00E+00
Ni-59					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Ni-63					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Co-60					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Se-79					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Sr-90					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Y-90					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Zr-93					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Nb-93m					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Tc-99					1.00E+00	1.00E+00	5.07E-04	1.00E+00
Ru-106					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Cd-113m					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Sb-125					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Sn-126					1.00E+00	1.00E+00	3.65E-04	1.00E+00
I-129					1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cs-134					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Cs-137					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Ba-137m					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Sm-151					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Eu-152					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Eu-154					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Eu-155					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Ra-226					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Ra-228					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Ac-227					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Pa-231					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Th-229					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Th-232					1.00E+00	1.00E+00	3.65E-04	1.00E+00
U-232					3.57E-01	3.57E-01	6.43E-01	1.00E+00
U-233					3.57E-01	3.57E-01	6.43E-01	1.00E+00
U-234					3.57E-01	3.57E-01	6.43E-01	1.00E+00
U-235					3.57E-01	3.57E-01	6.43E-01	1.00E+00
U-236					3.57E-01	3.57E-01	6.43E-01	1.00E+00
U-238					3.57E-01	3.57E-01	6.43E-01	1.00E+00
U-Total					3.57E-01	3.57E-01	6.43E-01	1.00E+00
Np-237					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Pu-238					6.26E-01	6.26E-01	3.74E-01	1.00E+00
Pu-239					6.26E-01	6.26E-01	3.74E-01	1.00E+00
Pu-240					6.26E-01	6.26E-01	3.74E-01	1.00E+00
Pu-241					6.26E-01	6.26E-01	3.74E-01	1.00E+00
Pu-242					6.26E-01	6.26E-01	3.74E-01	1.00E+00
Pu-Total					6.26E-01	6.26E-01	3.74E-01	1.00E+00
Am-241					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Am-243					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Cm-242					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Cm-243					1.00E+00	1.00E+00	3.65E-04	1.00E+00
Cm-244	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	3.65E-04	1.00E+00

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APPENDIX B

CHANGE RECORD FOR REVISION 5.0

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B.0 CHANGE RECORD FOR REVISION 5.0

This appendix documents the changes made to the various HDW Model workbooks for Revision 5.0 of the HDW Model.

B1.0 WORKBOOK CHANGE RECORDS

Table B-1 lists data sources used to construct the Solubility Workup workbook.
Table B-2 lists the changes made to the Hanford Defined Wastes workbook.

Table B-1. Change Record for the Solubility Workup Workbook.

Item	Location of Change	Description of Change	Rationale for Change	Reference
1	Solubility Workup workbook	Update dataset to newer data from the Tank Characterization Database	Previous dataset did not meet BBI QC preference	Appendix C, interoffice memo 7G300-02-NWK-037 and 7G300-02-JGF-010
2	Solubility Workup workbook	Incorporate complexed waste specific solubility data	HDW Model Rev. 4 did not include complexed waste specific solubility limits	Appendix C, interoffice memo 7G300-02-NWK-037 and 7G300-02-JGF-010
3	Solubility workbook and run5 macro	Developed and applied multi-point solubility waste stream description	Provides a better solubility description for individual waste stream than previous single-point description	None Applicable

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
1	Input to HDW worksheet	Added worksheet; allowed for automated data input and revision of ORIGEN2-DKPRO estimates	Model efficiency improvement; previous revisions were done by hand.	None Applicable
2	Input to HDW worksheet	Corrected an apparent input error for ^{243}Am	Correction of error	None
3	Input to HDW worksheet, cells A2:V50	Incorporated new ORIGEN2-DKPRO estimates	Previous ORIGEN2 results considered out-of-date. See Section 4.1 and 5:1	Watrous et al. (2002)
4	Input to HDW worksheet, cells B57:L57	Model separation plant ^{3}H losses with process condensate	Reduce over-conservatism of HDW ^{3}H tank inventory estimates	Appendix C, interoffice memo 7G300-02-NWK-023.

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
5	Input to HDW worksheet, cells M57:V57	Correction of ORIGEN2 ^{3}H estimate	The ORIGEN2 ^{3}H estimate is based on the Li impurity specification for aluminum cladding. The true Li impurity level is unknown.	Appendix C, interoffice memo 7G300-03-NWK-012
6	Input to HDW worksheet, cells B58:L58	Model separation plant ^{14}C losses to atmosphere	Reduce over-conservatism of HDW ^{14}C tank inventory estimates	Appendix C, interoffice memo 7G300-02-NWK-030
7	Input to HDW worksheet, cells B67:L67	Model ^{99}Tc losses with uranium product	Reduce over-conservatism of HDW ^{99}Tc tank inventory estimates	Appendix C, interoffice memo 7G300-03-NWK-001
8	Input to HDW worksheet, cells B72:L72	Model ^{129}I losses to atmosphere and solid waste	Reduce over-conservatism of HDW ^{129}I tank inventory estimates	Appendix C, interoffice memo 7G300-02-NWK-034
9	Input to HDW worksheet, cells BJ180:BM180	Model flushes of ^{129}I from silver reactors	Correct distribution of ^{129}I to proper waste stream	Appendix C, interoffice memo 7G300-02-NWK-034
10	Input to HDW worksheet, cells M165:M212	1CFeCN values patched from calculations	Correct 1CFeCN radionuclide composition.	Appendix C, e-mail dated October 9, 2003, "Material Balance Problem - 1C2 and 1CFeCN Wastes" and Watrous et al. (2002)
11	Solubilities worksheet	Worksheet added to enable waste stream specific solubility calculations	HDW Model 5 upgrade objective	None Applicable
12	Solubilities worksheet, cells AN29:AO29 and BD29	Set $CaCO_3$ solubility for DW and N waste at 0.009 M.	For very dilute waste streams, CO_3 solubility increased to HDW4008 value to keep carbonate concentration from going negative (physical constraint).	None Applicable
13	Solubilities worksheet, cell K39:N39	Reduced ^{90}Sr solubility	$Ca_3(PO_4)_2$ scavenging development report	Sloat (1955) and Appendix C, e-mail dated September 18, 2003, "Review of HDW5 Rev 232a Spreadsheets," e-mail dated August 22, 2003, "Review of HDW5 Rev 232a Spreadsheets."

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
14	Solubilities worksheet, cells K50:N50	Decreased 137Cs solubility	Metal waste scavenging purpose; precipitate 137Cs in FeCN wastes	Appendix C, e-mail dated September 18, 2003, "Review of HDW5 Rev 232a Spreadsheets," e-mail dated August 22, 2003, "Review of HDW5 Rev 232a Spreadsheets."
15	Solubilities worksheet, cells C68:D68	Increased U solubility in BiPO4 metal waste to original HDW Model Rev. 4.0 values.	Describes complexing action of carbonate and phosphate in metal waste.	Agnew et al. (1997)
16	hdwR2.X worksheet, cell L106	Corrected formula	Inconsistency between U total and U isotopes	Appendix C, e-mail dated November 17, 1997, "Preliminary Findings on U/Pu Model Inconsistencies."
17	hdwR2.X worksheet, cell AF209	Corrected formula	Inconsistency between Pu total and Pu isotopes	Appendix C, e-mail dated November 17, 1997, "Preliminary Findings on U/Pu Model Inconsistencies."
18	hdwR2.X worksheet, columns H and BN	Redefined 224 waste (52-56) to 224-1 (44-49) and 224-2 (50-56). Revised waste volumes to match fuel history.	Established that initial 224 waste sent to 361 tanks. 224 waste sent to farms beginning in Oct. 1, 1946	Seymour (1946) and Lauder (1946) pages 27-28, Greager (1946), page 87
19	hdwR2.X worksheet, column X	Redefined CWZr1 as 1965 to 1972. Changed Zr clad fuel from 977 tons to 1,954 tons	Redefined CWZr1 to include Zircaloy® clad fuel processed by REDOX	Fuel activity records (Watrous et al. 2002)
20	hdwR2.X worksheet, column AC	Redefined HS as 1961 to 1968.	Rev 4 of the HDW model was based on incomplete records	Appendix C, interoffice memo 7G400-03-SMM-003 and 7G240-03-BAH-001
21	hdwR2.X worksheet, column AJ	Redefined CSR as 1962 to 1976	Change made to include Cs recovery at 241-C-801 cask station	Appendix C, e-mail dated September 18, 2003, untitled.
22	hdwR2.X worksheet, column AS	Combined BSltCk and T1SltCk as a single model.	Space for new waste stream vectors was needed.	Appendix D
23	hdwR2.X worksheet, columns BJ and BM	Redefined P3 waste (83-88) and P3AZ1 (82-86) and P3AZ2 (86-90).	Determined that P3 wastes were substantially different.	Appendix C, e-mail dated September 8, 2003, "HDW5_03_246a DEP Review for P3 Waste Type," Lambert (1998a), and Lambert (1998b)
24	hdwR2.X worksheet, cell S9	Changed P2 "kgal waste out" from 10,208 to 9,454 kgal	Made consistent with WSTRS values	Appendix D, WSTRS5_245c

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
25	hdwR2.X worksheet, cell T9	Changed P2' "kgal waste out" from 397 to 1,367 kgal	CAW process records	Uebelacker (1967) and e-mail dated January 16, 2003, "HDW Modeling P2 (prime) Waste Stream Volume" (Appendix C)
26	hdwR2.X worksheet, cell W9	Changed CWP2 "kgal waste out" from 22,286 to 21,651 kgal	Reallocated CWP2 to CWZr1 waste.	None Applicable
27	hdwR2.X worksheet, cell X9	Changed CWZr1 "kgal waste out" from 1,650 to 2,285 kgal	Reallocated CWP2 to CWZr1 waste.	None Applicable
28	hdwR2.X worksheet, cell Z9	Changed OWW2 "kgal waste out" from 10,563 to 11,053 kgal	Made consistent with WSTRS values	None Applicable
29	hdwR2.X worksheet, cell AD9	Changed TH1 "kgal waste out" from 927 to 443 kgal	Reallocated TH1 and TH2 waste volumes.	None Applicable
30	hdwR2.X worksheet, cell AE9	Changed TH2 "kgal waste out" from 428 to 912 kgal	Reallocated TH1 and TH2 waste volumes.	None Applicable
31	hdwR2.X worksheet, cell AG9	Changed B "kgal waste out" from 10,569 to 11,536 kgal	Made consistent with WSTRS values	Appendix D, WSTRS5_245c
32	hdwR2.X worksheet, cell AH9	Changed BL "kgal waste out" from 14,845 to 14,425 kgal	Made consistent with WSTRS values	Appendix D, WSTRS5_245c
33	hdwR2.X worksheet, cell AI9	Changed SRR "kgal waste out" from 3,854 to 3,555 kgal	Made consistent with WSTRS values	Appendix D, WSTRS5_245c
34	hdwR2.X worksheet, cells AJ7 and AK9	Changed CSR "kgal waste in" from 21,744 to 25,638 and "kgal waste out" from 25,325 to 26,371 kgal	Made consistent with WSTRS values	Appendix D, WSTRS5_245c

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
35	hdwR2.X worksheet, cell BP733:BP752	BP733 from 8,078 to 30,230. BP734 from 4,445 to 17,630 BP735 from 36,602 to 43,037 BP736 from 8,124 to 7,637 BP737 from 16,476 to 11,788 BP738 from 4,668 to 6,788 BP742 from 15,743 to 14,213 BP743 from 7,706 to 6,748 BP744 from 43,311 to 47,414 BP745 from 10,828 to 12,714 BP746 from 43,709 to 39,219 BP747 from 11,364 to 15,819 BP749 from 9,105 to 9,826 BP750 from 3,562 to 8,076 BP751 from 0 to 34,739 BP752 from 1 to 10, 539	Density matching saltcake values in water balance.	BBI density data for saltcakes (http://twins.pnl.gov).
36	hdwR2.X worksheet, cells BJ6, BJ9, BM6, and BM9	New Inputs	Basis for P3AZ1 and P3AZ2 tons fuel and kgal out	Appendix C, e-mail dated September 8, 2003, "HDW5_03_246a DEP Review for P3 Waste Type," Lambert (1998a), and Lambert (1998b)
37	hdwR2.X worksheet, cells H31 and BN31	Changed 224 waste vol% solids from 3.9 to 2.1	CONFORM WITH PHYSICAL CONSTRAINTS IN WASTE VOLUMES AND SOLUBILITY BEHAVIOR.	Appendix D, WSTRS5_245c, and Ruppert and Heid (1954)

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
38	hdwR2.X worksheet, cell J31	Changed PFeCN1 vol% solids from 3.7 to 4.25	Changed to literature data.	Borsheim and Simpson (1991)
39	hdwR2.X worksheet, cell K31	Changed PFeCN2 vol% solids from 3.2 to 4.25	Changed to literature data.	Borsheim and Simpson (1991)
40	hdwR2.X worksheet, cell L31	Changed TFeCN vol% solids from 1.4 to 4.3	Changed to literature data.	Borsheim and Simpson (1991)
41	hdwR2.X worksheet, cell M31	Changed 1CFeCN vol% solids from 4.8 to 3	Changed to literature data.	Borsheim and Simpson (1991)
42	hdwR2.X worksheet, cells O31	Changed R2 vol% solids from 1.3 to 3	Better agreement with tank farm surveillance data regarding solids accumulation and physical properties in the solids-liquids partition.	Appendix D, WSTRS5_245c
43	hdwR2.X worksheet, cells Y31	Changed OWW1 vol% solids from 0.6 to 1.1	Better agreement with tank farm surveillance data regarding solids accumulation and physical properties in the solids-liquids partition.	Appendix D, WSTRS5_245c
44	hdwR2.X worksheet, cells AA31	Changed OWW3 vol% solids from 0.6 to 1.1	Better agreement with tank farm surveillance data regarding solids accumulation and physical properties in the solids-liquids partition.	Appendix D, WSTRS5_245c
45	hdwR2.X worksheet, cells AH31	Changed BL vol% solids from 0.68 to 1.0	Better agreement with tank farm surveillance data regarding solids accumulation and physical properties in the solids-liquids partition.	Appendix D, WSTRS5_245c
46	hdwR2.X worksheet, cells AS30 and AS33	Changed BT solids accumulation	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
47	hdwR2.X worksheet, cells AW33	Changed RSltCk kgal solids left from 1,065 to 880	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
48	hdwR2.X worksheet, cells AY33	Changed T2-SltCk kgal solids left from 5,997 to 5,467	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
49	hdwR2.X worksheet, cells BA33	Changed BYSltCk kgal solids left from 3,978 to 4,126	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
50	hdwR2.X worksheet, cells BC33	Changed S1-SltCk kgal solids left from 6,270 to 5,715	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
51	hdwR2.X worksheet, cells BE33	Changed S2-SltCk kgal solids left from 3,243 to 2,259	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
52	hdwR2.X worksheet, cells BG33	Changed A1-SltCk kgal solids left from 2,125 to 1,303	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
53	hdwR2.X worksheet, cells BI33	Changed A2-SltCk kgal solids left from 895 to 2,182	Conform with BBI information regarding waste volume accumulation	BBI (http://twins.pnl.gov)
54	hdwR2.X worksheet, cells B62:BN62	Added $Sr(NO_3)_2$ equation	Calculate total Sr based on ^{90}Sr and ORIGEN2 fuel records	Appendix C, interoffice memo 7G300-02-NWK-027
55	hdwR2.X worksheet, cells C58, E58, and M58	Added Hg to MW2, deleted Hg from 1C1, revised Hg for 1C2 and 1CFeCN	Incorrect modeling of Hg usage in HDW model Rev. 4	Appendix C, interoffice memo 6N100-00-051
56	hdwR2.X worksheet, cells D47:E47, D49:E49, D55:E55, and D60:E60	Revised NaOH, Na_2CO_3, NaCl, and $Ca(NO_3)_2$ content of 1C1 and 1C2 streams	Revised chemicals in description to prevent negative hydroxide condition and maintain reasonable physical parameters using variable solubility	None Applicable
57	hdwR2.X worksheet, cells H47, H49, H55, H60, BM47, BM49, BM55, and BM60	Increased NaOH, Na_2CO_3, NaCl, and $Ca(NO_3)_2$ content of 224-1 and 224-2 streams	Revised chemicals in description to prevent negative hydroxide condition and maintain reasonable physical parameters using variable solubility	None Applicable

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
58	hdwR2.X worksheet, cells I44:K44	Decreased $BiPO_4$ content of TBP and PFeCN streams	Rev 4 value suspect	Appendix C, e-mail dated January 13, 2003, "Bismuth Concentration of MW, TBP, and PFeCN."
59	hdwR2.X worksheet, cells J46:M46	Increased NiSO4 concentration by .0016 M.	Corrosion contribution	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
60	hdwR2.X worksheet, cells I58:K58	Added Hg data to TBP and PFeCN streams	Incorrect modeling of Hg usage in HDW model Rev. 4	Appendix C, interoffice memo 6N100-00-051
61	hdwR2.X worksheet, cell M49	Revised Na_2CO_3 of 1CFeCN stream	To conform 1CFeCN waste stream properties to scavenged 1C1 substrate	None Applicable
62	hdwR2.X worksheet, cells N61	Added $KMnO_4$ usage to REDOX HLW	REDOX used $KMnO_4$ to oxidize Ru	Appendix C, interoffice memo 7G300-02-NWK-028
63	hdwR2.X worksheet, cells P58 and Q58	Deleted Hg from CWR1 and CWR2 streams	Incorrect modeling of Hg usage in HDW model Rev. 4	Appendix C, interoffice memo 6N100-00-051
64	hdwR2.X worksheet, cells P63:W63	Revised $PbSO_4$ content of CWR1, CWR2, P1, P2, CWP1, and CWP2 streams. Deleted Pb from PL1	Incorrect modeling of Pb usage in HDW model Rev. 4	Appendix C interoffice memo 7G300-02-NWK-036
65	hdwR2.X worksheet, cells V58 and W58	Deleted Hg from CWP1 and CWP2 streams	Incorrect modeling of Hg usage in HDW model Rev. 4	Appendix C interoffice memo 6N100-00-051
66	hdwR2.X worksheet, cells AF58:AI58	Added Hg data to AR, B, BL, and SRR streams	Incorrect modeling of Hg usage in HDW model Rev. 4	Appendix C, interoffice memo 6N100-00-051
67	hdwR2.X worksheet, cells AH65:AH68 and AI65:AI68	Moved complexants from SRR to BL stream	Incorrect modeling assumptions	Appendix C, e-mail dated April 3, 2003, "Flowsheet Info for HDW 5."
68	hdwR2.X worksheet, cells BK49, BK55, BK59, and BK60	Revised NaOH, NaCl, KNO_3 and $Ca(NO_3)_2$ content of PL2 stream	Revised chemicals in description to prevent negative hydroxide condition and maintain reasonable physical parameters using variable solubility	None Applicable

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
69	hdwR2.X worksheet, cell BK63	Deleted Pb from PL2 stream	Incorrect modeling assumption in HDW model Rev. 4	Appendix C interoffice memo 7G300-02-NWK-036
70	hdwR2.X worksheet, cell BL58	Deleted Hg from CWZr2 stream	Incorrect modeling of Hg usage in HDW model Rev. 4	Appendix C, interoffice memo 6N100-00-051
71	hdwR2.X worksheet, cells B72:H119, N72:AA119, AD72:AE119, and BJ72:BN119	Updated fuel activity estimates	Previous ORIGEN2 results considered out-of-date. See Section 4.1 and 5.1	Watrous et al. (2002)
72	hdwR2.X worksheet, cells I72:K119	Linked TBP and PFeCN activity to MW sluicing	Better modeling description of TBP-UR and FeCN waste streams	None Applicable
73	hdwR2.X worksheet, cells L72:L119	Linked TFeCN activity to TBP supernatant activity	Better modeling description of TBP-UR and FeCN waste streams	None Applicable
74	hdwR2.X worksheet, cells AC72:AC119, AF72:AF119, AH72:AH119, and AI72:AH119	Changed distribution of sluiced PUREX sludge from 2.5 % HS, 19.5% AR, 19.5% BL and 58.5% SRR to 9.2% HS, 18.16% AR, 18.16% BL and 54.48% SRR	Reconcile with plant records for 90Sr recovery	Appendix C, interoffice memo 7G400-03-SMM-003, and 7G240-03-BAH-001
75	hdwR2.X worksheet, cells AS72:AS119, AU72:AU119, AW72:AW119, AY72:AY119, BA72:BA119, BC72:BC119, BE72:BE119, BG72:BG119, and BI72:BI119	Corrected cell reference error.	Cell reference error	None Applicable

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
76	hdwR2.X worksheet, cells D167:E214	Equations revised to reflect separation of cladding waste data.	Improved model description of core and cladding waste segregation	None Applicable
77	hdwR2.X worksheet, cells B322:BN322	Replaced liquid phase specific gravity equation	Replaced method for liquid phase specific gravity calculation with a validated equation	Orme (2003)
78	hdwR2.X worksheet, cells B754:BN754	Revised source volumes of CSR feed.	Made consistent with WSTRS values	Appendix D, WSTRS5_245c
79	hdwR2.X worksheet, cells B776:BN780	Links to these cells have been broken	These data are no longer used	None Applicable
80	hdwR2.X worksheet, cells B782:H829 and BN782:BN829	Revised Rad. Partition Factors	Previous rad. Partition factors based on an incorrect understanding of BiPO4 process chemistry.	Appendix C, interoffice memo 7G300-02-NWK-024
81	hdwR2.X worksheet, cells I782:M829	Contents of cells changed to 1.0 except as noted in following changes	The previous function of these cells was changed when the basis for activity in cell I72:M119 was changed	None Applicable
82	hdwR2.X worksheet, cells I782:K782	Tritium partition fraction set to 0.57	Accounts for tritium cribbed with TBP Plant waste evaporator process condensates	Appendix C, interoffice memo 7G300-02-NWK-023
83	hdwR2.X worksheet, cells I792:K792	Technetium partition fraction set at 0.72	Accounts for Tc contamination of uranium product	Appendix C, interoffice memo 7G300-03-NWK-001
84	hdwR2.X worksheet, cells I811:K817	Uranium partition fraction set at 0.01	Assumes recovery of 99% of the uranium	None Applicable
85	hdwR2.X worksheet, cells N782:Q829	Partition fractions for R1, R2, CWR1 and CWR2 set to 1.0	The previous function of these cells was replaced by DKPRO modeling	Section 5.1

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
86	hdwR2.X worksheet, cells R782:U829, Y782:AA829, and BK782:BK829	Partition factors for P1, P2, OWW1, OWW2, OWW3, PL1 and PL2 were updated	PUREX process partition factors were reviewed and revised.	Appendix C, interoffice memo 7G300-03-NWK-011
87	hdwR2.X worksheet, cells V782:X829, and BL782:BL829	Partition fractions for CWP1, CWP2, CWZr1 and CWZr2 set to 1.0	The previous function of these cells was replaced by DKPRO modeling	Section 5.1
88	hdwR2.X worksheet, cells AC788:AC789, and AC798:AC799	HS waste. Sr losses set to 0.1. Cs recovery removed from this stream	Sr losses were set at typical flowsheet values. Cs recover by 241-C-801 cask station included in CSR model	Engineering judgment. Subsequent B-Plant operational losses typically less than 5%
89	hdwR2.X worksheet, cells AD782:AE829	Partition fractions for TH1 and TH2 set to 1.0	The previous function of these cells was replaced by DKPRO modeling	Section 5.1
90	hdwR2.X worksheet, cells AF782:AF829	Partition fractions for AR set to 1.0	Changed modeling assumptions.	None Applicable
91	hdwR2.X worksheet, cells AK798:AK800	Cs partition fractions set to 0.03	Cs partition fractions revised based on historic plant performance	Typical B-Plant process losses
92	hdwR2.X worksheet, cells AK782	Calculated tritium partition fraction	Accounts for tritium cribbed by self-concentration of wastes	Appendix C, e-mail dated September 11, 2003, "Review Comments September 4-11, 2003."
93	hdwR2.X worksheet, cells AS782:BI782	Calculated tritium partition fraction	Accounts for tritium cribbed with tank farm evaporator process condensates	Appendix C, e-mail dated September 11, 2003, "Review Comments September 4-11, 2003."
94	hdwR2.X worksheet, cells B834:BN847	Cell values set to 1.0	The function of these cells was replaced by DKPRO modeling	Section 5.1
95	hdwR2.X worksheet, cells BP309	Changed Mol. Wt. from 55.85 to 55.847	Maintain consistency between spreadsheet locations	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
96	hdwR2.X worksheet, cells BP328	Changed effective Mol. Wt. from 6 to 8	Correction	None Applicable
97	hdwR2.X worksheet, cells BP336	Changed Mol. Wt. from 35.43 to 35.453	Correction	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
98	hdwR2.X worksheet, cells BP384	Changed Mol. Wt. from 238 to 238.03	Maintain consistency between spreadsheet locations	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
99	hdwR2.X worksheet, cells BP413	Changed Mol. Wt. from 151.99 to 103.02	Correction	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
100	hdwR2.X worksheet, cells BP422	Changed Mol. Wt. from 341 to 344	Correction	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
101	hdwR2.X worksheet, cells BP423	Changed Mol. Wt. from 378 to 380	Correction	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
102	hdwR2.X worksheet, cells M209	Added "1000" to formula	Corrected equation to match input value of kg Pu.	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
103	hdwR2.X worksheet, cells U30	Replaced formula	Corrected equation	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
104	hdwR2.X worksheet, row 349	Deleted "Na/12" term from formula	This term was a remnant from the Rev 4 tritium calculation which has been replaced	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
105	hdwR2.X worksheet, row B760:BO763	Changed formula describing degradation of NO2 & NO3 to NH3; applied scaling factor	Reflect change in decay date for ORIGEN2 run	Appendix C, e-mail dated October 17, 2003, "Review Comments HDW5_3_287b."
106	hdwR2.X worksheet, rows B475:BO475	Linked chemical Sr to 90Sr for precipitated solids	Maintain consistency in chemical behavior	Appendix C, e-mail dated September 18, 2003, "Spreadsheet Checks."
107	hdwR2.X worksheet, rows B498:BO498	Linked chemical Ni(OH)2 to 59Ni and 63Ni for precipitated solids except for FeCN wastes	Maintain consistency in chemical behavior	Appendix C, e-mail dated September 18, 2003, "Spreadsheet Checks."
108	hdwR2.X worksheet, cell L114	Added "1000" to formula	Corrected equation to match input value of kg Pu.	Appendix C, e-mail dated September 18, 2003, "Spreadsheet Checks."

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
109	hdwR2.X worksheet, cells AB110 and AB114	Changed 239Pu specific activity from .061 µCi/g to .0621 µCi/g; changed 240Pu specific activity from 0.229 µCi/g to 0.227 µCi/g	Improved estimate of 239Pu and 240Pu content from ORIGEN2	Appendix C, e-mail dated September 18, 2003, "Spreadsheet Checks."
110	hdwR2.X worksheet, rows 17 and 22	Changed 239Pu specific activity .061 µCi/g to .0621 µCi/g	Improved estimate of 239Pu and 240Pu content from ORIGEN2	Appendix C, e-mail dated September 18, 2003, "Spreadsheet Checks."
111	hdwR2.X worksheet, cells AB109, AB112 and AB113	Incorporated scaling factor for other Pu isotopes (.256*240Pu for 238Pu; 16.1*240Pu for 241Pu; 9.94E-05*240Pu)	Improved estimate of 239Pu and 240Pu content from ORIGEN2	Appendix C, e-mail dated September 18, 2003, "Spreadsheet Checks."
112	probs worksheet	Removed	Not needed in new model	None applicable
113	tr0 worksheet	Removed	Not needed in new model	None applicable
114	tr1 worksheet	Removed	Not needed in new model	None applicable
115	tr2 worksheet	Removed	Not needed in new model	None applicable
116	tr3 worksheet	Removed	Not needed in new model	None applicable
117	tr4 worksheet	Removed	Not needed in new model	None applicable
118	rsd4 worksheet	Removed	Not needed in new model	None applicable
119	hdwUpper worksheet	Removed	Not needed in new model	None applicable
120	hdwLower	Removed	Not needed in new model	None applicable
121	hdwRSD's	Removed	Not needed in new model	None applicable
122	ORIGEN2 splits worksheet	Added	Raw ORIGEN2 data for other worksheets	None applicable
123	waste stream descriptions worksheet	Added	Description of waste streams	None applicable

Table B-2. Change Record for the Hanford Defined Wastes Workbook. (14 Sheets)

Item	Location of Change	Description of Change	Rationale for Change	Reference
124	scratch worksheet	Added	Worksheet for converting ORIGEN ordering to HDW ordering	None applicable
125	SMM worksheet	Added	Output worksheet from HDW model runs	None applicable
126	TLM worksheet	Added	Output worksheet from HDW model runs	None applicable
127	hdwR2.X worksheet, cells H6, BN6	Added short tons of fuel to 224 waste	More complete description of waste generation	Watrous et al. (2002)
128	hdwR2.X worksheet, cells H9:H10, BN9:BN10	Changed waste volumes and added waste rate to 224 waste	More complete description of waste generation	Appendix C, e-mail dated December 13, 2002, "Volume of 224 Building Waste 10/46 to 2/56."
129	hdwR2.X worksheet, cells AB110	Revised equation to contain kg of residual 239Pu	Correction	Appendix C, e-mail dated January 28, 2004, "HDW5 Error for Z Plant Waste."
130	hdwR2.X worksheet, cells A19:BO 28	Revised spreadsheet format to display residual inventories	Improve usability and consolidate analytes of interest	None Applicable
131	hdwR2.X worksheet, cells A978:Z985	Incorporated tritium balance calculation	HDW Model 5 Objective	None Applicable
132	hdwR2.X worksheet, cells A882:BO972	Incorporated overall mass balance calculation	HDW Model 5 Objective	None Applicable
133	hdwR2.X worksheet, cells BQ19:BV28	Incorporated campaign specific sludge remnant and saltcake calculation	Improve usability and consolidate analytes of interest; mass balance constraints	None Applicable

B2.0 REFERENCES

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APPENDIX C

CORRESPONDENCE

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C1.0 LETTERS AND INTEROFFICE MEMORANDUMS

Interoffice memo 6N100-00-051, "Reconciliation of Process Knowledge and Sample Based Mercury Inventories of Underground Storage Tanks," B. A. Higley to T. T. Tran, dated April 27, 2000, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G240-03-BAH-001, "Hanford Material Balance for Strontium-90 and Cesium-137," B. A. Higley to T. M. Horner, dated April 30, 2003, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-JGF-010, "Solubility Calculations," S. R. Wilmarth to J. G. Field, dated October 21, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-023, "Tritium Partition Factors for the Hanford Defined Waste Model," B. A. Higley to J. G. Field, dated July 11, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-024, "Bismuth Phosphate Process Radionuclide Partition Factors for the Hanford Defined Waste Model," B. A. Higley to J. G. Field, dated July 24, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-027, "Strontium Modeling Parameters for the Hanford Defined Waste Model," B. A. Higley to J. G. Field, dated August 5, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-028, "Hanford Defined Waste Model Parameters for Manganese Used in the Redox Process," B. A. Higley to J. G. Field, dated August 5, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-030, "Recommended Process Distributions for Carbon-14," D. E. Place to J. G. Field, dated August 22, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-034, "Iodine-129 Partition Factors for the Hanford Defined Waste Model," B. A. Higley to J. G. Field, dated October 2, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-036, "Lead Modeling Parameters for the Hanford Defined Waste Model," B. A. Higley to J. G. Field, dated October 15, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-02-NWK-037, "Evaluation of Solubility Limits Based The Tank Characterization Database," D. E. Place to J. G. Field, dated October 29, 2002, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-03-NWK-001, "Recommended Separation Factors for Technetium-99," K. W. Kirch to J. G. Field, dated January 7, 2003, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-03-NWK-011, "Radionuclide Partition Factors for the Hanford Defined Waste Model – Plutonium Uranium Extraction Process," B. A. Higley to J. G. Field, dated February 26, 2003, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G300-03-NWK-012, "Hanford Defined Waste Model – Correction of ORIGEN2 Model Tritium Estimate," B. A. Higley to J. G. Field, dated March 19, 2003, CH2M HILL Hanford Group, Inc., Richland, Washington.

Interoffice memo 7G400-03-SMM-003, "Shipment of Cesium-137 and Strontium-90 form the Hanford Site (1961 through 1977)," M. E. Johnson to B. A. Higley, dated April, 22, 2003, CH2M HILL Hanford Group, Inc., Richland, Washington.

Letter FDNW-RJP-028, "Best-Basis Inventory DKPRO Code Run Additional Scope – Radionuclide Uncertainty Estimate Calculations," R. J. Puigh to J. W. Cammann, dated September 2, 1998, Fluor Daniel Northwest, Inc., Richland, Washington.

CH2MHILL
Hanford Group, Inc.

INTEROFFICE MEMO

From:	Process Development			6N100-00-051
Phone:	376-5694			
Date:	April 27, 2000			
Subject:	RECONCILIATION OF PROCESS KNOWLEDGE AND SAMPLE BASED MERCURY INVENTORIES OF UNDERGROUND STORAGE TANKS			
To:	T. T. Tran	R2-12		
Copies:	S. L. Lambert	R3-75	B. C. Simpson	R2-11
	D. E. Place	R3-73	BAH/LB file	
	K. A. Prindiville	R3-75	AFC/ LB file	

Reference:
(1) Kupfer, M. J., A. L. Boldt, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC); M. D. LeClair (SAIC); G. L. Borsheim (BA); R. T. Winward (MA); B. A. Higley and R. M. Orme (NHC); N. G. Coulton (PNNL); S. L. Lambert and D. E. Place (Cogema); and W. W. Shulz (W^2S), 1999, *Standard Inventories of Chemicals and Radionuclides in Hanford Tank Wastes*, HNF-SD-WM-TI-740, Rev 0C, Lockheed Martin Hanford Company, Richland, Washington.
(2) Simpson, B. C., 1998, *Best-Basis Inventory Change Package for Reconciliation of Mercury Values, Change Package #7*, letter to J. M. Cammann, 7A120-98-005, dated February 26, 1998, Lockheed Martin Hanford Company, Richland, Washington.

The attachment to this letter documents an update of the process knowledge and sample based estimates of mercury in the 200 Area underground storage tanks. Comments from the February 9, 2000 review have been incorporated. There are five major sections in the attachment to this letter.

Previously an estimate of 2,060 kg of mercury for the underground storage tanks was established by a review of process flowsheets and other documentation in the Standard Inventory Report (Kupfer et al., 1998). The previous strategy for distribution of this mercury to the tanks was based on the assumption that mercury was used to catalyze the dissolution of aluminum cladding from the fuel in a sodium hydroxide solution (Simpson 1998). Examination of process flowsheets has established that this logic is incorrect. The flowsheets indicate that mercury was added with or to the nitric acid dissolvent and would more logically have exited the various nuclear fuel reprocessing operations in the high-level waste streams.

Section 1.0 of the attachment establishes the strategy for integration of tank specific process knowledge and sample-based mercury estimates. The process knowledge-based global inventory estimate is distributed to specific tanks based on knowledge of the disposition of known mercury bearing waste streams. The process knowledge-derived values would be superceded by sample-based values when available and appropriate.

A review of the process knowledge relevant to mercury in Section 2.0 establishes a revised global inventory estimate for mercury of 2,097 kg. This section also identifies each waste stream from the various fuel reprocessing operations that would have contained mercury.

Section 3.0 of the study documents a review of tanks with sample-based mercury results that have been published in the Tank Characterization Database or in the Tank Characterization Reports. Many of the mercury results were found to be suspect or unusable due to quality assurance concerns. Sample results were also found to be no longer applicable due to waste transfers subsequent to the sampling event. Of the thirty sets of mercury data evaluate only samples from ten tanks survived inspection.

In Section 4.0, the results of the process knowledge-based distribution of the global mercury inventory are summarized. Those tanks where sample data should supercede the process knowledge-derived values are identified.

A set of vectors that facilitate the implementation of mercury inventories in the Best Basis Inventory maintenance software application are defined in Section 5.0. A table that references the applicable vectors for each tank is also provided.

B. A. Higley

B. A. Higley, Engineer II
Process Development

rln

Attachment

Distribution of Mercury in Tank Wastes

A global inventory estimate of 2,060 kg of mercury in the waste tanks was established by a review of process flowsheets and other documentation in the Standard Inventory Report Kupfer et al. (1998). Previously, the basis for mercury distribution to the tanks was a function of the cladding waste volume (Simpson 1998). This strategy was based on the assumptions used by the Hanford Defined Waste Model (HDW) [Agnew et al. 1997a]. The HDW Model assumed that mercury was used to catalyze the dissolution of aluminum cladding from the fuel in a sodium hydroxide solution. Evaluation of process flowsheets has established that this logic is incorrect. The flowsheets indicate that mercury was added with or to the nitric acid dissolvent and would have been contained in the high-level waste streams from the various nuclear fuel reprocessing operations.

1.0 Summary

The number of sample results that are available for mercury is extremely limited. Only ten sample-based mercury results survived inspection. Since a global inventory estimate derived from process knowledge is available, the proposed approach is to distribute this estimate on a tank-by-tank basis using knowledge of the distribution of waste in the tanks. The process knowledge-derived values would be superceded by sample-based values when available and appropriate.

Section 2.0 of this study documents a review of the process knowledge relevant to mercury and establishes a revised global inventory estimate for mercury of 2,097 kg and establishes the basis for distribution of mercury from various sources to specific waste streams. For convenience and consistency with current Best Basis Inventory (BBI) practices, the waste streams defined by the HDW Model (Agnew et al. 1997a) are used. The Tank Layer Model portion of the HDW Model provides for distribution of the mercury bearing waste streams to the tanks.

Section 3.0 of this study documents a review of tanks with sample-based mercury results that have been published in the Tank Characterization Database or in the Tank Characterization Reports. Many of the mercury results were found to be suspect or unusable due to quality assurance concerns. Sample results were also found to be no longer applicable due to waste transfers subsequent to the sampling event.

Section 4.0 summarizes the results of the process knowledge-based distribution of the global mercury inventory and identifies tanks where sample data should supercede the process knowledge-derived values.

Section 5.0 provides vectors for use in the Best Basis Inventory Maintenance Tool software application. Process knowledge vectors are based on the process knowledge assessment in Section 2.0. Sample vectors associated with the validated mercury sample data from Section 3.0 are identified. A table that cross-references which vectors are applicable to each tank is also provided.

Sample data and the known chemistry of mercury indicates that the amount of mercury in the aqueous phase in negligible. Because of these characteristics, the mercury values in the liquid phase vectors will be set at zero to simplify liquid transfer updates of the BBI.

2.0 Sources of Mercury.

Mercury was used at the Hanford Site 200 Area fuel re-processing facilities as a catalyst to dissolve aluminum alloy fuels and to suppress iodine volatilization during fuel dissolution.

The chemistry of mercury makes its presence in the aqueous phase extremely unlikely. Mercury halides are almost undissociated in aqueous solution. The equilibrium constants for common (Cl^-, Br^-, I^-, CN^-, and NH_3) complexes of mercury are extremely high and range from 10^{16} to 10^{41} (Cotton and Wilkinson 1988). Because of these characteristics, mercury is expected to have partitioned to the sludge layers rather than to saltcake or aqueous phases.

2.1 Dissolution of Al-U and Al-Pu Alloy Fuels.

Process Knowledge - REDOX: In the initial operation of the Plutonium Recycle Test Reactor (PRTR), the reactor used Zircaloy clad Al-Pu fuel elements. Later PRTR fuel was fabricated from PuO_2-UO_2. Only the Al-Pu elements required the use of mercury to catalyze dissolution of the aluminum alloy.

In 1963, the REDOX Plant processed four dissolver charges of Pu-Al PRTR fuel. Although not noted in the plant dissolver charging records, Jenkins and Foster (1978) report that Zircaloy clad, Pu-Al alloy PRTR fuel was processed in February, March, and December of 1963. The high-level waste (HLW) receiver tanks at this time were SX-107 and SX-108 (Agnew 1997b). PRTR fuel processed by the REDOX Plant in later years (1964, 1965 and 1966) was oxide fuel and did not require a mercury catalyst. Jenkins and Foster (1978) indicate that REDOX processed 1.7 tons U equivalent of PRTR in 1963. Kupfer et al.(1998) derived an estimate of 0.018 MT mercury using the Hanson (1963) flowsheet. A re-evaluation of the Hanson (1963) flowsheet indicates 4.54 lbs of $Hg(NO_3)_2$ was added in each dissolver cut for every 260 lbs of Pu-Al alloy charged to the dissolver. Three dissolver cuts were made on each charge which results in a mercury usage of 0.055 MT for dissolution of PRTR fuel at the REDOX Plant.

Probable Distribution to Tank Waste: The mercury would have followed the HLW stream (defined as R2 waste by the HDW model). It was not determined which of the two HLW receiver tanks (SX-107 and SX-108) in service in 1963, received the waste from processing Pu-Al alloy PRTR fuel. As an enabling assumption, the PRTR waste is assumed to have been split in direct proportion to the volume of R2 waste in the SX-107 and SX-108 tanks. Appendix C of the HDW Model Rev. 4, (Agnew 1997a) reports 24 kgal of R2 waste in SX-107 and 18 kgal of R2 waste in SX-108.

Process Knowledge - PUREX: In May 1972 the PUREX Plant ran ten dissolver charges of Pu-Al alloy material (McDonald 1995). The plant dissolver records indicate a total of 1.487 tons of PRTR. The flowsheet (Matheison 1972a and 1972b) indicates that 44 lbs of $Hg(NO_3)_2 \cdot H_2O$ was added for every 500-550 lb of low Pu content Pu-Al alloy charged.

and 22 lbs of $Hg(NO_3)_2 \cdot H_2O$ was added for every 200-220 lbs of high content Pu-Al alloy charged to the dissolver. Using averaged values, this results in an estimate of 0.082 MT mercury used for this purpose.

Probable Distribution to Tank Waste: The 0.082 MT of mercury would have been discharged with the HLW (HDW Model P2') stream. The P2' waste was routed to either the tanks or to B Plant for Cs and Sr recovery. The HDW Model (Agnew 1997a) does not predict any accumulation of P2' waste in the tanks which means that all of the P2' waste was apparently routed to B Plant for Cs and Sr recovery. Mercury in the P2' waste stream would have ended up in the B Plant high-level and low-level (B and BL) waste streams. As an enabling assumption, the mercury concentration in the B and BL waste solids are assumed to be equal.

2.2 Suppression of Radioiodine Volatilization

Mercury (II) forms a strong complex with iodine. This characteristic was used to minimize the volatilization of radioactive iodine, e.g. ^{129}I and ^{131}I, during the fuel dissolution processes.

Process Knowledge – T and B Plants: Mercury usage at T and B Plants began during the July 1950 to December 1951 time period and was used until the plants shutdown in 1956 and 1952, respectively. Appendix B of Kupfer et al. (1998) states that 3,683.2 MT of uranium metal was processed at B and/or T Plants during this time period. Mercuric nitrate was added to the nitric acid dissolvent to suppress iodine volatilization. Based on the Schneider (1951) flowsheet, 250 lbs of 0.385% $Hg(NO_3)_2$ solution was used for every 2,200 lbs of uranium that was dissolved. Thus, approximately 1.0 MT of mercury was used for this purpose. Essentially, all of the mercury would have been discharged with the Bismuth Phosphate Process metal waste (MW) stream. Most of the MW was subsequently recovered from the tanks and processed by the Tri-Butyl Phosphate [Uranium Recovery] process (UR waste) and by the in-plant ferrocyanide precipitation process (PFeCN waste).

Probable Distribution to Tank Waste: Approximately 1.0 MT of mercury is distributed into the MW, UR, and PFeCN streams. Appendix C of the HDW model Rev. 4, (Agnew 1997a) reports 651 kgal MW, 525 kgal of UR, 341 kgal of PFeCN1, and 446 kgal of PFeCN2 waste. Despite the known success of MW sluicing, the volume of MW that remains in the tanks is substantially over-estimated by the HDW model. Since the MW is thought to have mostly been recovered from the tanks, only the UR, PFeCN1 and PFeCN2 streams will be considered as mercury bearing wastes. PFeCN is essentially UR waste that was treated by in-plant ferrocyanide scavenging. The relative concentration of mercury in these three streams is not known. As an enabling assumption, the concentration of mercury in these three streams is assumed to be equal.

Process Knowledge – REDOX and PUREX: Until 1968, mercury was occasionally used at the REDOX and PUREX Plants for radioiodine suppression. Since the mercury was added as mercury nitrate to the nitric acid dissolvent, mercury would have left the plants in the HLW stream, i.e., into the R1, R2, P1 and P2 waste streams. Allen (1976) estimated from essential material records that 0.96 MT of mercury was used for this purpose. The review by Allen is believed to have captured all of the mercury used for radioiodine suppression at these plants. (Processing of Al clad fuel at PUREX halted in

1972). Kison (1999) states that mercury additions were only needed for green fuel, i.e., fuel recently discharged from the reactor. All the Zircaloy clad fuel processed during the subsequent 1983-1988 campaign was aged and addition of mercury nitrate for radioiodince suppression was not needed. The REDOX Plant processed 19,706 MTU between startup in 1952 and shutdown in 1966. The PUREX Plant processed 55,888 MTU between 1956 and 1967.

Probable Distribution to Tank Waste: Assuming that mercury usage was proportional to the amount of fuel processed, of the 0.96 MT used for radioiodine suppression at the REDOX and PUREX Plants, 0.25 MT of mercury would have been used by the REDOX Plant and 0.71 MT of mercury would have been used by the PUREX Plant. Mercury would have been discharged with the HLW aqueous streams. The HDW Model lists two HLW streams from the REDOX Plant, R1 and R2. As an enabling assumption, the concentration of mercury in the R1 and R2 streams is assumed to be equal. Using the notation of the HDW Model, only the P1 and P2 streams from the PUREX Plant were mercury bearing. Much of the P1 and P2 waste (pre-sluicing volume of 397 kgal per Agnew, 1997a, p 32) was sluiced and processed for ^{90}Sr recovery. Only 83 kgal (or 21%) of the P1 and P2 waste remains in the tanks after sluicing. Of the original 0.71 MT of mercury used in PUREX, 0.15 MT (21%) would be in P1 and P2 waste. Appendix C of the HDW Model Rev. 4, reports volumes of P1 and P2 waste as 4 and 79 kgal respectively. As an enabling assumption, the concentration of mercury is assumed to equal in these two wastes. The rest of the mercury (0.56 MT) would have followed the retrieved sludge through the B Plant Strontium Recovery Process and would have ended up in the B , BL and AR waste streams. The HDW Model reports 23 kgal of B, 123 kgal of BL, and 172 kgal of AR solids. The combined volume of these three wastes is about equal to the volume of P1 and P2 waste that was sluiced [318 kgal vs. 314 kgal]. This implies that strontium recovery did not significantly change the volume of the sludge. The relative concentration of mercury in these three streams (B, BL, and AR) is not known. As an enabling assumption, the concentration of mercury in these three streams is assumed to be equal.

2.3 Tank-by-Tank Distribution of the Global Mercury Estimate.

Based on process knowledge, sections 2.1 and 2.2 established a global mercury inventory of 2,097 kg. Sections 2.1 and 2.2 also identify, from assessment of process flowsheets, which waste streams were mercury bearing. This information was entered into a spreadsheet that calculated the distribution of the global mercury inventory on a tank-by-tank basis using knowledge of waste layers in the tanks. For convenience and consistency with current Best Basis Inventory (BBI) practice, the waste streams defined by the Tank Layer Model portion of the HDW Model (Agnew et al. 1997a) were used. All the tank specific inventories calculated using this method are summarized in Table 1. The mercury inventories reported in Table 1 are based on the waste volumes present in the tanks as of January 1, 1994 (with the exception of C-106 and AY-102 which were adjusted to reflect recent sludge transfers).

Table 1. Tank-by-Tank Distribution of the Global Mercury Estimate without Consideration of Sample Data. (Inventory estimates are based on January 1, 1994 sludge volumes.)

Tank No.	Estimated Inventory (kg)	Tank No.	Estimated Inventory (kg)	Tank No.	Estimated Inventory (kg)
A-101	5.29	C-110	0.00	TX-110	0.00
A-102	0.00	C-111	0.00	TX-111	0.00
A-103	5.30	C-112	0.00	TX-112	0.00
A-104	49.5	C-201	0.00	TX-113	0.00
A-105	33.5	C-202	0.00	TX-114	0.00
A-106	37.1	C-203	0.00	TX-115	6.10
AX-101	17.6	C-204	0.00	TX-116	0.00
AX-102	11.7	S-101	16.6	TX-117	0.00
AX-103	24.7	S-102	0.723	TX-118	0.00
AX-104	12.4	S-103	1.63	TY-101	0.00
B-101	58.3	S-104	19.5	TY-102	0.00
B-102	0.00	S-105	0.361	TY-103	46.5
B-103	0.00	S-106	0.00	TY-104	9.91
B-104	0.00	S-107	16.6	TY-105	120
B-105	0.00	S-108	0.903	TY-106	0.762
B-106	0.00	S-109	0.00	U-101	0.00
B-107	0.00	S-110	16.1	U-102	0.00
B-108	0.00	S-111	11.9	U-103	0.00
B-109	0.00	S-112	0.542	U-104	0.00
B-110	5.29	SX-101	27.8	U-105	0.00
B-111	45.9	SX-102	10.7	U-106	0.00
B-112	0.00	SX-103	1.81	U-107	0.00
B-201	0.00	SX-104	17.9	U-108	0.00
B-202	0.00	SX-105	4.34	U-109	0.00
B-203	0.00	SX-106	0.00	U-110	0.00
B-204	0.00	SX-107	47.1	U-111	2.35
BX-101	30.3	SX-108	39.3	U-112	1.26
BX-102	0.00	SX-109	10.8	U-201	0.00
BX-103	0.00	SX-110	5.78	U-202	0.00
BX-104	0.00	SX-111	15.0	U-203	0.00
BX-105	0.00	SX-112	12.5	U-204	0.00
BX-106	0.00	SX-113	0.361	AN-101	0.00
BX-107	0.00	SX-114	8.67	AN-102	0.00
BX-108	0.00	SX-115	1.08	AN-103	4.66
BX-109	121	T-101	0.00	AN-104	0.00
BX-110	0.00	T-102	0.00	AN-105	0.00
BX-111	0.00	T-103	0.00	AN-106	0.00
BX-112	0.00	T-104	0.00	AN-107	0.00
BY-101	0.00	T-105	0.00	AP-101	0.00
BY-102	0.00	T-106	0.00	AP-102	0.00
BY-103	0.00	T-107	0.00	AP-103	0.00
BY-104	114	T-108	0.00	AP-104	0.00

Table 1. Tank-by-Tank Distribution of the Global Mercury Estimate without Consideration of Sample Data. (Inventory estimates are based on January 1, 1994 sludge volumes.)

Tank No.	Estimated Inventory (kg)	Tank No.	Estimated Inventory (kg)	Tank No.	Estimated Inventory (kg)
BY-105	108	T-109	0.00	AP-105	0.00
BY-106	74.7	T-110	0.00	AP-106	0.00
BY-107	70.9	T-111	0.00	AP-107	0.00
BY-108	126	T-112	0.00	AP-108	0.00
BY-109	0.00	T-201	0.00	AW-101	0.00
BY-110	117	T-202	0.00	AW-102	0.00
BY-111	0.00	T-203	0.00	AW-103	0.00
BY-112	4.57	T-204	0.00	AW-104	0.00
C-101	22.9	TX-101	12.6	AW-105	0.00
C-102	12.2	TX-102	0.00	AW-106	2.33
C-103	44.2	TX-103	0.00	AY-101	42.0
C-104	3.53	TX-104	0.00	AY-102	353.5[1]
C-105	11.4	TX-105	0.00	AZ-101	2.33
C-106	14.1[1]	TX-106	0.723	AZ-102	0.0
C-107	0.00	TX-107	0.00	SY-101	0.0
C-108	19.1	TX-108	3.05	SY-102	0.0
C-109	0.00	TX-109	0.00	SY-103	0.0

[1] Includes an adjustment for the recent transfer of sludge from tank 241-C-106 to tank 241-AY-102.

3.0 Review of Measured Mercury Values.

Mercury values reported in the Tank Characterization Database (TCD) and in the Tank Characterization Reports (TCR) were reviewed. Table 2 summarizes all of the mercury values reported in the TCD [Tank Sample Results Tables] (LMHC 1999) or in the TCRs as of September 1999. The table includes the average sample result, an estimate of the mercury inventory based on the sample result for the tank, whether or not the tank contains one of the mercury bearing wastes identified in Section 2.0, and other information pertinent to interpretation of the sample result.

Table 2. Review and Assessment of Sample-Based Mercury Data.

Tank No.	Mean Concentration of Mercury in Sample	Mercury inventory estimated from sample (kg)	Probable Mercury Bearing Waste Type	Comment	Conclusions
AN-102	<50 ug/L	<0.2 liq. inv. only	None identified	1998 liquid data only. Tank is 90% liquid-10% saltcake	The sample data are inconclusive with respect to the total inventory of mercury in the tank since the tank solids were not sampled.
AN-103	<50 ug/L	<0.08 liq. inv. only	BL	1998 liquid data. Tank is 44% liquid-56% solids	The sample data are inconclusive with respect to the total inventory of mercury in the tank since the tank solids were not sampled.
AN-104	<20 ug/L	<0.045 liq. inv. only	None identified	1998 supernate composite. Tank is 57% liquid-43% slurry	The sample data are inconclusive with respect to the total inventory of mercury in the tank since the tank solids were not sampled.
AN-107	<500 ug/L	<1.51 liq. inv. only	None identified	1996 liquid data. Tank is 76% liquid-24% slurry	The sample data are inconclusive with respect to the total inventory of mercury in the tank since the tank solids were not sampled.
AP-101	<5 ug/L	<0.02	None identified	1993 grab sample. Tank was 100% liquid. Moved to AW-102 Aug. 94	The sample data are no longer applicable since the tank contents were moved after the sample was taken.
AP-102	<5 ug/L	<0.02	None identified	1993 grab sample. Tank is 100% liquid.	The mercury inventory is assumed to be zero based on low detection limit results and the absence of an identified Hg bearing waste.
AP-103	<1.7 ug/L	<0.0062	None identified	1991 grab sample. Tank was 100% liquid. Moved to AW-102 May 94	The sample data are no longer applicable since the tank contents were moved after the sample was taken.

Table 2. Review and Assessment of Sample-Based Mercury Data.

Tank No.	Mean Concentration of Mercury in Sample	Mercury inventory estimated from sample (kg)	Probable Mercury Bearing Waste Type	Comment	Conclusions
AP-105	<17.5 ug/L	<0.055	None identified	1993 grab sample. Tank was 80% liquid - 0% saltcake. Pumped to AW-102 June 95	The sample data are no longer applicable since the tank contents were moved after the sample was taken.
AP-106	<2.5 ug/L	<0.011	None identified	1993 grab sample. Tank was 100% liquid. Moved 83 kgal to AW-102 and 943 kgal to AP-108 May/June 95	The sample data are no longer applicable since the tank contents were moved after the sample was taken.
AP-107	<3 ug/L	<0.013	None identified	1993 grab sample. Tank was 100% liquid. Moved to AW-102 Aug. 94	The sample data are no longer applicable since the tank contents were moved after the sample was taken.
AW-102	<5 ug/L	1991 evaporator feed grab sample, no longer applicable			The sample result is no longer applicable since the tank contents were moved after the sample was taken.
AW-106	<5 ug/L	<0.01	None identified	1991 grab sample. Tank was 50% liquid – 50% saltcake. The tank was filled and pumped after the sample was taken.	The sample result is no longer applicable since the tank contents were moved after the sample was taken.
AY-102 pre C-106 sluicing	76,000 ug/kg	12.1	BL	1987 sludge data. Tank is 95% liquid – 5% sludge. Sample only reflects sludge layer.	Inventory estimate incomplete without consideration of C-106 sludge. Sample results suspect due to age and documentation.
C-106 transfer	11,000-165,000 ug/kg	18.4-142.3	AR, BL	Estimated inventory sluiced from C-106 (146.5 kgal)	Sample data are suspect due to irreproducibility of duplicate analysis.
AY-102 post C-106 sluicing	--	30.5-154.4	AR, BL	Estimated from AY-102 and C-106 data	Inventory estimate is suspect due to age of sample results and irreproducibility of C-106 results.

Table 2. Review and Assessment of Sample-Based Mercury Data.

Tank No.	Mean Concentration of Mercury in Sample	Mercury inventory estimated from sample (kg)	Probable Mercury Bearing Waste Type	Comment	Conclusions
B-110	1,087 ug/kg	1.38	P2	89/90 core composite. Tank is 100% sludge.	Inventory estimate is suspect due to age of the sample and the lack of quality assurance records.
B-111	9,350 ug/kg	9.93	P2	1991 core sample. Tank is 100% sludge.	Sample results are suspect since a large number of estimated values are reported in the TCD.
B-201	599 ug/kg	0.0822	None identified	1991 core sample. Tank is 100% sludge.	Sample results are suspect since a large number of rejected values are reported by the TCD.
B-202	314 ug/kg	0.0389	None identified	1991 core composites. Tank is 100% sludge. Possibly includes B waste.	The CVAA[1] mercury values reported in the TCD are considered to be valid.
BX-107	565 ug/kg	1.06	None identified	1992 core samples. Tank is 100% sludge. Possibly includes UR waste.	The CVAA[1] mercury values reported in the TCD are considered to be valid.
C-106 Pre-sluicing	11,000-165,000 ug/kg	24.7-191.3	UR, BL, AR	1988 sample. Pre-sluicing inventory. Based on two sample results.	Sample data are suspect due to irreproducibility of duplicate analysis.
C-106 Post sluicing	11,000-165,000 ug/kg	6.3-49.0	UR, AR	Based on post sluicing sludge volume of 50.5 kgal	Sample data are suspect due to irreproducibility of duplicate analysis.
C-109	7,350 ug/kg solids	2.125	None identified	1992 core sample. Tank is 100% sludge. Liquid composite = 91 ug/kg. Solids composite = 7,350 ug/kg.	The CVAA[1] mercury values reported in the TCD are considered to be valid.
C-110	382 ug/kg	0.373	None identified	1992 core sample. Tank is 100% sludge. Possibly includes UR waste.	Two values reported as estimated in the TCD were excluded from consideration. The accepted mercury concentration is based on eight values.
C-112	4,400 ug/kg	2.86	None identified	1992 core sample. Tank is 100% sludge. Possibly contains UR waste.	The CVAA[1] mercury values reported in the TCD are considered to be valid.

Table 2. Review and Assessment of Sample-Based Mercury Data.

Tank No.	Mean Concentration of Mercury in Sample	Mercury inventory estimated from sample (kg)	Probable Mercury Bearing Waste Type	Comment	Conclusions
C-201	7,000 ug/kg	0.0615	None identified	Water soluble fraction of 1978 sample. Tank is 100% sludge. Possibly contains MW.	Results are suspect due to the age of the analysis and due to the lack of an acid digested or fusion analysis of the solids.
S-104	<126 ug/kg	<0.23	R1	1992 core sample. Tank is 100% sludge.	The mercury inventory is assumed to be zero based on all measurements being below the detection limit.
SY-101	161 ug/kg	1.04	None identified	Dec 1991 core sample. TCD value. Tank is 100% DSS. TCR reports 0.161 ug/kg for same Dec 1991 core (est. tank inv. = 0.0011 kg)	The CVAA[1] mercury values reported in the TCD are considered to be valid. The inventory estimate does not reflect recent transfers (1st Q-2000) from SY-101 to SY-102. The inventory is based on the gas free waste volume established as of September 1999
T-102	6,250 ug/kg	0.8	None identified	1993 sludge core sample. Tank is 41% liq.-59% sludge. Possibly contains MW. Sample is sludge only.	Sample results are suspect since one of the two values reported in the TCD is estimated.
T-104	<127 ug/kg	<0.202	None identified	1992 core sample. Tank is 100% sludge. Tank was saltwell pumped 96-99	The mercury inventory is assumed to be zero based on all measurements being below the detection limit and the absence of an identified mercury bearing waste.
T-107	134 ug/kg	0.133	None identified	92/93 core sample. Tank is 100% sludge. Possibly contains UR waste.	The CVAA[1] mercury values reported in the TCD are considered to be valid.
T-111	1,430 ug/kg	3.09	None identified	1991 core sample. Tank is 100% sludge.	Sample results are suspect since a large number of estimated values are reported in the TCD and no mercury bearing waste was identified.
U-110	728 ug/kg	0.748	None identified	1989 core sample-CVAA[1] results. Tank is 100% sludge. Possibly contains R1 waste.	Sample results are suspect since a large number of estimated values and detection limit values are reported in the TCD.

(1) Cold Vapor Atomic Absorption Spectroscopy (CVAA)

Sample results were located for 30 of the underground storage tanks. Most of the sample-based inventory estimates were no longer applicable because of waste transfers subsequent to the sampling event, or were suspect due to data quality concerns. Only ten of the sample based inventory estimates discussed in Table 2 were considered to be valid. Table 3 summarizes these results.

Table 3. Estimated Mercury Inventories of Tanks with Validated Sample Results.

Tank No.	Hg Inventory Estimate (kg)	Basis
AP-102	0.0	Engineering assessment of sample and process knowledge
B-202	0.0389	Sample based assessment
BX-107	1.06	Sample based assessment
C-109	2.125	Sample based assessment
C-110	0.373	Sample based assessment
C-112	2.86	Sample based assessment
S-104	0.0	Engineering assessment of sample and process knowledge
SY-101	1.04[1]	Sample based assessment
T-104	0.0	Engineering assessment of sample and process knowledge
T-107	0.133	Sample based assessment

[1] The mercury inventory estimate for tank 241-SY-101 is based on the gas free waste volume in the tank as of September 1999.

4.0 Integration of the Global Inventory Based Distribution with Sample Based Inventory Estimates.

The number of sample results for mercury that are available is extremely limited. Only ten of the thirty sample results reviewed survived inspection. Since a global inventory estimate, derived from process knowledge is available, the tank specific distribution will be integrated with sample-based inventory estimates. In accordance with the strategy stated in Section 1.0 (and with BBI practice), the sample-based estimates will supercede the process knowledge-based estimates.

Table 4 summarizes the process knowledge-based (engineering) estimates and the sample-based inventory estimates developed in this study.

Table 4. Integrated Process Knowledge-Based (Engineering) and Sample-Based Inventory Estimates of Mercury in the Hanford Site Underground Storage Tanks.

Tank No.	Engineering Based Estimates for Hg (kg)	Sample Based Estimates for Hg (kg)	Basis[1]	Tank No.	Engineering Based Estimates for Hg (kg)	Sample Based Estimates for Hg (kg)	Basis[1]
A-101	5.29	NR	E	SX-112	12.5	NR	E
A-102	0.00	NR	E	SX-113	0.361	NR	E
A-103	5.30	NR	E	SX-114	8.67	NR	E
A-104	49.5	NR	E	SX-115	1.08	NR	E
A-105	33.5	NR	E	T-101	0.00	NR	E
A-106	37.1	NR	E	T-102	0.00	NR	E

Table 4. Integrated Process Knowledge-Based (Engineering) and Sample-Based Inventory Estimates of Mercury in the Hanford Site Underground Storage Tanks.

Tank No.	Engineering Based Estimates for Hg (kg)	Sample Based Estimates for Hg (kg)	Basis[1]	Tank No.	Engineering Based Estimates for Hg (kg)	Sample Based Estimates for Hg (kg)	Basis[1]
AX-101	17.6	NR	E	T-103	0.00	NR	E
AX-102	11.7	NR	E	T-104	NR	0.0	S/E
AX-103	24.7	NR	E	T-105	0.00	NR	E
AX-104	12.4	NR	E	T-106	0.00	NR	E
B-101	58.3	NR	E	T-107	NR	0.133	S
B-102	0.00	NR	E	T-108	0.00	N	E
B-103	0.00	NR	E	T-109	0.00	NR	E
B-104	0.00	NR	E	T-110	0.00	NR	E
B-105	0.00	NR	E	T-111	0.00	NR	E
B-106	0.00	NR	E	T-112	0.00	NR	E
B-107	0.00	NR	E	T-201	0.00	NR	E
B-108	0.00	NR	E	T-202	0.00	NR	E
B-109	0.00	NR	E	T-203	0.00	NR	E
B-110	5.29	NR	E	T-204	0.00	NR	E
B-111	45.9	NR	E	TX-101	12.6	NR	E
B-112	0.00	NR	E	TX-102	0.00	NR	E
B-201	0.00	NR	E	TX-103	0.00	NR	E
B-202	NR	0.0389	S	TX-104	0.00	NR	E
B-203	0.00	NR	E	TX-105	0.00	NR	E
B-204	0.00	NR	E	TX-106	0.723	NR	E
BX-101	30.3	NR	E	TX-107	0.00	NR	E
BX-102	0.00	NR	E	TX-108	3.05	NR	E
BX-103	0.00	NR	E	TX-109	0.00	NR	E
BX-104	0.00	NR	E	TX-110	0.00	NR	E
BX-105	0.00	NR	E	TX-111	0.00	NR	E
BX-106	0.00	NR	E	TX-112	0.00	NR	E
BX-107	NR	1.06	S	TX-113	0.00	NR	E
BX-108	0.00	NR	E	TX-114	0.00	NR	E
BX-109	121	NR	E	TX-115	6.10	NR	E
BX-110	0.00	NR	E	TX-116	0.00	NR	E
BX-111	0.00	NR	E	TX-117	0.00	NR	E
BX-112	0.00	NR	E	TX-118	0.00	NR	E
BY-101	0.00	NR	E	TY-101	0.00	NR	E
BY-102	0.00	NR	E	TY-102	0.00	NR	E
BY-103	0.00	NR	E	TY-103	46.5	NR	E
BY-104	114	NR	E	TY-104	9.91	NR	E
BY-105	108	NR	E	TY-105	120	NR	E
BY-106	74.7	NR	E	TY-106	0.762	NR	E
BY-107	70.9	NR	E	U-101	0.00	NR	E
BY-108	126	NR	E	U-102	0.00	NR	E
BY-109	0.00	NR	E	U-103	0.00	NR	E
BY-110	117	NR	E	U-104	0.00	NR	E
BY-111	0.00	NR	E	U-105	0.00	NR	E
BY-112	4.57	NR	E	U-106	0.00	NR	E
C-101	22.9	NR	E	U-107	0.00	NR	E
C-102	12.2	NR	E	U-108	0.00	NR	E
C-103	44.2	NR	E	U-109	0.00	NR	E
C-104	3.53	NR	E	U-110	0.00	NR	E
C-105	11.4	NR	E	U-111	2.35	NR	E
C-106	14.1[2]	NR	E	U-112	1.26	NR	E

Table 4. Integrated Process Knowledge-Based (Engineering) and Sample-Based Inventory Estimates of Mercury in the Hanford Site Underground Storage Tanks.

Tank No.	Engineering Based Estimates for Hg (kg)	Sample Based Estimates for Hg (kg)	Basis[1]	Tank No.	Engineering Based Estimates for Hg (kg)	Sample Based Estimates for Hg (kg)	Basis[1]
C-107	0.00	NR	E	U-201	0.00	NR	E
C-108	19.1	NR	E	U-202	0.00	NR	E
C-109	NR	2.125	S	U-203	0.00	NR	E
C-110	NR	0.373	S	U-204	0.00	NR	E
C-111	0.00	NR	E	AN-101	0.00	NR	E
C-112	NR	2.86	S	AN-102	0.00	NR	E
C-201	0.00	NR	E	AN-103	4.66	NR	E
C-202	0.00	NR	E	AN-104	0.00	NR	E
C-203	0.00	NR	E	AN-105	0.00	NR	E
C-204	0.00	NR	E	AN-106	0.00	NR	E
S-101	16.6	NR	E	AN-107	0.00	NR	E
S-102	0.723	NR	E	AP-101	0.00	NR	E
S-103	1.63	NR	E	AP-102	NR	0.0	S/E
S-104	NR	1.04	S/E	AP-103	0.00	NR	E
S-105	0.361	NR	E	AP-104	0.00	NR	E
S-106	0.00	NR	E	AP-105	0.00	NR	E
S-107	16.6	NR	E	AP-106	0.00	NR	E
S-108	0.903	NR	E	AP-107	0.00	NR	E
S-109	0.00	NR	E	AP-108	0.00	NR	E
S-110	16.1	NR	E	AW-101	0.00	NR	E
S-111	11.9	NR	E	AW-102	0.00	NR	E
S-112	0.542	NR	E	AW-103	0.00	NR	E
SX-101	27.8	NR	E	AW-104	0.00	NR	E
SX-102	10.7	NR	E	AW-105	0.00	NR	E
SX-103	1.81	NR	E	AW-106	2.33	NR	E
SX-104	17.9	NR	E	AY-101	42.0	NR	E
SX-105	4.34	NR	E	AY-102	353.5[2]	NR	E
SX-106	0.00	NR	E	AZ-101	2.33	NR	E
SX-107	47.1	NR	E	AZ-102	0.00	NR	E
SX-108	39.3	NR	E	SY-101	NR	1.04[3]	S
SX-109	10.8	NR	E	SY-102	0.00	NR	E
SX-110	5.78	NR	E	SY-103	0.00	NR	E
SX-111	15.0	NR	E				

[1] An "E" indicates that the inventory estimate is an engineering estimate based on process knowledge. An "S" indicates that the inventory estimate is based on sample data.
[2] The inventory estimates reflect recent transfers of sludge from tank 241-C-106 to tank 241-AY-102.
[3] The mercury inventory estimate for tank 241-SY-101 is based on the gas-free waste volume in the tank as of September 1999.

5.0 Development of Vectors.

The Best Basis Inventory is managed through the use of the Best Basis Inventory Maintenance (BBIM) Tool software application. The BBIM application uses both solid phase and liquid phase vectors. The solid phase vectors describe the composition the sludge and the saltcake. The liquid phase vectors describe the composition of the supernate and interstitial liquids.

5.1 Solid Phase Vectors

In order to use the results of this study in the BBIM application, the global inventory distribution in Section 2.0 must be translated into a set of mercury vectors that can be used to calculate the tank-by-tank mercury inventories. These vectors are designed to be used in conjunction with the volumes of specific waste layers identified in Appendix C of the HDW Model Rev. 4. Since the waste layers defined by the HDW Model are solid phase layers, the vectors must be solid phase vectors. These solid phase vector parameters are summarized in Table 5. The density value is a calculation placeholder for the BBIM application and is not intended to be adjusted.

Table 5. Parameters for Solid Phase Process Knowledge-Based Mercury Vectors.

Vector Type	Vector Name	Waste Site ID	Density (g/mL)	Mercury Concentration (ug/g)	Restrictions[1]
Process Knowledge	Hg-UR-PFeCN	To be assigned	1.0 (The density value is not to be adjusted)	201.4	Applies to UR, PFeCN1 and PFeCN2 waste layers only.
Process Knowledge	Hg-R1-R2	To be assigned	1.0 (The density value is not to be adjusted)	47.72	Applies to R1 and R2 waste layers only
Process Knowledge	Hg-P1-P2	To be assigned	1.0 (The density value is not to be adjusted)	466.2	Applies to P1 and P2 waste layers only.
Process Knowledge	Hg-AR	To be assigned	1.0 (The density value is not to be adjusted)	466.7	Applies to AR waste layer only.
Process Knowledge	Hg-B-BL	To be assigned	1.0 (The density value is not to be adjusted)	616.1	Applies to B and BL waste layers only.
Process Knowledge	Hg-PRTR	To be assigned	1.0 (The density value is not to be adjusted)	345.9	Applies to the R2 layers in SX-107 and SX-108 only and is in addition to the Hg-R1-R2 vector for these tanks
Process Knowledge	Process Knowledge (P/U107/04)	241-U-107	1.0 (The density value is not to be adjusted)	0	Applies to all tanks without an identified mercury bearing layer.

[1] The volumes of waste layers specific to each tank are reported in Appendix C of the HDW model Rev. 4.

The sample data review in Section 3.0 identified ten tanks where sample-based estimates should supercede process knowledge-based estimates. These tanks, and the mercury vector parameters are identified in Table 6. These vectors are applicable to the solids phase only.

Table 6. Sample Vectors for Those Tanks with Validated Mercury Sample Results.

Vector Type	Vector Name	Waste Site ID	Density (g/mL)	Concentration (ug/g)	Comments
Sample	1991 core composite	B-202	1.215	0.314	Vector Handle: S/B202/01
Sample	1992 core composite samples	BX-107	1.44	0.565	Vector Handle: S/BX107/02
Sample	1992 sludge sample	C-109	1.23	7.35	Vector Handle: S/C109/3
Sample	1992 core sample	C-110	1.45	0.382 (1)	Vector Handle: S/C110/03
Sample	1992 core sample	C-112	1.65	4.40	Vector Handle: S/C112/02
Sample/Engr.		S-104	1.0	0.0	Vector Handle: P/U107/04
Sample/Engr.		T-104	1.0	0.0	Vector Handle: P/U107/04
Sample	1992/1993 core sample	T-107	1.51	0.134	Vector Handle: S/T107/01
Sample/Engr.		AP-102	1.0	0.0	Vector Handle: P/U107/04
Sample	1991 core sample (Window E)	SY-101	1.7	0.161	Vector Handle: S/SY101/07 See Note (2)

(1) Mean mercury concentration from eight of ten values reported in the TCD.
(2) For waste in tank 241-SY-101, the mercury concentration value is based on the average of composite samples from both the convective and non-convective layer.

5.2 Liquid Phase Vectors

Very little of the mercury estimated from process knowledge has been detected by sampling of the tank waste. Of the mercury that has been detected in the tank waste, the amount detected in the aqueous phase has been negligible. The chemistry of mercury makes its presence in the aqueous phase highly unlikely. Mercury halides are almost undissociated in aqueous solution. The equilibrium constants for common (Cl^-, Br^-, I^-, CN^-, and NH_3) complexes of mercury are extremely high and range from 10^{16} to 10^{41} (Cotton and Wilkinson 1988). Because of these characteristics, liquid phase vectors for mercury should be set at zero. Setting the mercury value in liquid phase vectors at zero will facilitate liquid transfer updates of the BBI.

5.3 Implementation of Mercury Vectors in the BBIM.

Table 7 references the applicable vectors and volume of mercury bearing waste solids in each tank with the corresponding tank number. For those tanks that do not contain mercury, the P/U107/04 vector is used. The P/U107/04 has a zero concentration for mercury and when applied to the total waste volume of a tank, will calculate an inventory of zero. Correct implementation can be verified by comparing the result calculated by the BBIM Tool with the value shown in Table 4.

Table 7. Vectors and Volumes Applicable to the Mercury Inventory in Each Tank.

Tank No.	Vector Name or Handle	Waste Layer Volume (kgal)	Tank No.	Vector Name or Handle	Waste Layer Volume (kgal)
A-101	Hg-P1-P2	3	SX-112	Hg-R1-R2	69
A-102	P/U107/04	--	SX-113	Hg-R1-R2	2
A-103	Hg-AR	3	SX-114	Hg-R1-R2	48
A-104	Hg-P1-P2, Hg-AR	1 27	SX-115	Hg-R1-R2	6
A-105	Hg-P1-P2	19	T-101	P/U107/04	--
A-106	Hg-AR	21	T-102	P/U107/04	--
AX-101	Hg-P1-P2	10	T-103	P/U107/04	--
AX-102	Hg-B-BL	5	T-104	P/U107/04	--
AX-103	Hg-P1-P2	14	T-105	P/U107/04	--
AX-104	Hg-P1-P2	7	T-106	P/U107/04	--
B-101	Hg-B-BL	25	T-107	S/T107/01	173
B-102	P/U107/04	--	T-108	P/U107/04	--
B-103	P/U107/04	--	T-109	P/U107/04	--
B-104	P/U107/04	--	T-110	P/U107/04	--
B-105	P/U107/04	--	T-111	P/U107/04	--
B-106	P/U107/04	--	T-112	P/U107/04	--
B-107	P/U107/04	--	T-201	P/U107/04	--
B-108	P/U107/04	--	T-202	P/U107/04	--
B-109	P/U107/04	--	T-203	P/U107/04	--
B-110	Hg-P1-P2	3	T-204	P/U107/04	--
B-111	Hg-P1-P2	26	TX-101	Hg-R1-R2	70
B-112	P/U107/04	--	TX-102	P/U107/04	--
B-201	P/U107/04	--	TX-103	P/U107/04	--
B-202	S/B202/01	27	TX-104	P/U107/04	--
B-203	P/U107/04	--	TX-105	P/U107/04	--
B-204	P/U107/04	--	TX-106	Hg-R1-R2	4
BX-101	Hg-B-BL	13	TX-107	P/U107/04	--
BX-102	P/U107/04	--	TX-108	Hg-UR-PFeCN	4
BX-103	P/U107/04	--	TX-109	P/U107/04	--
BX-104	P/U107/04	--	TX-110	P/U107/04	--
BX-105	P/U107/04	--	TX-111	P/U107/04	--
BX-106	P/U107/04	--	TX-112	P/U107/04	--
BX-107	S/BX107/02	344	TX-113	P/U107/04	--

Table 7. Vectors and Volumes Applicable to the Mercury Inventory in Each Tank.

Tank No.	Vector Name or Handle	Waste Layer Volume (kgal)	Tank No.	Vector Name or Handle	Waste Layer Volume (kgal)
BX-108	P/U107/04	--	TX-114	P/U107/04	--
BX-109	Hg-UR-PFeCN	159	TX-115	Hg-UR-PFeCN	8
BX-110	P/U107/04	--	TX-116	P/U107/04	--
BX-111	P/U107/04	--	TX-117	P/U107/04	--
BX-112	P/U107/04	--	TX-118	P/U107/04	--
BY-101	P/U107/04	--	TY-101	P/U107/04	--
BY-102	P/U107/04	--	TY-102	P/U107/04	--
BY-103	P/U107/04	--	TY-103	Hg-UR-PFeCN	61
BY-104	Hg-UR-PFeCN	150	TY-104	Hg-UR-PFeCN	13
BY-105	Hg-UR-PFeCN	142	TY-105	Hg-UR-PFeCN	158
BY-106	Hg-UR-PFeCN	98	TY-106	Hg-UR-PFeCN	1
BY-107	Hg-UR-PFeCN	93	U-101	P/U107/04	--
BY-108	Hg-UR-PFeCN	165	U-102	P/U107/04	--
BY-109	P/U107/04	--	U-103	P/U107/04	--
BY-110	Hg-UR-PFeCN	153	U-104	P/U107/04	--
BY-111	P/U107/04	--	U-105	P/U107/04	--
BY-112	Hg-UR-PFeCN	6	U-106	P/U107/04	--
C-101	Hg-UR-PFeCN	30	U-107	P/U107/04	--
C-102	Hg-UR-PFeCN	16	U-108	P/U107/04	--
C-103	Hg-AR	25	U-109	P/U107/04	--
C-104	Hg-P1-P2	2	U-110	P/U107/04	--
C-105	Hg-UR-PFeCN	15	U-111	Hg-R1-R2	13
C-106	Hg-UR-PFeCN, Hg-AR	15 1.5[1]	U-112	Hg-R1-R2	7
C-107	P/U107/04	--	U-201	P/U107/04	--
C-108	Hg-UR-PFeCN	25	U-202	P/U107/04	--
C-109	S/C109/03	62	U-203	P/U107/04	--
C-110	S/C110/03	178	U-204	P/U107/04	--
C-111	P/U107/04	--	AN-101	P/U107/04	--
C-112	S/C112/02	104	AN-102	P/U107/04	--
C-201	P/U107/04	--	AN-103	Hg-B-BL	2

Table 7. Vectors and Volumes Applicable to the Mercury Inventory in Each Tank.

Tank No.	Vector Name or Handle	Waste Layer Volume (kgal)	Tank No.	Vector Name or Handle	Waste Layer Volume (kgal)
C-202	P/U107/04	--	AN-104	P/U107/04	--
C-203	P/U107/04	--	AN-105	P/U107/04	--
C-204	P/U107/04	--	AN-106	P/U107/04	--
S-101	Hg-R1-R2	92	AN-107	P/U107/04	--
S-102	Hg-R1-R2	4	AP-101	P/U107/04	--
S-103	Hg-R1-R2	9	AP-102	P/U107/04	--
S-104	P/U107/04	--	AP-103	P/U107/04	--
S-105	Hg-R1-R2	2	AP-104	P/U107/04	--
S-106	P/U107/04	--	AP-105	P/U107/04	--
S-107	Hg-R1-R2	92	AP-106	P/U107/04	--
S-108	Hg-R1-R2	5	AP-107	P/U107/04	--
S-109	P/U107/04	--	AP-108	P/U107/04	--
S-110	Hg-R1-R2	89	AW-101	P/U107/04	--
S-111	Hg-R1-R2	66	AW-102	P/U107/04	--
S-112	Hg-R1-R2	3	AW-103	P/U107/04	--
SX-101	Hg-R1-R2	154	AW-104	P/U107/04	--
SX-102	Hg-R1-R2	59	AW-105	P/U107/04	--
SX-103	Hg-R1-R2	10	AW-106	Hg-B-BL	1
SX-104	Hg-R1-R2	99	AY-101	Hg-B-BL	18
SX-105	Hg-R1-R2	24	AY-102	Hg-B-BL, Hg-AR	80 94.5[1]
SX-106	P/U107/04	--	AZ-101	Hg-B-BL	1
SX-107	Hg-R1-R2, Hg-PRTR	87 24	AZ-102	P/U107/04	--
SX-108	Hg-R1-R2, Hg-PRTR	87 18	SY-101	S/SY101/07	1,004[2]
SX-109	Hg-R1-R2	60	SY-102	P/U107/04	--
SX-110	Hg-R1-R2	32	SY-103	P/U107/04	--
SX-111	Hg-R1-R2	83			

[1] Volumes have been adjusted to reflect the recent transfer of sludge from tank 241-C-106 to tank 241-AY-102.

[2] September 1999 gas free volume.

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Hanford Group, Inc.

INTEROFFICE MEMO

From:	Tank Sampling Engineering	7G240-03-BAH-001
Phone:	376-5694	
Date:	April 30, 2003	
Subject:	HANFORD MATERIAL BALANCE FOR STRONTIUM-90 AND CESIUM-137	

To:	T. M. Horner	S5-13
Copies:	K. D. Boomer	L4-07
	B. A. Higley	R3-73
	M. A. Johnson	L4-07
	N. W. Kirch	R3-73
	S. M. Mackay	L4-07
	D. E. Place	R3-73
	TSE LB/file	

The attachment to this letter establishes the quantity of ^{90}Sr and ^{137}Cs removed from the tank waste by various recovery operations. This evaluation is based on current information with respect to the radionuclide inventory in irradiated fuel, records of early offsite shipments to the Oak Ridge National Laboratory and other U.S. Department of Energy sites, and the disposition of Waste Encapsulation Storage Facility capsules. This evaluation concludes that of the original 87.9 MCi ^{90}Sr and 104.1 MCi ^{137}Cs in the irradiated fuel, only 56.1 MCi ^{90}Sr and 43.4 MCi ^{137}Cs remain in the tanks. The balance of the inventory was either shipped offsite, remains in WESF capsules or is in solid waste, cribs and leaks. This information will be used to benchmark the Hanford Defined Waste model.

B. A. Higley

B. A. Higley, Process Engineer
Tank Sampling Engineering

vmm

Attachment

7G240-03-BAH-001

Attachment

HANFORD SITE MATERIAL BALANCE FOR STRONTIUM-90 AND CESIUM-137

Consisting of 7 pages,
including coversheet

HANFORD SITE MATERIAL BALANCE FOR STRONTIUM-90 AND CESIUM-137

The purpose of this evaluation is to establish the quantity of ^{90}Sr and ^{137}Cs removed from tank waste by various recovery operations. This information will be used to benchmark the Hanford Defined Waste (HDW) model.

Two previous ^{90}Sr and ^{137}Cs material balances by Petersen (1996) and Kupfer et al. (1999) were reviewed. Several discrepancies between the two material balance studies were noted. These differences include different initial inventories in the fuel, differences in the inventory shipped offsite, and differences in the inventory of the capsules stored onsite. Table 1 summarizes these two material balance estimates.

Table 1. Comparison of Previous Strontium-90 and Cesium-137 Material Balance Estimates. (Decayed to January 1, 2001)

Inventory Disposition	Mass Balance Estimate by Petersen (1996)		Mass Balance Estimate by Kupfer et al. (1999)	
	Sr-90 (MCi)	Cs-137 (MCi)	Sr-90 (MCi)	Cs-137 (MCi)
Inventory in Fuel Processed	80.0	96.7	87.9	102.2
Capsules currently at the Hanford Site	19.9	46.3	21.8	55.4
Offsite Shipments	5.8	9.5	3.8 to 4.5	2.4
Solid Waste, Cribs, and Leaks	0.9	2.2	0.9	2.2
Residual B Plant and WESF Contamination	0.7	2.7	0.9	2.6 to 3.6
Residual Tank Inventory	52.7	36.0	59.8 to 60.5	38.6 to 39.6

Since the Pedersen (1996) and Kupfer et al. (1999) material balance studies were published, additional information has become available. This information includes a new

estimate of the radionuclide inventory in irradiated fuel, a recent review of records of early offsite shipments to the Oak Ridge National Laboratory (ORNL) and other U.S. Department of Energy (DOE) sites, and current Waste Encapsulation Storage Facility (WESF) capsule disposition records.

The initial inventory for this evaluation is based on a recent Oak Ridge Isotopic Generation and Depletion Code, ORIGEN2, estimate of the isotopic inventory of the irradiated fuel decayed to January 1, 2001 (Watrous 2002). This estimate reflects currently accepted fission product half-lives and specific activities, and fission product yield values.

Estimates of the 1961 through 1972 recovery of ^{90}Sr and ^{137}Cs for offsite use are from a review of logbooks and monthly reports (Johnson 2003). The inventory of onsite encapsulated waste is from the *WESF Encapsulation Database* (Laughtery 2003). The estimate of capsules dispositioned for offsite use was determined from records provided by Laughtery and reports by Clements (1992a and 1992b).

This evaluation identifies the use of crude ^{90}Sr obtained from B Plant tanks as the source of ^{90}Sr for the Federal Republic of Germany glass canister heat sources. This source appears to have been overlooked in the Petersen and Kupfer material balance studies.

In 1984 B Plant and WESF were directed by DOE to provide ^{90}Sr and ^{137}Cs to the Pacific Northwest Laboratory for manufacture into glass filled canisters as heat and radiation sources for the Federal Republic of Germany. The cesium was provided from WESF capsules and the strontium from crude strontium stored in B Plant. A total of 184 cesium capsules were opened. B Plant processed the recovered CsCl to remove chloride and the crude strontium to remove extraneous metals before shipping the product to the 324 Building. The ^{137}Cs inventory of the cut up capsule was determined from WESF records. The quantity of crude ^{90}Sr product removed from B Plant storage tanks could not be determined directly from records and was estimated as being proportional to the ^{137}Cs recovered from the cut up cesium capsules. Table 2 summarizes the ^{90}Sr and ^{137}Cs material balance for this activity.

Table 2. Strontium-90 and Cesium-137 Material Balance for Production of Federal Republic of Germany Glass Canister Heat and Radiation Sources.

Source Inventory and Disposition	Sr-90 (MCi)	Cs-137 (MCi)	Reference or Basis
Sr-90 crude from B Plant	3.48	--	Estimated Value – assumed to be proportional to Cs-137
Cut up Cs-137 capsules	--	4.72	Clements (1992a) and Laughtery (2003)
B Plant purification losses returned to tank farms	0.17	0.24	Rogers (1984), the maximum allowable purification losses were 5%
Federal Republic of	2.63	3.57	Holton (1989)

Germany glass canister heat sources			
Residual 324 Building Inventory	0.68	0.91	Estimated Value – calculated by difference

The Petersen material balance estimates that cleanout of B Plant will return 0.2 to 0.7 MCi ^{90}Sr and 0.9 to 2.8 MCi ^{137}Cs to the tanks. This evaluation discounts this assumption. According to the *B Plant – Cleanout and Stabilization Program Update FY 1994* (Gehrke 1994) aqueous inventories were removed from B Plant in 1993 and the plant had been flushed of readily removable material. Residual B Plant inventories consisted of contaminated organic solvents, contaminated filters and contaminated equipment and cell walls. The radioactive inventory in these wastes are unlikely to be returned to the tanks and will predominantly be disposed of as solid waste.

Table 3 summarizes this evaluation of the disposition of ^{137}Cs and ^{90}Sr from irradiated fuel reprocessed by the Hanford Site.

Table 3. Hanford Reprocessing Plants Cesium-137 and Strontium-90 Material Balance (Decayed to January 1, 2001)

Source Inventory and Disposition	Sr-90 (MCi)	Cs-137 (MCi)	Reference
ORIGEN2 Estimates for Hanford Reprocessing Plants	87.86	104.06	Watrous et al. (2002)
Cesium and Strontium Recovery Prior to B Plant Waste Fractionization			
Shipped offsite from PUREX cask station to ORNL (1961-1962)	0.022	0.34	Johnson (2003) and Chapman (1967)
Shipped offsite from Hot-Semiworks to ORNL, NYO, and BNW (1961-1967)	3.33	0	Johnson (2003) and Chapman (1967)
241-C-801 cask station (1963-1968) cask loading	0	1.73	Johnson (2003) and Chapman (1967)
Subtotal	3.35	2.07	
Cesium and Strontium Recovery during B Plant Fractionization			
212-B Cask station loadout (Rare Earth crude and 1st cycle IX product) shipped to ORNL & BNW (1968-1972)	0.84	0.46	Johnson (2003) and Chapman (1967)
Cs-137 and Sr-90 capsules stored in WESF	20.33	47.34	Langhtery (2003)
Encapsulated Cs-137 and Sr-90 dispositioned for offsite use	2.12	2.47	Clements (1992a and 1992b), and Laughtery (2003)

Residual B Plant and WESF Contamination	0.88	2.64	Kupfer et al. (1999)
Federal Republic of Germany glass canister heat sources	2.63	3.57	Holton (1989)
Residual 324 Building Inventory	0.68	0.91	From Table 2.
Solid Waste (primarily from B Plant and WESF)	0.88	1.15	Petersen (1996)
Subtotal	28.36	58.54	
Other Removals and Additions to Tank Farms			
Returns from 324 Building Clean Out	None	None	Disposed as solid waste
Estimated Future Returns from B Plant Clean Out	None	None	Assumed to be disposed of as solid waste.
Crib discharges	0.01	0.01	Waite (1991)
Leaks and Spills	0.0	0.06	Waite (1991)
Subtotal	0.01	0.07	
Current Estimated Tank Inventory	56.14	43.38	

This evaluation concludes that of the original 87.9 MCi ^{90}Sr and 104.1 MCi ^{137}Cs generated, only 56.1 MCi ^{90}Sr and 43.4 MCi ^{137}Cs remain in the tanks. Table 4 summarizes the overall disposition.

Table 4. Current Estimate of the Hanford Site Strontium-90 and Cesium-137 Disposition (Decayed to January 1, 2001).

Source Inventory and Disposition	Sr-90 (MCi)[a]	Cs-137 (MCi)[a]
Inventory in Fuel Processed	87.9	104.1
Capsules currently at the Hanford Site	20.3	47.3
Offsite Shipments	6.3	5.0
Solid Waste, Cribs, and Leaks	4.2	5.7
Residual B Plant, and WESF Contamination	0.9	2.6
Residual Tank Inventory	56.1	43.4

(a) Values have been rounded to the nearest 0.1 MCi.

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From: Data Development and Interpretation 7G300-02-JGF-010
Phone: 373-6250
Date: October 21, 2002
Subject: SOLUBILITY CALCULATIONS

To: J. G. Field R2-12

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D. J. Washenfelder	R2-12
R. A. Watrous	R3-75
S. R. Wilmarth	R2-12

References:
1. Tank Waste Information Network System (TWINS), [Sample Analysis / Tank Results Consolidated], <http://twins.pnl.gov:8001/datamenu.htm>.
2. LA-UR-94-3590, Stephen F. Agnew and John G. Watkin, "Estimation of Limiting Solubilities for Ionic Species in Hanford Tank Supernates," October 1994, Los Alamos National Laboratory, Los Alamos, New Mexico.

This letter provides solubility estimates using data from the Tank Waste Information Network System (Reference 1). The statistics are based on the method first applied in "Estimation of Limiting Solubilities for Ionic Species in Hanford Tank Supernates" (Reference 2). The original analysis used data from May 1963 to October 1993. The data for the new calculations includes post-1989 results up to August 6, 2002.

The method for estimating solubility uses trimmed averages. Specifically, the calculations are done on "trimmed data" created by discarding either 50% or 75% of the lowest observations (by constituent). The trimmed averages, along with 99% lower and upper confidence limits, represent the "limiting solubility," as described in the 1994 report.

Confidence limits are computed using the standard deviation of values remaining after the lowest numbers are discarded. Assuming the trimmed data is normally distributed, the confidence limits equal the average, plus or minus 2.326 times the standard deviation of the mean. Table 1 shows the original output for aluminum (Reference 2). The data behind the Table 1 results is from Table 1A of Attachment 1.

Table 1. Original Solubility Estimates for Aluminum*

	50% Discarded		75% Discarded		
	Lower sol. limit	Upper sol. limit	Lower sol. limit	Upper sol. Limit	Total data points
Aluminum (M)	0.97	1.22	1.43	1.74	401[1]

* As reported in Reference 2

[1] This number was 404, but only 401 observations are in the data set; an additional check found that calcium has 79, rather than 78 data points. All other constituents had the correct number of observations.

New estimates were calculated using the data in Table 1B. The results for aluminum are given in Table 2. For 50% discarded data, the new aluminum estimates are higher than the original values. Because of changes in the underlying data, there was a significant change in the estimate. Specifically, the new lower limit (1.35 M) is higher than the old upper limit (1.22 M). The limits based on the 75% discarded data, however, overlap each other. Hence, the 75% trimmed averages are not significantly different.

Table 2. New Solubility Estimates for Aluminum*

	50% Discarded		75% Discarded		
	Lower sol. limit	Upper sol. limit	Lower sol. Limit	Upper sol. limit	Total data points
Aluminum (M)	1.34	1.45	1.68	1.82	923

* Using data for non-complexed waste

Eighty-six tanks have liquid data. Four tanks have highly "complexed" liquid: AN-102, AN-107, U-105, and U-106. For purposes of this solubility limit evaluation, other tanks are regarded as non-complexed liquid. Attachment 2 has the summary statistics and graphs grouped by liquid type. Statistics include the number of observations, mean, and standard deviation of the mean, for all observations plus the 50% and 75% discarded data. To produce lower and upper limits (as in the aluminum example) convert to molarity, then add and subtract 2.326 times the standard deviation of the mean. The last step requires the assumption that the sample averages are normally distributed.

Graphs show the data by constituent, sorted from lowest to highest, along with lines representing the 50% discarded and 75% discarded averages. Although the new data does not contain any of the old observations and have been screened for outliers, there is still "considerable spread of data at high concentrations", as was originally reported (Reference 2). The spread causes uncertainty in solubility estimates derived from the extreme values. In particular, there is uncertainty in the statistic that best "represents" a solubility limit. This uncertainty is not part of statistical uncertainty based on sample variation.

Steven R. Wilmarth

S. R. Wilmarth, Statistician/Scientist I
Data Development and Interpretation

mev

Attachments - 3

7G300-02-JGF-010

Attachment 1

ALUMINUM DATA

Consisting of 6 pages
including coversheet

Table 1A. Original Aluminum Data (2 sheets)

Row #	Data Sorted From Lowest to Highest, Eight Observations per Row, Units (M)							
1	1.81E-05	3.80E-05	5.90E-05	9.90E-05	0.000138	0.000222	0.000334	0.000354
2	3.96E-04	4.08E-04	4.37E-04	0.000463	0.000515	0.000515	0.000648	0.000717
3	0.000815	0.00102	0.00109	0.00119	0.00127	0.00135	0.00136	0.00138
4	0.00153	0.0016	0.00172	0.00192	0.002	0.00222	0.00229	0.00251
5	0.00257	0.00257	0.00275	0.0028	0.00326	0.005	0.00532	0.00553
6	0.005733	0.006	0.00602	0.00605	0.00691	0.00727	0.0076	0.00783
7	0.00835	0.00861	0.00913	0.00965	0.00996	0.01	0.01	0.01
8	0.011	0.0112	0.0117	0.0118	0.0139	0.0158	0.0164	0.0164
9	0.0186	0.0188	0.0196	0.0202	0.0212	0.022	0.022	0.023
10	0.0232	0.0238	0.024	0.0244	0.0248	0.0252	0.0256	0.026
11	0.0261	0.027	0.0301	0.031	0.0314	0.032	0.0345	0.0355
12	0.036	0.0365	0.0371	0.0383	0.0389	0.039	0.0391	0.0406
13	0.0428	0.0439	0.0442	0.0443	0.0454	0.0456	0.046	0.0502
14	0.0505	0.0519	0.053	0.0532	0.0545	0.055	0.0626	0.063
15	0.064	0.0662	0.067	0.0672	0.0697	0.07	0.0702	0.0737
16	0.0765	0.0796	0.081	0.0905	0.097	0.099	0.0991	0.0995
17	0.1	0.102	0.12	0.122	0.1297	0.135	0.135	0.136
18	0.138	0.14	0.147	0.147	0.147	0.1577	0.16	0.1631
19	0.165	0.1664	0.17	0.174	0.174	0.18	0.18	0.188
20	0.189	0.192	0.1949	0.195	0.198	0.198	0.211	0.211
21	0.214	0.219	0.22	0.222	0.224	0.23	0.23	0.238
22	0.244	0.244	0.2444	0.249	0.25	0.257	0.261	0.265
23	0.268	0.274	0.278	0.281	0.283	0.286	0.291	0.292
24	0.294	0.294	0.294	0.296	0.297	0.302	0.325	0.329
25	0.333	0.348	0.348	0.352	0.359	0.362	0.363	0.367
26	0.368	0.368	0.374	0.375	0.376	0.377	0.378	0.383
27	0.386	0.396	0.398	0.4	0.41	0.41	0.41	0.415
28	0.425	0.426	0.432	0.436	0.44	0.44	0.44	0.444
29	0.448	0.461	0.462	0.466	0.468	0.471	0.477	0.477
30	0.481	0.485	0.498	0.5	0.501	0.514	0.52	0.521
31	0.531	0.537	0.54	0.543	0.546	0.548	0.55	0.55
32	0.561	0.565	0.578	0.579	0.589	0.597	0.598	0.601
33	0.611	0.621	0.624	0.624	0.626	0.638	0.642	0.646
34	0.651	0.653	0.667	0.671	0.684	0.69	0.71	0.724
35	0.741	0.742	0.747	0.752	0.754	0.758	0.7635	0.771
36	0.8	0.812	0.812	0.818	0.818	0.823	0.83	0.837
37	0.8413	0.842	0.867	0.87	0.888	0.898	0.9	0.911
38	0.914	0.923	0.924	0.94	0.958	0.9636	0.978	0.978
39	0.982	0.983	0.99	1	1.01	1.02	1.02	1.05
40	1.06	1.06	1.07	1.08	1.08	1.085	1.09	1.09

Table 1A. Original Aluminum Data (2 sheets)

Row #	Data Sorted From Lowest to Highest, Eight Observations per Row, Units (M)							
41	1.11	1.11	1.11	1.13	1.13	1.14	1.15	1.17
42	1.17	1.19	1.206	1.21	1.21	1.21	1.212	1.22
43	1.22	1.26	1.2602	1.3	1.3	1.3	1.34	1.35
44	1.36	1.364	1.37	1.37	1.375	1.39	1.3947	1.4
45	1.4069	1.4084	1.426	1.45	1.46	1.49969	1.52	1.52
46	1.52	1.52	1.53	1.5469	1.55	1.58	1.6	1.6
47	1.61	1.67	1.75	1.758	1.8	1.87	1.91	1.92
48	1.95	2	2	2.06	2.063	2.0703	2.08	2.157
49	2.17	2.185	2.23	2.27	2.325	2.342	2.37	2.41
50	2.42	2.48	2.5	2.54	2.58	2.89	2.959	3.28
51	4.64							

Table 1B. New Aluminum Data (4 sheets)

Row #	Data Sorted From Lowest to Highest, Eight Observations per Row, Units (M)							
1	8.04E-06	2.38E-05	2.42E-05	2.77E-05	2.86E-05	2.86E-05	3.04E-05	3.20E-05
2	3.56E-05	3.62E-05	3.88E-05	4.02E-05	4.08E-05	5.24E-05	8.90E-05	0.000158
3	0.000424	0.00044	0.00044	0.000459	0.000477	0.000484	0.000517	0.000519
4	0.000547	0.000556	0.000582	0.000584	0.000587	0.000597	0.000602	0.000617
5	0.000619	0.000626	0.000638	0.000639	0.000693	0.000701	0.000713	0.000713
6	0.000775	0.00078	0.00078	0.000782	0.0012	0.00122	0.00123	0.00125
7	0.00134	0.00134	0.00152	0.00153	0.00156	0.00158	0.00163	0.00177
8	0.00181	0.00181	0.00182	0.00183	0.00188	0.00192	0.00192	0.00195
9	0.00199	0.00201	0.00203	0.00208	0.00209	0.00214	0.00222	0.00245
10	0.00282	0.00297	0.00329	0.00366	0.00378	0.00378	0.00382	0.00382
11	0.00384	0.00385	0.00389	0.00391	0.0045	0.00489	0.00526	0.00536
12	0.0061	0.0063	0.00634	0.00669	0.00689	0.00699	0.0071	0.00728
13	0.00728	0.00751	0.0076	0.00795	0.00802	0.00812	0.00841	0.00842
14	0.00845	0.00852	0.00873	0.00875	0.0096	0.0099	0.0102	0.0103
15	0.0113	0.0114	0.013	0.0131	0.0138	0.014	0.0161	0.0162
16	0.0165	0.0169	0.0171	0.0176	0.0177	0.0179	0.0179	0.0182
17	0.0186	0.0187	0.0201	0.0202	0.0202	0.0203	0.0204	0.0206
18	0.0208	0.0208	0.0211	0.0212	0.0218	0.0219	0.0225	0.0225
19	0.0229	0.0232	0.0232	0.0239	0.0241	0.0242	0.0243	0.0245
20	0.0246	0.0248	0.0248	0.0249	0.0249	0.0249	0.0249	0.0249
21	0.0251	0.0251	0.0251	0.0251	0.0252	0.0253	0.0253	0.0255
22	0.0257	0.0257	0.0257	0.0257	0.0258	0.0258	0.0259	0.0259
23	0.0259	0.0259	0.0259	0.026	0.0261	0.0261	0.0261	0.0262
24	0.0263	0.0266	0.0276	0.0301	0.0301	0.0309	0.0312	0.0314
25	0.0328	0.0333	0.0344	0.0351	0.0352	0.0354	0.036	0.0362

Table 1B. New Aluminum Data (4 sheets)

Row #	Data Sorted From Lowest to Highest, Eight Observations per Row, Units (M)							
26	0.0373	0.0389	0.0393	0.0395	0.0395	0.0404	0.0415	0.0443
27	0.045	0.045	0.0458	0.0458	0.046	0.0467	0.0471	0.0474
28	0.0478	0.048	0.0489	0.0495	0.0495	0.05	0.0504	0.0506
29	0.0508	0.0511	0.0511	0.0517	0.0517	0.0519	0.0519	0.0526
30	0.0537	0.0563	0.0573	0.0573	0.0574	0.058	0.0612	0.0636
31	0.0658	0.0671	0.068	0.0682	0.0723	0.0728	0.0838	0.0869
32	0.0873	0.089	0.0895	0.0958	0.0966	0.0977	0.0977	0.0986
33	0.101	0.104	0.106	0.106	0.107	0.11	0.114	0.116
34	0.119	0.12	0.122	0.123	0.127	0.128	0.128	0.128
35	0.128	0.129	0.135	0.136	0.136	0.137	0.137	0.139
36	0.146	0.15	0.152	0.156	0.158	0.16	0.164	0.165
37	0.169	0.17	0.174	0.175	0.184	0.184	0.187	0.188
38	0.189	0.196	0.217	0.222	0.223	0.227	0.227	0.245
39	0.245	0.247	0.251	0.257	0.26	0.261	0.264	0.265
40	0.274	0.275	0.282	0.287	0.288	0.292	0.292	0.293
41	0.293	0.295	0.297	0.298	0.298	0.299	0.3	0.301
42	0.302	0.304	0.305	0.306	0.306	0.307	0.307	0.308
43	0.308	0.309	0.309	0.31	0.311	0.312	0.313	0.315
44	0.315	0.316	0.316	0.316	0.317	0.317	0.319	0.319
45	0.32	0.323	0.324	0.328	0.33	0.33	0.331	0.333
46	0.333	0.339	0.34	0.342	0.343	0.343	0.344	0.344
47	0.344	0.344	0.35	0.351	0.36	0.362	0.366	0.369
48	0.37	0.371	0.372	0.374	0.391	0.395	0.4	0.404
49	0.404	0.406	0.406	0.408	0.41	0.41	0.411	0.411
50	0.413	0.417	0.421	0.421	0.421	0.423	0.424	0.424
51	0.426	0.426	0.426	0.426	0.428	0.428	0.428	0.428
52	0.43	0.43	0.434	0.434	0.434	0.434	0.434	0.436
53	0.439	0.441	0.441	0.443	0.447	0.456	0.458	0.46
54	0.461	0.463	0.463	0.469	0.469	0.471	0.471	0.474
55	0.484	0.487	0.493	0.5	0.5	0.504	0.508	0.51
56	0.511	0.511	0.517	0.519	0.521	0.521	0.526	0.537
57	0.545	0.545	0.547	0.547	0.549	0.554	0.562	0.562
58	0.565	0.571	0.573	0.602	0.619	0.627	0.631	0.638
59	0.641	0.645	0.647	0.649	0.654	0.656	0.658	0.662
60	0.673	0.691	0.693	0.695	0.71	0.715	0.717	0.722
61	0.723	0.724	0.725	0.725	0.732	0.738	0.738	0.741
62	0.743	0.745	0.749	0.752	0.756	0.762	0.767	0.777
63	0.778	0.782	0.784	0.784	0.786	0.791	0.793	0.795
64	0.81	0.818	0.821	0.823	0.824	0.827	0.83	0.834
65	0.838	0.84	0.843	0.852	0.856	0.856	0.871	0.878
66	0.878	0.88	0.895	0.903	0.91	0.919	0.923	0.927

Table 1B. New Aluminum Data (4 sheets)

Row #	Data Sorted From Lowest to Highest, Eight Observations per Row, Units (M)							
67	0.928	0.93	0.93	0.935	0.938	0.938	0.938	0.943
68	0.945	0.949	0.949	0.953	0.953	0.96	0.964	0.973
69	0.98	0.984	0.986	0.99	0.99	0.991	0.995	0.997
70	1	1	1.01	1.01	1.02	1.02	1.02	1.02
71	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04
72	1.04	1.05	1.05	1.06	1.06	1.06	1.06	1.06
73	1.07	1.07	1.07	1.07	1.08	1.08	1.09	1.1
74	1.1	1.1	1.1	1.11	1.11	1.11	1.11	1.12
75	1.12	1.12	1.12	1.13	1.13	1.14	1.14	1.14
76	1.15	1.15	1.15	1.15	1.16	1.16	1.16	1.16
77	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17
78	1.18	1.18	1.18	1.19	1.19	1.19	1.19	1.19
79	1.19	1.2	1.2	1.2	1.2	1.2	1.2	1.2
80	1.2	1.2	1.2	1.2	1.21	1.21	1.21	1.21
81	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22
82	1.22	1.23	1.23	1.24	1.25	1.26	1.26	1.27
83	1.27	1.27	1.28	1.28	1.28	1.28	1.29	1.29
84	1.29	1.3	1.3	1.3	1.3	1.3	1.31	1.32
85	1.32	1.32	1.32	1.33	1.33	1.33	1.33	1.34
86	1.34	1.35	1.35	1.35	1.35	1.35	1.35	1.36
87	1.36	1.36	1.36	1.36	1.37	1.37	1.37	1.38
88	1.38	1.38	1.38	1.38	1.38	1.39	1.39	1.39
89	1.39	1.39	1.39	1.39	1.39	1.4	1.4	1.4
90	1.4	1.4	1.4	1.4	1.41	1.41	1.41	1.42
91	1.42	1.43	1.43	1.43	1.43	1.43	1.44	1.44
92	1.44	1.44	1.45	1.45	1.46	1.46	1.46	1.46
93	1.47	1.48	1.48	1.49	1.49	1.49	1.49	1.49
94	1.5	1.5	1.5	1.5	1.51	1.51	1.51	1.51
95	1.51	1.51	1.51	1.51	1.51	1.52	1.52	1.52
96	1.52	1.52	1.53	1.53	1.53	1.53	1.53	1.53
97	1.53	1.54	1.54	1.54	1.54	1.54	1.55	1.55
98	1.55	1.55	1.55	1.55	1.56	1.56	1.56	1.56
99	1.57	1.58	1.58	1.59	1.59	1.59	1.59	1.59
100	1.59	1.59	1.6	1.6	1.6	1.61	1.61	1.62
101	1.62	1.62	1.62	1.63	1.63	1.63	1.63	1.63
102	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
103	1.64	1.64	1.65	1.65	1.65	1.65	1.65	1.65
104	1.66	1.66	1.66	1.67	1.67	1.67	1.67	1.68
105	1.68	1.68	1.69	1.69	1.69	1.7	1.7	1.7
106	1.72	1.72	1.72	1.73	1.73	1.74	1.74	1.75
107	1.76	1.76	1.77	1.77	1.78	1.79	1.79	1.8

Table 1B. New Aluminum Data (4 sheets)

Row #	Data Sorted From Lowest to Highest, Eight Observations per Row, Units (M)							
108	1.8	1.81	1.81	1.82	1.83	1.83	1.83	1.84
109	1.85	1.87	1.88	1.88	1.89	1.89	1.9	1.91
110	1.91	1.91	1.92	1.94	1.96	1.98	2	2.01
111	2.01	2.02	2.02	2.03	2.03	2.04	2.04	2.06
112	2.06	2.07	2.07	2.08	2.1	2.1	2.16	2.22
113	2.23	2.24	2.27	2.28	2.28	2.3	2.31	2.32
114	2.34	2.39	2.46	2.48	2.54	2.56	2.57	2.6
115	2.67	2.77	2.82	2.82	2.85	3.02	3.07	3.17
116	3.24	3.27	3.62					

7G300-02-JGF-010

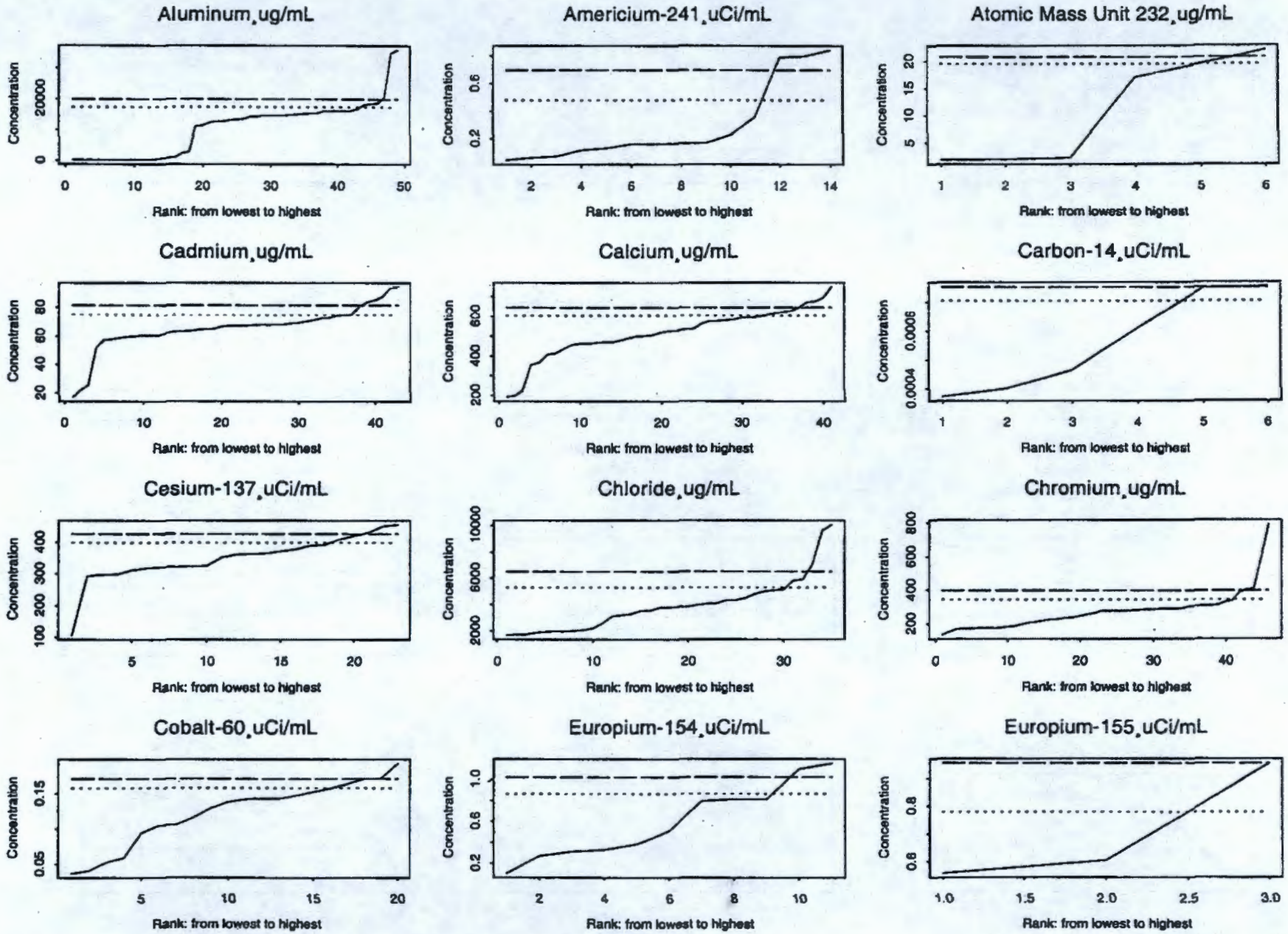
Attachment 2

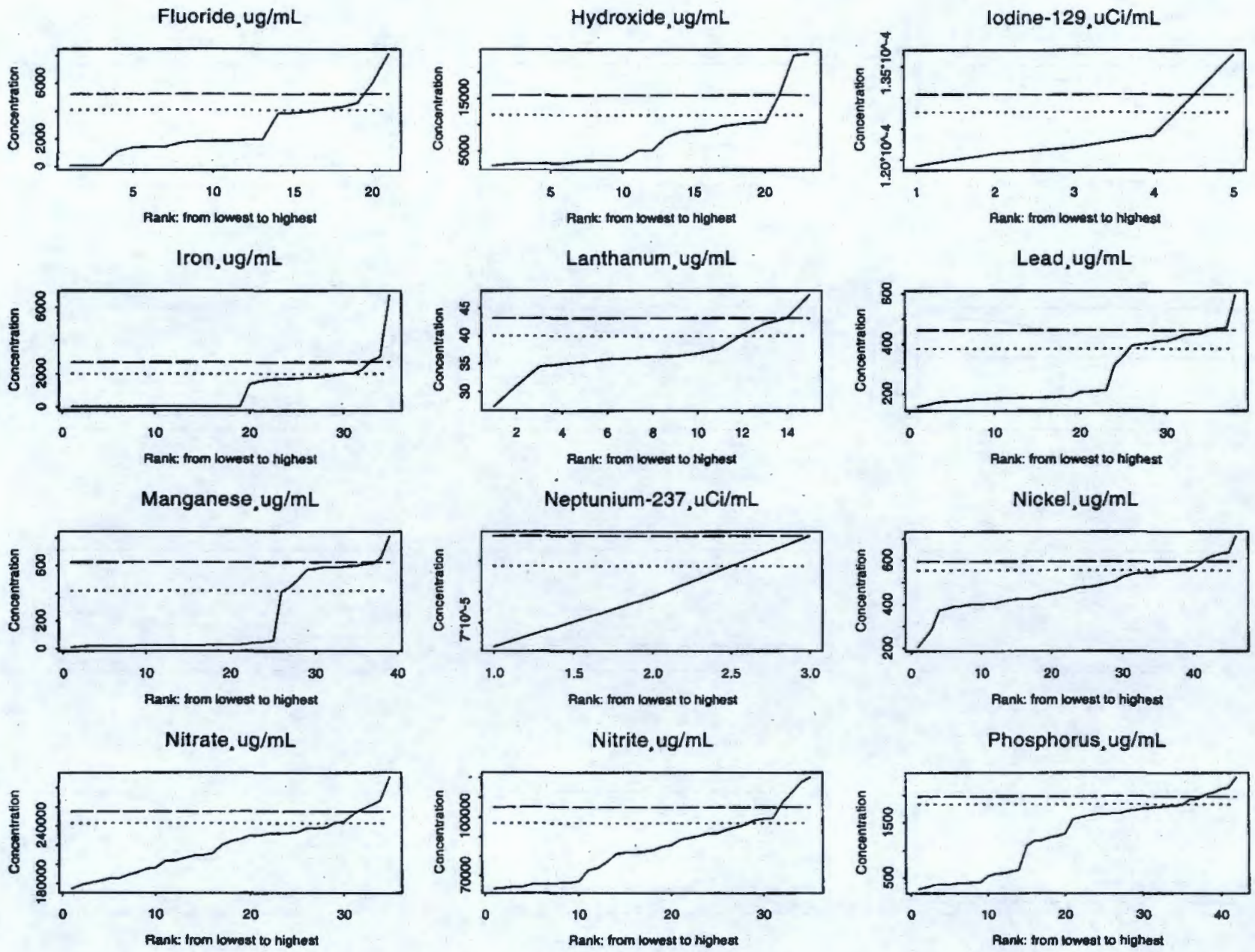
STATISTICS AND GRAPHS

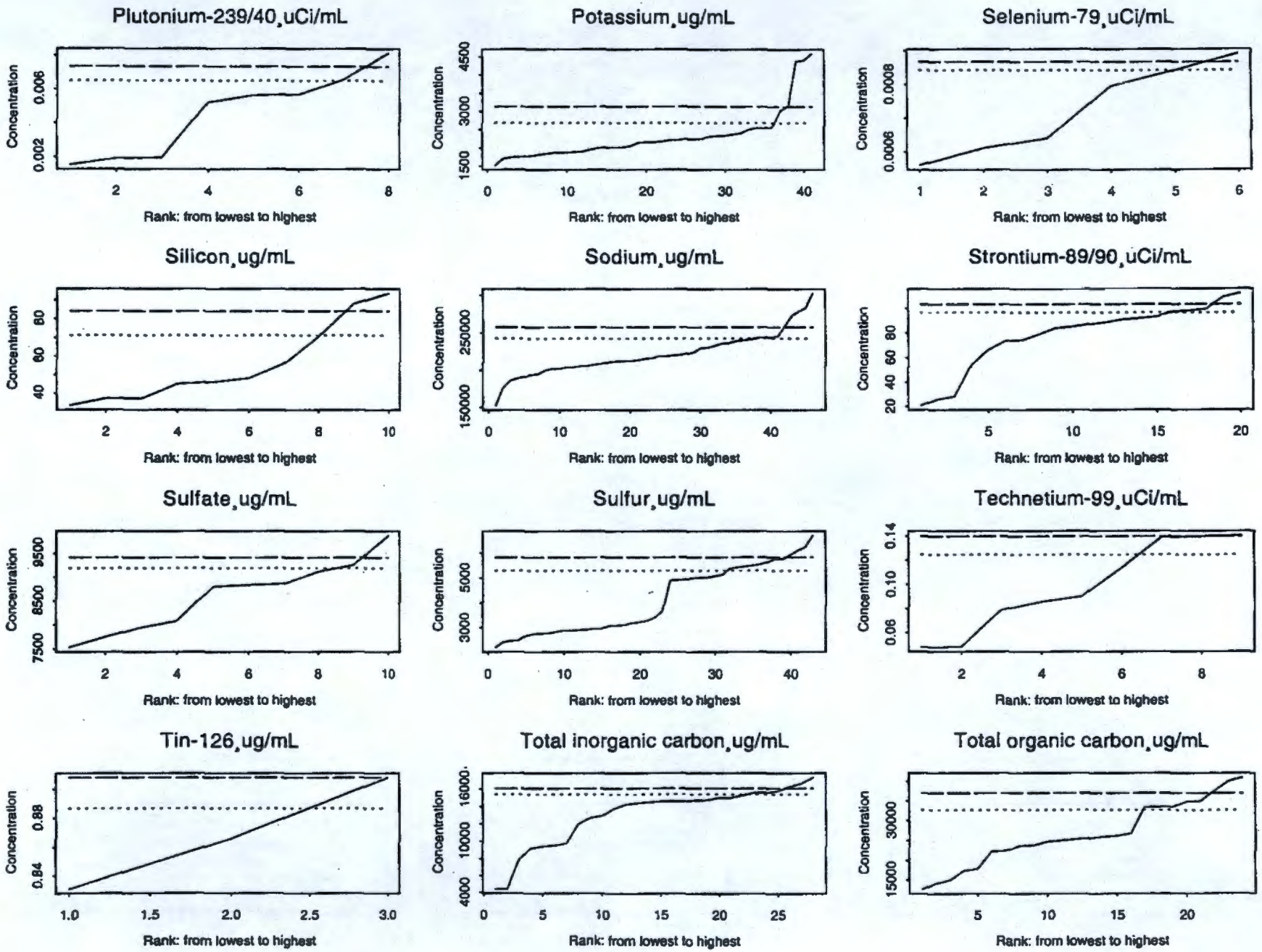
Consisting of 11 pages
including coversheet

Table 2A. Complex Waste Statistics

Constituent	Units	#Obs	Average	SD(Avg)	Avg50	SD(Avg50)	Avg75	SD(Avg75)
Aluminum	ug/mL	49	1.06E+04	1.26E+03	1.73E+04	1.14E+03	1.99E+04	1.95E+03
Americium-241	uCi/mL	14	2.92E-01	7.77E-02	4.77E-01	1.20E-01	6.96E-01	1.14E-01
Atomic Mass Unit 232	ug/mL	6	1.08E+01	3.98E+00	1.96E+01	1.43E+00	2.08E+01	1.21E+00
Cadmium	ug/mL	43	6.56E+01	2.34E+00	7.50E+01	1.84E+00	8.14E+01	2.43E+00
Calcium	ug/mL	41	5.13E+02	1.93E+01	6.04E+02	1.25E+01	6.44E+02	1.41E+01
Carbon-14	uCi/mL	6	5.58E-04	6.95E-05	7.04E-04	4.70E-05	7.51E-04	2.00E-06
Cesium-137	uCi/mL	23	3.51E+02	1.50E+01	3.99E+02	9.71E+00	4.27E+02	9.91E+00
Chloride	ug/mL	35	3.93E+03	3.40E+02	5.30E+03	4.41E+02	6.50E+03	6.75E+02
Chromium	ug/mL	46	2.72E+02	1.68E+01	3.43E+02	2.52E+01	3.98E+02	4.31E+01
Cobalt-60	uCi/mL	20	1.23E-01	1.02E-02	1.58E-01	5.16E-03	1.71E-01	5.83E-03
Europium-154	uCi/mL	11	5.98E-01	1.06E-01	8.62E-01	9.55E-02	1.02E+00	1.06E-01
Europium-155	uCi/mL	3	NA	NA	NA	NA	NA	NA
Fluoride	ug/mL	21	2.67E+03	4.54E+02	4.08E+03	5.65E+02	5.23E+03	6.63E+02
Hydroxide	ug/mL	23	7.66E+03	1.29E+03	1.19E+04	1.71E+03	1.56E+04	2.63E+03
Iodine-129	uCi/mL	5	1.25E-04	3.20E-06	1.28E-04	4.70E-06	1.31E-04	6.50E-06
Iron	ug/mL	35	1.05E+03	2.35E+02	1.99E+03	3.25E+02	2.70E+03	5.18E+02
Lanthanum	ug/mL	15	3.70E+01	1.25E+00	4.00E+01	1.40E+00	4.32E+01	1.50E+00
Lead	ug/mL	38	2.79E+02	2.06E+01	3.81E+02	2.42E+01	4.54E+02	1.66E+01
Manganese	ug/mL	39	2.26E+02	4.42E+01	4.20E+02	5.97E+01	6.23E+02	2.26E+01
Neptunium-237	uCi/mL	3	NA	NA	NA	NA	NA	NA
Nickel	ug/mL	46	4.75E+02	1.49E+01	5.55E+02	1.23E+01	5.95E+02	1.43E+01
Nitrate	ug/mL	35	2.20E+05	4.84E+03	2.43E+05	4.02E+03	2.55E+05	5.63E+03
Nitrite	ug/mL	35	8.43E+04	2.73E+03	9.69E+04	2.57E+03	1.05E+05	3.20E+03
Phosphorus	ug/mL	42	1.28E+03	9.97E+01	1.84E+03	4.26E+01	1.98E+03	5.11E+01
Plutonium-239/40	uCi/mL	8	4.58E-03	8.72E-04	6.51E-03	5.84E-04	7.35E-03	7.95E-04
Potassium	ug/mL	41	2.31E+03	1.08E+02	2.68E+03	1.63E+02	3.13E+03	2.67E+02
Selenium-79	uCi/mL	6	7.24E-04	5.57E-05	8.43E-04	2.77E-05	8.67E-04	2.45E-05
Silicon	ug/mL	10	5.55E+01	6.79E+00	7.12E+01	8.80E+00	8.41E+01	6.88E+00
Sodium	ug/mL	46	2.21E+05	4.17E+03	2.42E+05	4.69E+03	2.57E+05	6.15E+03
Strontium-89/90	uCi/mL	20	7.79E+01	5.93E+00	9.67E+01	2.64E+00	1.03E+02	3.06E+00
Sulfate	ug/mL	10	8.61E+03	2.37E+02	9.19E+03	1.87E+02	9.41E+03	2.32E+02
Sulfur	ug/mL	43	4.10E+03	2.07E+02	5.30E+03	1.58E+02	5.82E+03	1.19E+02
Technetium-99	uCi/mL	9	9.84E-02	1.24E-02	1.25E-01	1.00E-02	1.40E-01	4.66E-04
Tin-126	ug/mL	3	NA	NA	NA	NA	NA	NA
Total inorganic carbon	ug/mL	28	1.30E+04	6.52E+02	1.54E+04	2.29E+02	1.61E+04	2.74E+02
Total organic carbon	ug/mL	24	2.65E+04	1.65E+03	3.28E+04	1.59E+03	3.70E+04	1.23E+03
Tritium	uCi/mL	3	NA	NA	NA	NA	NA	NA
Zinc	ug/mL	1	NA	NA	NA	NA	NA	NA
Zirconium	ug/mL	31	4.55E+01	7.14E+00	7.95E+01	6.24E+00	9.15E+01	1.10E+01


Aluminum,ug/mL
Americium-241,uCi/mL
Atomic Mass Unit 232,ug/mL
Cadmium,ug/mL
Calcium,ug/mL
Carbon-14,uCi/mL
Cesium-137,uCi/mL
Chloride,ug/mL
Chromium,ug/mL
Cobalt-60,uCi/mL
Europium-154,uCi/mL
Europium-155,uCi/mL
Concentration
Rank: from lowest to highest


Fluoride,ug/mL
Hydroxide,ug/mL
Iodine-129,uCi/mL
Iron,ug/mL
Lanthanum,ug/mL
Lead,ug/mL
Manganese,ug/mL
Neptunium-237,uCi/mL
Nickel,ug/mL
Nitrate,ug/mL
Nitrite,ug/mL
Phosphorus,ug/mL
Concentration
Rank: from lowest to highest


Plutonium-239/40,uCi/mL
Potassium,ug/mL
Selenium-79,uCi/mL
Silicon,ug/mL
Sodium,ug/mL
Strontium-89/90,uCi/mL
Sulfate,ug/mL
Sulfur,ug/mL
Technetium-99,uCi/mL
Tin-126,ug/mL
Total inorganic carbon,ug/mL
Total organic carbon,ug/mL
Concentration
Rank: from lowest to highest

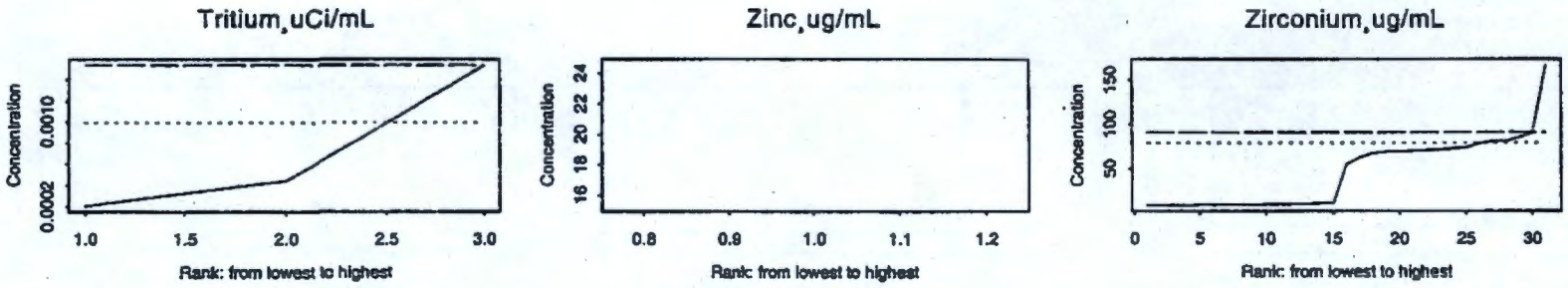
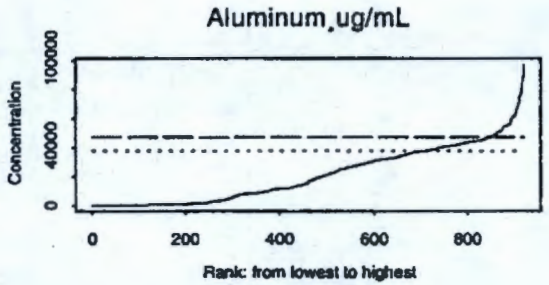
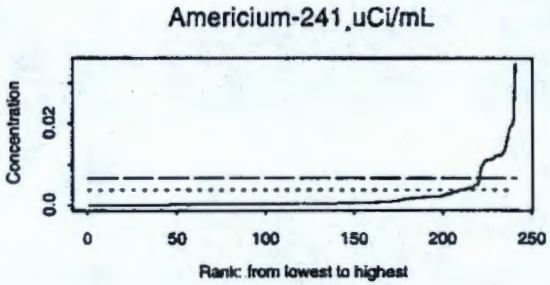
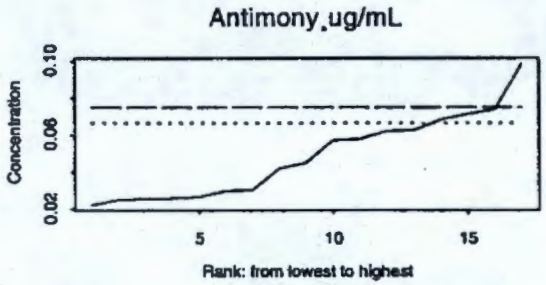

Tritium,uCi/mL
Concentration
0.0002
0.0010
1.0
1.5
2.0
2.5
3.0
Rank: from lowest to highest
Zinc,ug/mL
Concentration
16
18
20
22
24
0.8
0.9
1.0
1.1
1.2
Rank: from lowest to highest
Zirconium,ug/mL
Concentration
50
100
150
0
5
10
15
20
25
30
Rank: from lowest to highest

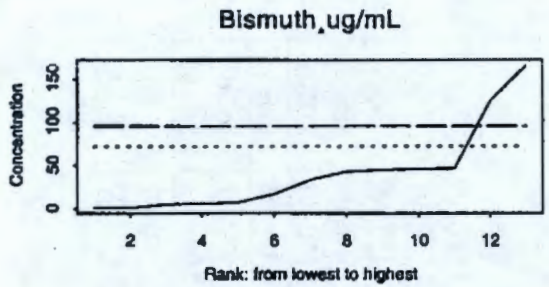
Table 2B. Non-Complex Waste Statistics

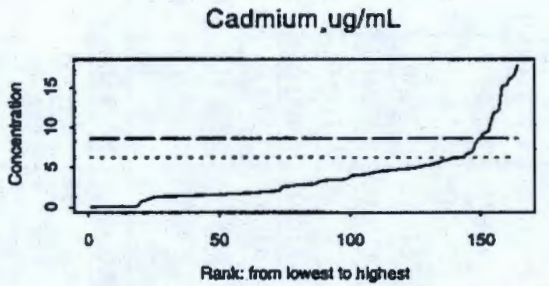
Constituent	Units	#Obs	Average	SD(Avg)	Avg50	SD(Avg50)	Avg75	SD(Avg75)
Aluminum	ug/mL	923	2.10E+04	6.35E+02	3.77E+04	5.97E+02	4.73E+04	7.03E+02
Americium-241	uCi/mL	241	1.95E-03	2.75E-04	3.71E-03	4.98E-04	6.73E-03	8.23E-04
Antimony	ug/mL	17	4.87E-02	5.46E-03	6.65E-02	4.95E-03	7.51E-02	6.17E-03
Bismuth	ug/mL	13	4.18E+01	1.39E+01	7.22E+01	1.95E+01	9.60E+01	2.98E+01
Cadmium	ug/mL	164	3.82E+00	2.83E-01	6.27E+00	4.08E-01	8.60E+00	6.26E-01
Calcium	ug/mL	175	7.47E+01	4.30E+00	1.19E+02	4.81E+00	1.50E+02	6.32E+00
Carbon-14	uCi/mL	140	4.12E-04	4.25E-05	6.91E-04	6.99E-05	9.59E-04	1.24E-04
Cesium-137	uCi/mL	508	3.32E+02	2.13E+01	5.96E+02	3.54E+01	9.25E+02	5.68E+01
Chloride	ug/mL	874	4.60E+03	1.44E+02	8.26E+03	1.40E+02	1.06E+04	1.33E+02
Chromium	ug/mL	886	8.91E+02	7.06E+01	1.69E+03	1.30E+02	2.88E+03	2.35E+02
Cobalt-60	uCi/mL	60	1.27E-02	1.70E-03	2.30E-02	2.07E-03	3.24E-02	2.11E-03
Curium-243/244	uCi/mL	3	NA	NA	NA	NA	NA	NA
Europium	ug/mL	3	NA	NA	NA	NA	NA	NA
Fluoride	ug/mL	568	1.73E+03	1.34E+02	3.13E+03	2.40E+02	5.20E+03	4.13E+02
Hydroxide	ug/mL	397	2.68E+04	1.13E+03	4.50E+04	1.24E+03	5.76E+04	1.62E+03
Iodine-129	uCi/mL	61	1.59E-04	1.16E-05	2.25E-04	1.39E-05	2.80E-04	1.74E-05
Iron	ug/mL	119	3.48E+01	5.55E+00	6.59E+01	9.44E+00	1.05E+02	1.52E+01
Lanthanum	ug/mL	20	1.01E-01	7.34E-03	1.27E-01	4.20E-03	1.39E-01	1.51E-03
Lead	ug/mL	155	8.69E+01	4.11E+00	1.30E+02	2.92E+00	1.49E+02	3.03E+00
Manganese	ug/mL	63	1.09E+01	2.08E+00	1.91E+01	3.54E+00	3.11E+01	5.71E+00
Mercury	ug/mL	35	3.25E-01	1.15E-01	6.40E-01	2.04E-01	1.12E+00	3.35E-01
Neptunium-237	uCi/mL	27	1.97E-04	3.46E-05	3.27E-04	4.25E-05	4.69E-04	2.61E-05
Nickel	ug/mL	211	4.56E+01	3.22E+00	7.50E+01	4.88E+00	1.07E+02	7.54E+00
Nitrate	ug/mL	887	1.12E+05	2.81E+03	1.80E+05	2.82E+03	2.17E+05	4.24E+03
Nitrite	ug/mL	903	6.68E+04	1.77E+03	1.11E+05	1.75E+03	1.42E+05	1.62E+03
Phosphorus	ug/mL	800	9.52E+02	4.04E+01	1.58E+03	6.70E+01	2.19E+03	1.19E+02
Plutonium-239/40	uCi/mL	185	1.68E-03	4.23E-04	3.29E-03	8.10E-04	6.25E-03	1.49E-03
Potassium	ug/mL	839	7.68E+03	3.56E+02	1.33E+04	5.93E+02	2.14E+04	8.80E+02
Protactinium-231	ug/mL	7	1.37E-01	1.61E-02	1.70E-01	6.12E-03	1.80E-01	2.75E-03
Ruthenium	ug/mL	43	1.83E+01	2.26E+00	3.05E+01	2.14E+00	3.70E+01	2.63E+00
Selenium-79	uCi/mL	71	5.40E-04	5.94E-05	9.50E-04	6.16E-05	1.21E-03	7.14E-05
Silicon	ug/mL	745	1.39E+02	4.19E+00	2.23E+02	5.40E+00	2.95E+02	7.62E+00
Sodium	ug/mL	950	1.49E+05	2.96E+03	2.32E+05	1.22E+03	2.52E+05	7.79E+02
Strontium	ug/mL	7	1.93E+00	1.11E+00	3.33E+00	1.67E+00	5.66E+00	2.26E+00
Strontium-90	uCi/mL	454	7.55E-01	7.04E-02	1.46E+00	1.24E-01	2.57E+00	1.98E-01
Sulfur	ug/mL	767	1.59E+03	6.12E+01	2.64E+03	9.49E+01	3.96E+03	1.31E+02
Technetium-99	uCi/mL	260	1.17E-01	6.41E-03	1.94E-01	8.08E-03	2.64E-01	9.65E-03
Thorium-232	ug/mL	10	7.94E-01	2.92E-01	1.35E+00	4.79E-01	2.03E+00	4.27E-01
Tin-126	ug/mL	9	4.70E-01	8.99E-02	6.56E-01	9.83E-02	7.78E-01	1.10E-01
Total inorganic carbon	ug/mL	453	3.67E+03	1.40E+02	5.66E+03	2.02E+02	7.67E+03	2.97E+02
Total organic carbon	ug/mL	377	2.87E+03	1.27E+02	4.59E+03	1.71E+02	5.98E+03	2.72E+02
Tritium	uCi/mL	101	8.11E-03	1.22E-03	1.42E-02	2.09E-03	2.23E-02	3.42E-03
Uranium	ug/mL	158	1.03E+01	1.47E+00	1.87E+01	2.57E+00	3.10E+01	4.34E+00
Zirconium	ug/mL	121	1.21E+01	1.31E+00	1.91E+01	2.26E+00	2.68E+01	3.98E+00

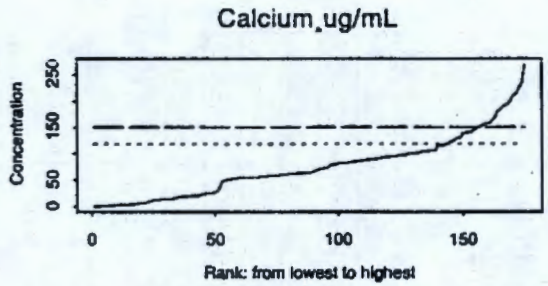

Aluminum,ug/mL
Concentration
0
40000
100000
0
200
400
600
800
Rank: from lowest to highest

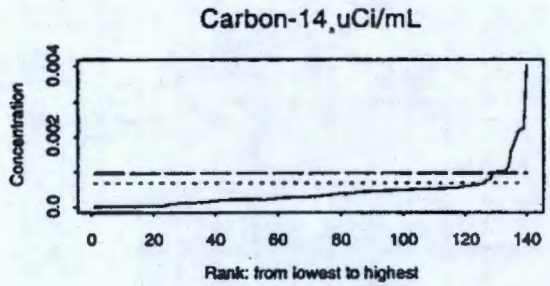

Americium-241,uCi/mL
Concentration
0.0
0.02
0
50
100
150
200
250
Rank: from lowest to highest

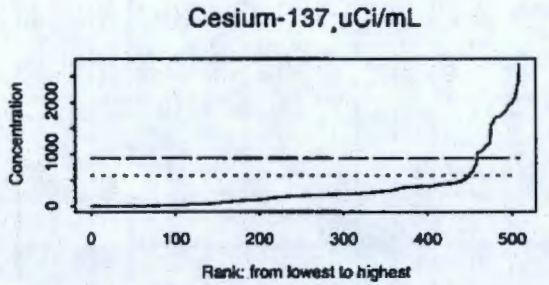

Antimony,ug/mL
Concentration
0.02
0.06
0.10
5
10
15
Rank: from lowest to highest

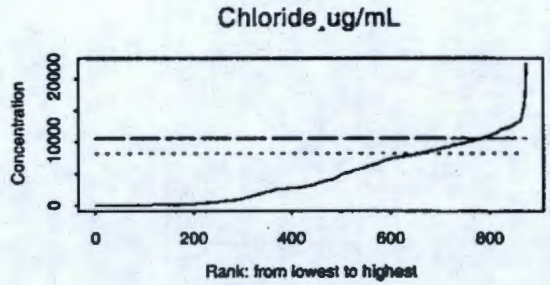

Bismuth,ug/mL
Concentration
0
50
100
150
2
4
6
8
10
12
Rank: from lowest to highest

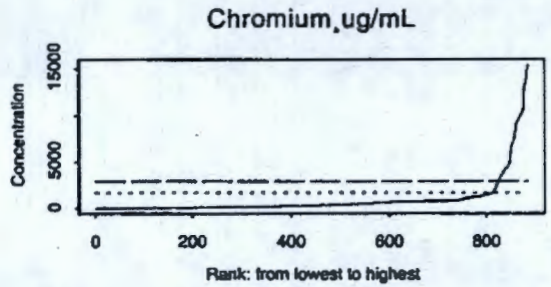

Cadmium,ug/mL
Concentration
0
5
10
15
0
50
100
150
Rank: from lowest to highest

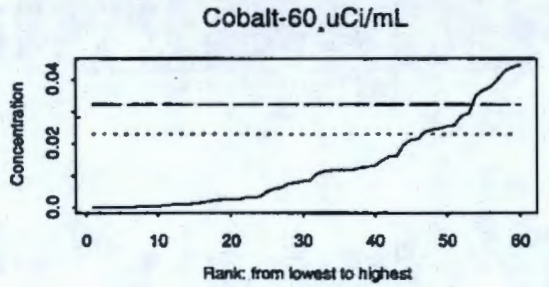

Calcium,ug/mL
Concentration
0
50
150
250
0
50
100
150
Rank: from lowest to highest

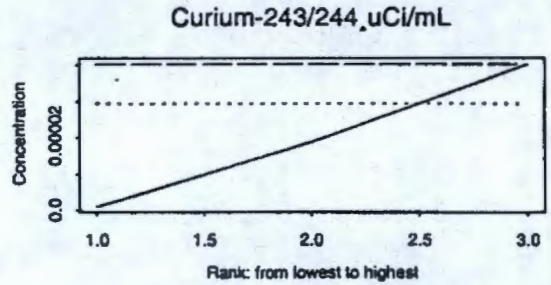

Carbon-14,uCi/mL
Concentration
0.0
0.002
0.004
0
20
40
60
80
100
120
140
Rank: from lowest to highest

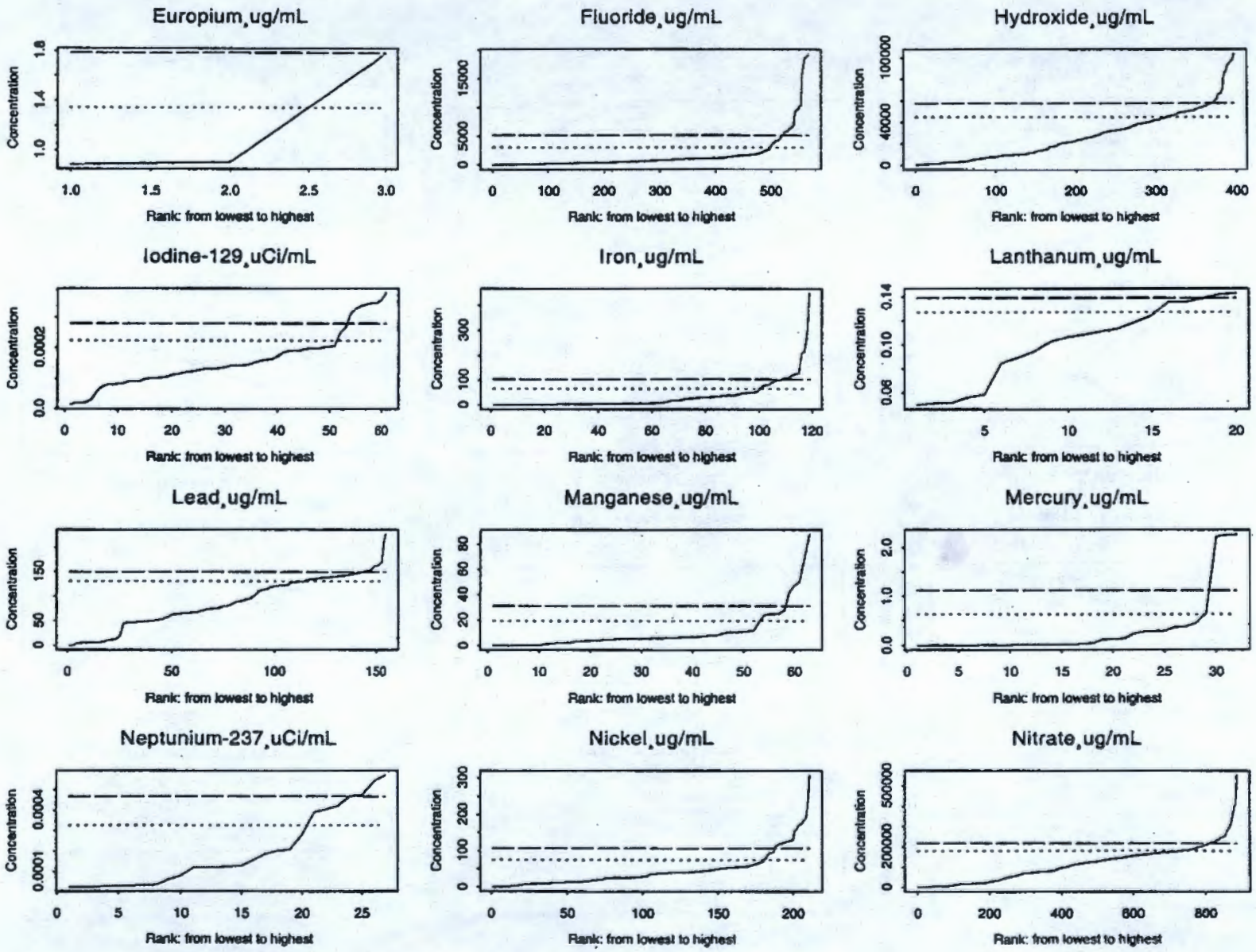

Cesium-137,uCi/mL
Concentration
0
1000
2000
0
100
200
300
400
500
Rank: from lowest to highest

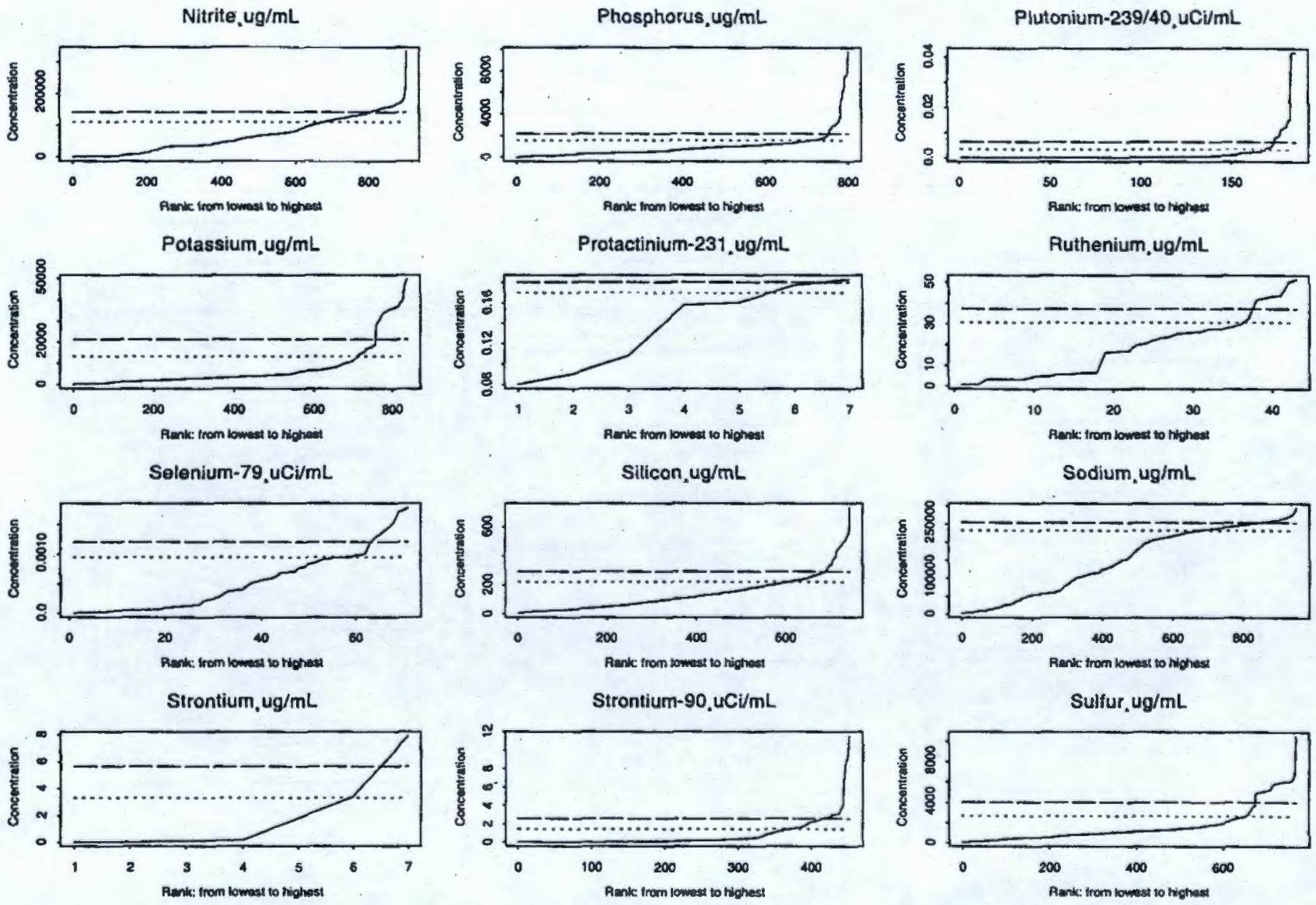

Chloride,ug/mL
Concentration
0
10000
20000
0
200
400
600
800
Rank: from lowest to highest

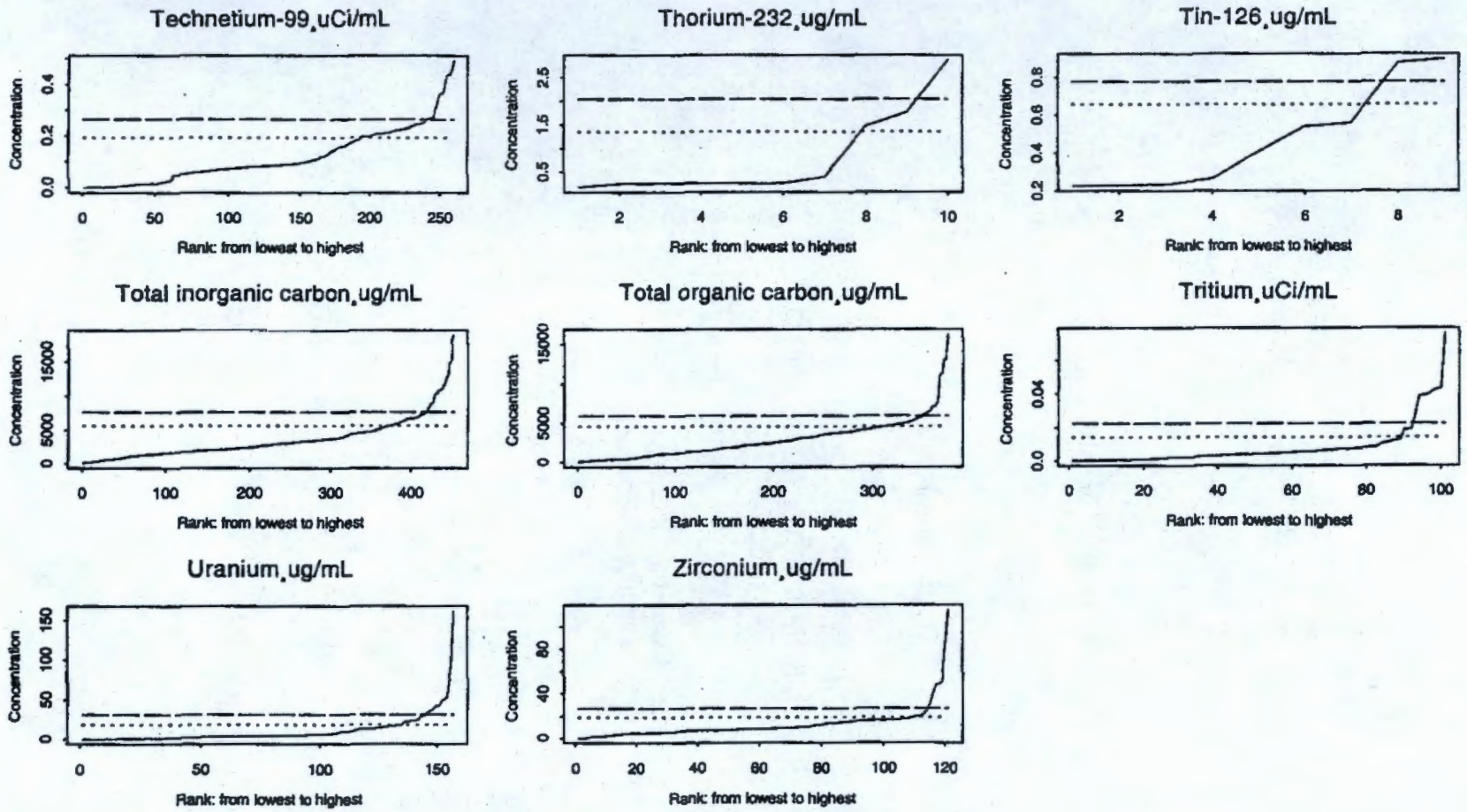

Chromium,ug/mL
Concentration
0
5000
15000
0
200
400
600
800
Rank: from lowest to highest


Cobalt-60,uCi/mL
Concentration
0.0
0.02
0.04
0
10
20
30
40
50
60
Rank: from lowest to highest


Curium-243/244,uCi/mL
Concentration
0.0
0.00002
1.0
1.5
2.0
2.5
3.0
Rank: from lowest to highest


Europium,ug/mL
Fluoride,ug/mL
Hydroxide,ug/mL
Iodine-129,uCi/mL
Iron,ug/mL
Lanthanum,ug/mL
Lead,ug/mL
Manganese,ug/mL
Mercury,ug/mL
Neptunium-237,uCi/mL
Nickel,ug/mL
Nitrate,ug/mL
Concentration
Rank: from lowest to highest


Nitrite,ug/mL
Phosphorus,ug/mL
Plutonium-239/40,uCi/mL
Potassium,ug/mL
Protactinium-231,ug/mL
Ruthenium,ug/mL
Selenium-79,uCi/mL
Silicon,ug/mL
Sodium,ug/mL
Strontium,ug/mL
Strontium-90,uCi/mL
Sulfur,ug/mL
Concentration
Rank: from lowest to highest


Technetium-99,uCi/mL
Thorium-232,ug/mL
Tin-126,ug/mL
Total inorganic carbon,ug/mL
Total organic carbon,ug/mL
Tritium,uCi/mL
Uranium,ug/mL
Zirconium,ug/mL
Concentration
Rank: from lowest to highest

7G300-02-JGF-010

Attachment 3

DESIGN REVIEW CHECKLIST

Consisting of 2 pages
including coversheet

Design Review Checklist for Simple Designs/Simple Design Changes (Routine Engineering Change Notices)

Subject: Calculation check for letter 7G300-02-JGF-010, "Solubility Calculations".

Originator: S. R. Wilmarth Steven R. Wilmarth Date: 10/21/2002

Checker: C. W. Burrup Craig W Burrup Date: 10/21/2002

This document consists of 1 pages and the following attachments (if applicable):
Attachment A: N/A
Attachment B: N/A

Documents/Engineering Change Notices Reviewed: Letter 7G300-02-JGF-010

Affected Document(s) (Optional): N/A

Yes	No	N/A	
[x]	[ ]	[ ]	Were the design inputs correctly selected?
[ ]	[ ]	[x]	Are assumptions necessary to perform the design activity adequately described and reasonable?
[ ]	[ ]	[x]	Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities area completed?
[x]	[ ]	[ ]	Was an appropriate design method used?
[x]	[ ]	[ ]	Were the design inputs correctly incorporated into the design?
[x]	[ ]	[ ]	Is the design output reasonable compared to design inputs?
[ ]	[ ]	[x]	Are the necessary design input and verification requirements for interfacing organizations specified in the design documents or in supporting procedures or instructions?

Checklist Completed By: C. W. Burrup Craig W Burrup Date: 10/21/2002

Notes:

- Confidence Intervals for Aluminum were checked using S-Plus. Notes and S-Plus output are located in \\AP012\Chardocs\All Staff Member\Burrup\7G300-02-JGF-010_CI_checks.doc.
- Tables were spot checked directly against the raw data files.

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INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From: Inventory and Flowsheet Engineering 7G300-02-NWK-023
Phone: 376-5694
Date: July 11, 2002
Subject: TRITIUM PARTITION FACTORS FOR THE HANFORD DEFINED WASTE MODEL

To: File

Copies: K. M. Bowen
D. E. Place
R. A. Watrous
NWK LB/File

The Hanford Defined Waste (HDW) Model is being updated to reflect new information that has become available since Revision 4.0 of the model was published in January 1997. Users of the Best-Basis Inventory are concerned that the model–based inventories for critical, mobile, long-lived radionuclides are unduly conservative and, therefore, designs for waste disposal may be unnecessarily conservative and expensive.

The current version of the HDW Model (Revision 4.0) assumes that all of the tritium (^3H) present in the irradiated fuel exited the separation plants in waste streams that were sent to the tank farms. This assumption is thought to be overly conservative, and that changes to the HDW Model should be made to account for atmospheric emissions and direct discharges to the soil by the separation plants.

The attachment to this letter establishes tritium soil discharge and tank receipt partition factors for the next version of the HDW Model. Other releases to the environment via tank farm evaporators, tank leaks, and direct discharges to cribs are already accounted for by the HDW Model.

Bruce A Higley

Bruce A. Higley
Engineer

jjs

Attachment

7G300-02-NWK-023

Attachment 1

TRITIUM – PLANT EMISSIONS

Consisting of 4 pages
including cover page

TRITIUM – PLANT EMISSIONS.

BACKGROUND

The HDW Model, Revision 4.0, currently assumes that all of the tritium (^3H) present in the irradiated fuel exited the separation plants in waste streams that were sent to the tank farms. This assumption is thought to be overly conservative. The separation plants are known to have released significant fractions of the tritium to the soil. This attachment establishes tritium soil discharge, and tank farm receipt partition factors for the next version of the HDW Model. Releases from the tank farms via tank farm evaporators, leaks or discharges to cribs are currently accounted for by the HDW Model.

This assessment assumes that tritium followed the same chemical paths through the separation processes as water. The primary pathway of interest is discharge of tritium by the separation plants to soil. The most important pathway for release was the process condensates produced by plant evaporators. Although tritium was undoubtedly released to the atmosphere as water vapor, only a very small fraction of the total tritium released is believed to be via this pathway.

BISMUTH PHOSPHATE PROCESS

The Bismuth Phosphate process did not include waste concentrators. However, the process for dissolution of irradiated uranium fuel involved boiling in a nitric acid solution. This operation could have released water (and tritium) to the atmosphere via the plant stack. A review of the flowsheets (GE 1944 and Schneider 1951) indicates that the dissolvers were equiped with reflux condensers. By examination of the reported liquid volumes before and after fuel dissolution, it is apparent that the reflux condensers were efficient and essentially all of the water remained in the dissolvers. Thus the net fraction of tritium sent to the tank farms by the Bismuth Phosphate process is 1.0.

TRIBUTYL PHOSPHATE PROCESS

The Tributyl Phosphate process was used to separate uranium from metal waste (MW) retrieved from the underground storage tanks. The aqueous raffinate from the extraction column was concentrated before being returned to the tank farms. Process condensate from the waste concentrator was sent to cribs. The TBP plant waste concentrator generated 60.9 L/min. of process condensate and 104 L/min. of evaporator bottoms (GE 1951a). The evaporator bottoms had a specific gravity of 1.398 g/ml. and a water content of 56.2 wt%. Roughly 57% of water went to the waste tanks and 43% to the cribs or vessel vent system. The net fraction of tritium sent to the tanks is 0.57.

REDOX PROCESS

The REDOX plant underwent several significant equipment and flowsheet changes over the plant's fifteen-year operating life. Six REDOX process flowsheets were issued (Nos. 4 through 9) between 1951 and 1966 (GE 1951b, Merrill and Stevenson 1955, Crawley and Harmon 1960, Issacson 1965, and Boldt 1966).

Ideally it would be desirable to assign specific time periods and fuel quantities reprocessed to each of the six flowsheets. This is not practical since the date of application of the various flowsheets is uncertain. New flowsheets frequently documented changes already in place or documented pending equipment changes.

REDOX 1952-1958 The 1952-1958 campaign is based on the No. 5 REDOX flowsheet which was issued in August 1955 (Merrill and Stevenson 1955). This flowsheet reflects a chronology of plant and process improvements implemented between 1952 and 1955 subsequent to the *REDOX Technical Manual* (GE 1951b) being issued. Virtually all of the tritium in the irradiated uranium fuel core would have followed the HA column waste to the D-12 waste concentrator. The D-12 waste concentrator generated 178 L/min. of process condensate and 110 L/min. of evaporator bottoms. The evaporator bottoms had a specific gravity of 1.415 and a water content of 57.8 wt%. Roughly 34% of the water went to the waste tanks and 66% to the cribs or vessel vent system. The net fraction of tritium sent to the tanks is 0.34.

REDOX 1959-1967 The 1959-1967 campaign is based on the No. 6 REDOX flowsheet which was issued in October 1960 (Crawley and Harmon 1960). Virtually all of the tritium in the irradiated uranium fuel core would have followed the 1A column waste to the D-12 waste concentrator. The D-12 waste concentrator generated 150 L/min. of process condensate and 102 L/min. of evaporator bottoms. The evaporator bottoms had a specific gravity of 1.42 and a water content of 58.3 wt%. Roughly 42% of the water went to the waste tanks and 58% to the cribs or vessel vent system. The net fraction of tritium sent to the tanks is 0.42.

PUREX

The primary pathways for tritium out of the PUREX process are via the neutralized HLW and the process condensates from the acid absorber and the vacuum fractionator. All of the other pathways, backcycle concentrator condensate, organic wash waste, UNH product, etc. are believed to account for less than 1% of the tritium entering the plant.

PUREX 1956-1967 The 1956 to 1967 campaign is based on *PUREX Two-Cycle Flowsheet* (Swift and Irish 1957). Based on a review of the stream flows in the waste concentration and acid recovery section, and assuming 100% recycle of the AFA recovered acid to the headend of the PUREX plant, the process condensate streams from the acid absorber and vacuum fractionator would have contained over 98% of the tritium in the irradiated fuel. Only 1.1% of the tritium went to the underground tanks. The net fraction of tritium sent to the tanks is 0.011.

PUREX 1968-1972 The 1968 to 1972 campaign is based on *PUREX Chemical Flowsheet – Processing of Aluminum-Clad Uranium Fuels* (Matheison and Nicholson 1968). The process condensate streams from the acid absorber and vacuum fractionator would have contained over 97% of the tritium entering the PUREX plant. Only 2.8% of the tritium went to the underground tanks. The net fraction of tritium sent to the tanks is 0.028.

PUREX 1983-1988 The 1983 to 1988 campaign is based on *PUREX Process Flowsheet – Processing of N Reactor Fuels* (Jacobs and Allen 1985). Unlike previous flowsheets, this flowsheet included recycle of significant amounts of process condensate. Only 12.8% of tritium went to the underground tanks. The net fraction of tritium sent to the tanks is 0.128.

REFERENCES

Boldt, A. L., 1966, *REDOX Chemical Flowsheet – HW No. 9*, ISO-335, Isochem, Richland, Washington.

Crawley, D. T., M. K. Harmon, 1960, *REDOX Chemical Flowsheet – HW No. 6*, HW-66203, General Electric Company, Richland, Washington.

GE, 1944, *Hanford Works Technical Manual Section C- Separations (Bismuth Phosphate Manual)*, HW-10475C, Hanford Engineering Works, General Electric Company, Richland, Washington

GE, 1951a, *Uranium Recovery Technical* Manual, HW-19140, General Electric Company, Richland, Washington

GE, 1951b, *REDOX Technical Manual*, HW-18700, General Electric Company, Richland, Washington

Issacson, R. E., 1965, *REDOX Chemical Flowsheet – HW No. 7 and 8*, RL-SEP-243, General Electric Company, Richland, Washington.

Jacobs, L. L., and G. K. Allen, 1985, *PUREX Process Flowsheet – Processing of N Reactor Fuels*, PFD P-020-00001, Rev A-8, Westinghouse Hanford Company, Richland, Washington.

Matheison, W. E., and G. A. Nicholson, 1968, *PUREX Chemical Flowsheet – Processing of Aluminum-Clad Uranium Fuels*, ARH-214-DEL, Atlantic Richfield Hanford Company, Richland, Washington.

Merrill, E. T., and R. L. Stevenson, 1955, *REDOX Chemical Flowsheet – HW No. 5*, HW-38684, General Electric Company, Richland, Washington.

Schneider, K. L., 1951, *Flow Sheets and Flow Diagrams of Precipitation Separation* Processes, HW-23043, General Electric Company, Richland, Washington.

Swift, W. H. and E. R. Irish, 1957, *PUREX Two-Cycle Flowsheet*, HW-52389-DEL, General Electric Company, Richland, Washington.

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INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From: Inventory and Flowsheet Engineering 7G300-02-NWK-024
Phone: 376-5694
Date: July 24, 2002
Subject: BISMUTH PHOSPHATE PROCESS RADIONUCLIDE PARTITION FACTORS FOR THE HANFORD DEFINED WASTE MODEL

To: J. G. Field R2-12

Copies: K. M. Bowen
N. W. Kirch NWK
D. E. Place
R. A. Watrous
NWK LB/File

The Hanford Defined Waste (HDW) Model is being updated to reflect new information that has become available since Revision 4.0 of the model was published in January 1997. Users of the Best-Basis Inventory are concerned that the model–based inventories for critical, mobile, long-lived radionuclides are unduly conservative and, therefore, designs for waste disposal may be unnecessarily conservative and expensive.

The Bismuth Phosphate process radionuclide partition factors used by the current version of the HDW Model (Revision 4.0) have become suspect for a number of reasons. Currently the Integrated Groundwater Vadose Zone Project is sponsoring a laboratory simulation of the Bismuth Phosphate process chemistry in an attempt to better understand the fate of radionuclides in the Bismuth Phosphate process. Although preliminary results have been obtained, final results from this study will not be available until later this year or early next year. As an interim measure, Bismuth Phosphate process flowsheets and other documents were examined to establish new radionuclide partition factors for use in updating the HDW model. These partition factors are subject to change when experimental data becomes available.

The attachment to this letter establishes new Bismuth Phosphate process partition factors for the next version of the HDW Model. These revised partition factors will redistribute the radionuclides between the tanks that received waste from the Bismuth Phosphate process and are not expected to change the total inventory of the underground storage tanks.

Bruce A Higley

Bruce A. Higley
Engineer

jjs

Attachment

7G300-02-NWK-024

Attachment 1

BISMUTH PHOSPHATE PROCESS RADIONUCLIDE PARTITION FACTORS

Consisting of 17 pages
including cover page

Bismuth Phosphate Process Radionuclide Partition Factors

The Integrated Groundwater Vadose Zone Project is funding a laboratory simulation of the Bismuth Phosphate process through the first cycle decontamination step. Although preliminary results have been obtained, final results from this work will not be available to review until later this year. To facilitate updating of the HDW model, new $BiPO_4$ partition factors have been developed as is discussed in this attachment.

BACKGROUND

The partition factors used by the HDW model for the $BiPO_4$ process have come under suspicion based on contradictory data from the Groundwater Vadose Zone Project that indicates that the HDW model overestimates the fraction of ^{99}Tc that was discharged with the first cycle (1C) waste.

The partition factors used by Revision 4.0 of the HDW model to distribute radionuclides are summarized in Table 1.

Table 1. HDW Model Distribution of Radionuclides for the Bismuth Phosphate Process.

Radionuclide	Metal Waste (MW)	First Cycle and Coating Waste (1C/CW)	Second Cycle (2C)	224 Waste
	Fraction	Fraction	Fraction	Fraction
^{90}Sr and ^{137}Cs	0.35	0.584	0.006	0.006
Pu	0.33 (a)	0.33 (a)	0.33 (a)	0.01 (a)
U	0.889	0.100	0.010	0.001
All other radionuclides	0.889	0.100	0.010	0.001

(a) Distribution of Pu product losses

The 0.889/0.1/0.01 split is believed to be based a statement in the *Hanford Works Technical Manual Part C* (GE 1944) which states that approximately 90% of the fission products went with the metal waste (MW), about 10% with the first cycle (1C) waste and second cycle (2C) waste. (Note: The flow diagram indicates 85% partitioning to metal waste.).

The low percentage of ^{90}Sr and ^{137}Cs sent to the metal waste (35%) is suspect because the *Hanford Works Technical Manual Part C* (GE 1944) specifically states that Sr is phosphate-soluble. Cesium is not known to be phosphate insoluble. During the extraction step most of the phosphate-soluble species would have left the process with the metal waste stream.

There is evidence from vadose zone studies and plant process tests that the radionuclide distribution used by the HDW model is incorrect.

Vadose Zone Studies Vadose zone modeling, using the HDW model, predicts that approximately 2 Ci of ^{99}Tc were in the 378 kgal of B Plant first cycle waste discharged to the 216-B-38 trench in 1954. However, analytical data from the 14 soil samples collected between 3.5 and 265.5 ft below ground surface at the 216-B-38 trench borehole showed very low levels of

^{99}Tc in only three of the 14 samples. Although ^{99}Tc values were reported in the intervals of 52-54 ft below ground surface, 97-100 ft below ground surface, and 147-150 ft below ground surface, none of the three ^{99}Tc values were above the laboratory "quantification limit" (Jones 2002).

One means of determining if the ^{99}Tc inventory estimates in the first cycle waste stream are correct is to compare the estimated and measured ratio of "nitrate to technetium" in the 216-B-38 crib. The estimated ratio of nitrate to technetium in the discharges to 216-B-38 is 717 kg/Ci. The ratio of nitrate to ^{99}Tc assays in the crib is 1.13×10^6 kg/Ci in the 52-54 ft zone. The ratios for the other two zones that contained both ^{99}Tc and nitrate are much larger. These ratios suggest that there is far less ^{99}Tc in the soil column than would have been suggested from the projected first cycle waste composition (Jones 2002). If it is assumed that the nitrate to ^{99}Tc ratios found in the soil samples are the same as in the first cycle waste, then these ratios imply that less than 0.1% of the total ^{99}Tc was in the first cycle waste.

T Plant Process Data Bismuth Phosphate process plant solutions from T Plant were analyzed for ^{131}I in 1945 (Dreher 1945). Table 2 lists the waste streams and their activity.

Table 2. Iodine-131 activity of T Plant solutions.

Solution	Iodine-131 Activity (Ci)	Description
4-7-M	260	Metal Solution Storage
8-1-M	220	Metal Solution (Process Feed)
8-1-MR	219	Extraction Slurry (Process Feed)
8-3-WS	192	Extraction Waste Solution (Metal Waste)
8-4-P	3.1	Extraction Cake Solution (Product Stream to 1st cycle Decontamination)

The iodine-131 DF between the extraction waste solution and extraction cake solution is about 60 (98.4% of iodine not evolved went to the metal waste, 1.6% to the 1C and 2C wastes).

A sample analysis of first cycle (acidic) waste taken from within T Pant on June 17, 1954 was assayed at 0.18 μCi/ml Cs (β) and 13 μCi/ml Sr (β) (Burns 1954). This sample is believed to be a byproduct sample from tank 13-4 (i.e. a 13-4-BP sample). Because no corresponding sample of metal solution or metal waste was taken on this date, the value of these sample results are limited. However, using flowsheet data from Schneider (1951), T Plant fuel processing records (200 MWD/ton and 99 days cooling), and uranium irradiation data, this sample assay implies that first cycle waste contained less than 1% (and probably less than 0.1%) of the initial Cs and Sr.

From this evidence it appears that the existing Bismuth Phosphate process split factors used by the HDW model are incorrect.

ISOTOPIC COMPOSITION OF BISMUTH PHOSPHATE PROCESS FEED

Table 3 lists the isotopic composition of the Bismuth Phosphate process plant feed 48 days after reactor discharge. The composition is from Section 1, Figure 7 of the *Hanford Works Technical Manual* (GE 1944).

Table 3. Isotopic Composition of Fuel with 48 Days Cooling.

Radionuclide	Half-life	Percent of Total Curies
^{95}Nb	34.97 d	18
^{95}Zr	64.02 d	14
^{91}Y	58.5 d	12
^{89}Sr	50.52 d	10
^{141}Ce	32.5 d	10
^{103}Ru	39.27 d	5
^{143}Pr	13.57 d	3
^{140}Ba	12.75 d	3
^{140}La	1.678 d	3
^{129}Te	33.6 d	0.85
^{90}Sr and ^{90}Y	28.78 yr	0.53
^{137}Cs and ^{137m}Ba	30.07 yr	0.53
^{131}I	8.02 d	0.23
Others	--	20
Total	--	100

Note that with respect to the previous statement that "90% of the fission products went with the metal waste", the isotopes to which this statement applies have relatively short half-lives and this general statement is unlikely to be applicable to the present isotopic distribution.

CHEMISTRY OF THE BISMUTH PHOSPHATE PROCESS

In the *Hanford Works Technical Manual*, the flowsheet diagram indicates that 86.67% (± 3%) of the fission products went to metal waste, 13.23% to 1C waste, 0.08% to 2C waste and 0.001% with the product to concentration and isolation (GE 1944).

From the chemistry discussion in the *Hanford Works Technical Manual* it appears ^{95}Zr may have been the source of this statement. Zirconium-95 contributed about 15% of the total activity to the metal solution at the time of separation during operation of T and B Plants. Based on phosphate chemistry, the ^{95}Zr would have followed the plutonium and not the metal waste during the extraction step.

The *Hanford Works Technical Manual* classifies important phosphate solubility behavior as follows:

(a) phosphate soluble; Ba, Sr, Pa, Y and La
(b) phosphate insoluble; Zr and Nb
(c) oxidation state dependant; Ce and Ru.

In general the elements in class (b) (and oxidized Ce and Ru) are carried quite well with $BiPO_4$ and other insoluble phosphates [$Ce_3(PO_4)_4$ or $ZrO(H\ PO_4)_2$] while those in class (a) and reduced forms of Ce and Ru do not precipitate well with $BiPO_4$. This discussion implies that little of the Ce and Ru will be removed by the $BiPO_4$ process extraction step as the metal waste solution is reduced at that point in the process.

Theoretical Decontamination Factors

Theoretical decontamination factors (DFs) can be calculated by comparing the water mass in the centrifuge feed batch to the water mass in the centrifuge cake. This calculation does not account for water washing of the solids in the centrifuge bowl. Theoretical decontamination factors are only applicable to species that are totally in solution.

Water balance reported by in the *Hanford Works Technical Manual Section C- Separations* (GE 1944)

Extraction water balance – reduction step
20,696 lb H_2O in,
39 lb H_2O out with $BiPO_4$ - Pu bearing cake
Theoretical DF = 530

First cycle water balance – oxidation step
17,862 lb H_2O in,
Pu bearing solution decanted,
196 lb H_2O out with by-product cake [$BiPO_4$, $Ce_3(PO_4)_4$, and $ZrO(HPO_4)_2$]
Theoretical DF = 91

First cycle water balance – reduction step
23,285 lb H_2O in,
55 lb H_2O out with $BiPO_4$ - Pu bearing cake
Centrifuge liquid to tank farms
Theoretical DF = 432

Second cycle water balance – oxidation step
14,968.5 lb H_2O in,
Pu bearing solution decanted,
48 lb H_2O out with by-product cake
Theoretical DF = 312

Second cycle water balance – reduction step
20,003 lb H_2O in,
62 lb H_2O out with $BiPO_4$ - Pu bearing cake
Theoretical DF = 323

Water balance reported by Schneider (1951).

Extraction water balance – reduction step
8,671 lb H_2O in,
86 lb out with $BiPO_4$ - Pu bearing cake
Theoretical DF = 100
First cycle water balance – oxidation step
6,628 lb H_2O in,
Pu bearing solution decanted,
83.9 lb H_2O out with by-product cake [$BiPO_4$, $Ce_3(PO_4)_4$, and $ZrO(HPO_4)_2$]
Theoretical DF = 79
First cycle water balance – reduction step
9,585 lb H_2O in,
69.8 lb H_2O out with $BiPO_4$ - Pu bearing cake
Centrifuge liquid to tank farms
Theoretical DF = 137
Second cycle water balance – oxidation step
7,798 lb H_2O in,
Pu bearing solution decanted,
67 lb H_2O out with by-product cake
Theoretical DF = 116
Second cycle water balance – reduction step
10,467 lb H_2O in,
79.2 lb H_2O out with $BiPO_4$ - Pu bearing cake
Theoretical DF = 132

BISMUTH PHOSPHATE PROCESS FLOWSHEET DATA

In 1951 a new flowsheet for the $BiPO_4$ process was issued (Schneider 1951). Subsequent to October 1, 1951, double cerium and zirconium scavenger precipitations in the first cycle by-product step and double lanthanum fluoride precipitation and barium sulfate scavenenging in the bismuth phosphate step (224 building) were initiated to obtain satisfactory decontamination.

From the Schneider (1951) flowsheet several plant partition factors can be inferred. The data reported by Schneider are summarized in Table 4 and the plant partition factors are summarized in Table 5.

According to the Schneider flowsheet, metal waste (MW) separated in tank 7-3 went to tank 9-1 where it was neutralized before being sent to tank farms. The first cycle (1C) decontamination step generated an oxidation waste and a reduction waste. Waste streams from tanks 13-4 and 14-3 were collected in tank 15-8 before being sent to tank farms. Second cycle (2C) wastes were generated in tanks 18-4 and 19-3 and were collected in tank 15-9 before being sent to tank farms.

Table 4. Bismuth Phosphate process plant stream compositions reported in the 1951 $BiPO_4$ process flowsheet.

Radio-nuclide	Extraction Feed (tk 7-1)	MW Centrifuge Decant– (tk 7-3 sent to tk 9-1)	Extraction Product (7-4-P sample to tk 13-1)	1C waste Dissolved Cake – (13-4-BP sample to 15-8)	First Cycle Oxidation Product (14-1)	1C waste Centrifuge Decant– (14-3-WS sample to 15-8)	First Cycle Product (14-4-P sample)	2C waste Dissolved Cake (18-4-BP sample to 15-9)	Second Cycle Oxidation Product (19-1)	2C waste Centrifuge Decant – (19-3-WS sample to 19-3)	Second Cycle Product (19-4-P sample)	224 waste Dissolved Cake (A-4-BP sample to C-8)	224 waste Dissolved Cake (D-4-BP sample to C-8)	224 waste Centrifuge Decant – (B-3-WS sample to C-8)	224 Product to 231 (F-10-P sample)
Pu (gm)	330	1.3	329	2.5	326	2.1	324	0.6	324	0.7	323	0.4 (a)	0.2 (a)	0.7 (a)	321.4 (b)
U (lb)	1,240	1,236	4.1	0.2	3.9	3.8	0.1	-	-	-	0.18 gm	-	-	-	0.01
Am-Cm (Total Count)	0.11 E+13	0.10 E+13	0.01 E+13	-	-	-	3.0 E+10	1.0 E+10	-	-	1.0 E+10	-	-	-	-
Gamma (Total Count)	9.0 E+13	7.2 E+13	1.8E+13	1.6 E+13	1.8 E+12	1.7 E+12	9.0 E+10	7.2 E+10	1.8 E+10	1.7 E+10	9.0 E+08	6.0 E+10	2.8 E+08	7.0 E+06	9.0 E+6
Beta	1.4 E+16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
^{131}I (Ci)	170	150	20	-	-	-	-	-	-	-	-	-	-	-	-
Hg (oz)	5.2	4.2	1.0	-	-	-	-	-	-	-	-	-	-	-	-

(a) Cumulative 224 Building Pu loss is 1.4 g.

(b) (Reported as 345 g. Adjusted 321.4 g to correct for flowsheet recycle.

Table 5. Bismuth Phosphate process partition factors derived from the 1951 $BiPO_4$ process flowsheet. [See Table 4]

Radionuclide	Metal Waste (MW)	First Cycle Waste (1C)	Second Cycle Waste (2C)	224 Waste	Product Stream	Accountability Check
	Percent	Percent	Percent	Percent	Percent	Percent
Pu	0.394	1.39	0.394	0.42	97.4	99.998
U	99.677	0.323	0.00806	3.0 E-5	1.8 E-06	100.008
Am-Cm	90.91	6.36	1.82	0.909	0	99.999
Gamma	80	19.67	0.0989	9.9 E-04	1.0 E-05	99.77
^{131}I	88	12	0	0	0	100
Hg	80	20	0	0	0	100

BISMUTH PHOSPHATE PROCESS LABORATORY SIMULATION

The Groundwater Vadose Zone Project is sponsoring a laboratory simulation of the Bismuth Phosphate process through the first cycle decontamination step. Preliminary results have been received for review and are included here. Final results from this work will not be available to review until later this year.

Table 6 summarizes the preliminary results of the laboratory simulation of the Bismuth Phosphate process. Gamma counting was used to analysis the samples unless otherwise identified. The extraction product was also analyzed for ^{99}Tc by ICP-MS[1]. No ^{99}Tc was detected in the extraction product, indicating that nearly all of the ^{99}Tc partitioned to the metal waste in the simulation (Serne 2002).

Table 6. Distribution of Fission Products and Uranium Daughters determined by Laboratory Simulation of the Bismuth Phosphate Process.

Radionuclide	Metal Waste (MW)	Extraction Product (1C, 2C, and 224 Waste)	Material not Accounted For
	Percent	Percent	Percent
^{75}Se	81.1	10.2	8.7
^{85}Sr	83.9	0.0	16.1
^{125}I (a)	100.6	0.0	-0.6
^{152}Eu	71.6	21.7	6.6
^{137}Cs	90.2	0.0	9.8
^{137}Cs (a)	100.6	0.0	-0.6
^{233}Pa	0.0	122.8	-22.8
^{234}Th	25.5	57.7	16.7
^{237}Np	0.0	30.2	69.8
^{237}Np (a)	0.7	18.2	81.1

(a) determined by low energy photon (LEPS) counting

The ^{125}I results indicate a near perfect separation of iodine from the extraction product while the plant test results discussed earlier indicate that 1.6% of the iodine remained in the extraction product. The reason for a less than quantitative separation of iodine in the plants is not known. The implication is that the separation of other highly soluble species, such as Sr and Cs, may have been less than perfect in the plants.

DEVELOPMENT OF BISMUTH PHOSPHATE PLANT PARTITIONING FACTORS

Based on the flowsheet and plant test observations, revised $BiPO_4$ process radionuclide partition factors have been developed for the HDW model. These factors are compiled in Tables 7 and 8. The basis for the values in Tables 7 and 8 are discussed in the sections following the tables. Note that the first cycle waste (1C) does not include the cladding waste contribution.

[1] ICP-MS, Inductively coupled plasma – mass spectrometer

The cladding waste split is being determined independently and will be treated as a separate waste generation source by the HDW model. The HDW model will combine the 1C and CW streams to model the 1C/CW that was discharged to tank farms. The impact of these new partition factors on the HDW model will result in the redistribution of radionuclides between the tanks that received waste from the Bismuth Phosphate process and are not expected to change the total inventory of the underground storage tanks.

Table 7. Revised Radionuclide Partition Factors for the Bismuth Phosphate Plants (1944-1949).

Radionuclide	Metal Waste (MW)	First Cycle (1C) Waste	Second Cycle (2C) Waste	224 Waste	Basis
H-3	9.9812E-01	1.8800E-03	4.4373E-06	1.3769E-08	Water balance
C-14	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ni-59	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ni-63	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Co-60	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Se-79	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Sr-90	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate-soluble. Based on iodine
Y-90	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	In equilibrium with Sr-90
Zr-93	3.940E-03	8.9645E-01	9.9606E-02 The 2C/224 distribution of Zr has not been determined.	The 2C/224 distribution of Zr has not been determined. Use 0.00	Insoluble phosphate. Precipitated with Zr and Ce. Assumed 1st cycle DF of 10 based 1st cycle oxidation step gamma DF
Nb-93m	3.940E-03	8.9645E-01	9.9606E-02 The 2C/224 distribution of Nb has not been determined.	The 2C/224 distribution of Nb has not been determined. Use 0.00	Insoluble phosphate. Precipitated with Zr and Ce. Assumed 1st cycle DF of 10 based 1st cycle oxidation step gamma DF
Tc-99	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate soluble. Assumed to behave like iodine without Hg
Ru-106	3.940E-03	8.9645E-01	7.9685E-02	1.9921E-02	See Basis for Partition Factors
Cd-113m	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Sb-125	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Sn-126	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
I-129	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Without Hg. Dreher (1945)
Cs-134	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate soluble. Assumed to behave like iodine without Hg

Table 7. Revised Radionuclide Partition Factors for the Bismuth Phosphate Plants (1944-1949) continued.

Radionuclide	Metal Waste (MW)	First Cycle (1C) Waste	Second Cycle (2C) Waste	224 Waste	Basis
Cs-137	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate soluble. Assumed to behave like iodine without Hg
Ba-137m	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	In equilibrium with Cs-137
Sm-151	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Assumed to behave like europium
Eu-152	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Preliminary $BiPO_4$ process laboratory simulation result
Eu-154	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Preliminary $BiPO_4$ process laboratory simulation result
Eu-155	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Preliminary $BiPO_4$ process laboratory simulation result
Ra-226	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ra-228	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ac-227	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Based on Am
Pa-231	3.940E-03	6.721E-01	1.923E-01	9.616E-02	Preliminary $BiPO_4$ process laboratory simulation result and Am
Th-229	3.0E-01	4.898E-01	1.401E-01	7.007E-02	Preliminary $BiPO_4$ process laboratory simulation result and Am
Th-232	3.0E-01	4.898E-01	1.401E-01	7.007E-02	Preliminary $BiPO_4$ process laboratory simulation result and Am
U-232	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-233	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-234	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-235	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-236	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-237	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-238	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-Total	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
Np-237	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Based on Am
Pu-238	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-239	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.

Table 7. Revised Radionuclide Partition Factors for the Bismuth Phosphate Plants (1944-1949) continued.

Radionuclide	Metal Waste (MW)	First Cycle (1C) Waste	Second Cycle (2C) Waste	224 Waste	Basis
Pu-240	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-241	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-242	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-Total	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Am-241	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Am-243	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Cm-242	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Cm-243	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Cm-244	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.

Table 8. Revised Radionuclide Partition Factors for the Bismuth Phosphate Plants (1950-1956).

Radionuclide	Metal Waste (MW)	First Cycle (1C) Waste	Second Cycle (2C) Waste	224 Waste	Basis
H-3	9.9008E-01	9.8459E-03	7.1679E-05	5.4651E-07	Water balance
C-14	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ni-59	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ni-63	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Co-60	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Se-79	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Sr-90	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate-soluble. Based on iodine wo/Hg
Y-90	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	In equilibrium with Sr-90
Zr-93	3.940E-03	8.9645E-01	9.9606E-02 The 2C/224 distribution of Zr has not been determined.	The 2C/224 distribution of Zr has not been determined. Use 0.00	Insoluble phosphate. Precipitated with Zr and Ce. Assumed 1st cycle DF of 10 based 1st cycle oxidation step gamma DF
Nb-93m	3.940E-03	8.9645E-01	9.9606E-02 The 2C/224 distribution of Nb has not been determined.	The 2C/224 distribution of Nb has not been determined. Use 0.00	Insoluble phosphate. Precipitated with Zr and Ce. Assumed 1st cycle DF of 10 based 1st cycle oxidation step gamma DF

Table 8. Revised Radionuclide Partition Factors for the Bismuth Phosphate Plants (1950-1956) continued.

Radionuclide	Metal Waste (MW)	First Cycle (1C) Waste	Second Cycle (2C) Waste	224 Waste	Basis
Tc-99	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate soluble. Assumed to behave like iodine without Hg
Ru-106	3.940E-03	8.9645E-01	7.9685E-02	1.9921E-02	See Basis for Partition Factors
Cd-113m	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Sb-125	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Sn-126	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
I-129	8.80E-01	1.20E-01	0	0	With Hg. Schneider (1951)
Cs-134	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate soluble. Assumed to behave like iodine without Hg
Cs-137	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	Phosphate soluble. Assumed to behave like iodine without Hg
Ba-137m	9.8333E-01	1.6389E-02	2.7315E-04	4.6296E-06	In equilibrium with Cs-137
Sm-151	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Assumed to behave like europium
Eu-152	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Preliminary $BiPO_4$ process laboratory simulation result
Eu-154	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Preliminary $BiPO_4$ process laboratory simulation result
Eu-155	7.5000E-01	1.8750E-01	4.6875E-02	1.5625E-02	Preliminary $BiPO_4$ process laboratory simulation result
Ra-226	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ra-228	8.8900E-01	1.0000E-01	1.0000E-02	1.0000E-03	From HDW Rev 4.0
Ac-227	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Based on Am
Pa-231	3.940E-03	6.721E-01	1.923E-01	9.616E-02	Preliminary $BiPO_4$ process laboratory simulation result and Am
Th-229	3.0E-01	4.898E-01	1.401E-01	7.007E-02	Preliminary $BiPO_4$ process laboratory simulation result and Am
Th-232	3.0E-01	4.898E-01	1.401E-01	7.007E-02	Preliminary $BiPO_4$ process laboratory simulation result and Am
U-232	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-233	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.

Table 8. Revised Radionuclide Partition Factors for the Bismuth Phosphate Plants (1950-1956) continued.

Radionuclide	Metal Waste (MW)	First Cycle (1C) Waste	Second Cycle (2C) Waste	224 Waste	Basis
U-234	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-235	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-236	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-237	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-238	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
U-Total	9.9677E-01	3.23E-03	8.06E-05	3.00E-07	Table 5.
Np-237	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Based on Am
Pu-238	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-239	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-240	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-241	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-242	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Pu-Total	1.52E-01	5.35E-01	1.52E-01	1.62E-01	Table 5. Adjusted for DKPRO modeling of Pu recovery.
Am-241	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Am-243	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Cm-242	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Cm-243	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.
Cm-244	9.091E-01	6.36E-02	1.82E-02	9.09E-03	Table 5.

BASIS FOR PARTITION FACTORS

This section summarizes the basis for the partition factors presented in Tables 7 and 8. Flowsheets and plant process test data are the preferred basis for the partition factors. Laboratory simulation results are preferred over process chemistry knowledge.

Tritium – Tritium is assumed to follow and partition with water per the theoretical water balance based on the DFs of the reduction steps.

Carbon-14 – No flowsheet data or other information was found to establish new partition factors for carbon. The previously assumed partition factors are unchanged.

Nickel-59 and 63 – No flowsheet data or other information was found to establish new partition factors for nickel. The previously assumed partition factors are unchanged.

Cobalt-60 – No flowsheet data or other information was found to establish new partition factors for cobalt. The previously assumed partition factors are unchanged.

Selenium-79 – No flowsheet data or other information was found to establish new partition factors for selenium. The results from the Bismuth Phosphate process laboratory simulation confirm the existing partition factors. The previously assumed partition factors are unchanged.

Strontium-90 and Yttrium-90 – No flowsheet data or other information was found to establish partition factors for strontium. Strontium is specifically described as a phosphate-soluble species in the *Hanford Works Technical Manual Part C* (GE 1944). Most of the soluble phosphates would have left the $BiPO_4$ process as metal waste during the extraction step. The results from the Bismuth Phosphate process laboratory simulation confirm this assessment. Because a high DF for strontium in the extraction step is expected, the iodine partition factors are assumed. Yttrium-90 is in equilibrium with strontium-90.

Zirconium-93 and Neodymium-93m – Zirconium and neodymium form insoluble phosphates and would follow the Pu through the extraction reduction step. The Zr loss fraction to the metal waste is assumed to be the same as the metal waste Pu loss fraction. Zirconium and Nd would have been precipitated by the first cycle Zr-Ce strike during the oxidation step. The gamma DF for this step is 10 and is assumed to reflect the precipitation of Zr-95. The distribution of zirconium and neodymium between the 2C and 224 waste streams has not been determined.

Technetium-99 – No flowsheet data or other information was found to establish partition factors for technetium. Technetium is not expected to be precipitated by phosphate. This expectation is supported by a preliminary result from the laboratory simulation of the $BiPO_4$ extraction step. Most of the soluble phosphates would have left the $BiPO_4$ process as metal waste during the extraction step. Because a high DF for technetium in the extraction step is expected, the iodine partition factors are assumed.

Ruthenium-106 – During the extraction step ruthenium is reduced and most of the Ru would follow the Pu. The Zr loss fraction to the metal waste is assumed to be the same as the metal waste Pu loss fraction. During the 1st cycle oxidation step Ru would be expected to precipitate and would have followed the by-product cake to 1C waste. About 90% of the gamma activity follows this stream so a DF of 10 is assumed. During the 2nd cycle oxidation step Ru would again precipitate. A DF of 5 is assumed based on 80% of the gamma activity following the by-product cake.

Cadmium-113m – No flowsheet data or other information was found to establish new partition factors for cadmium. The previously assumed partition factors are unchanged.

Antimony-125 – No flowsheet data or other information was found to establish new partition factors for antimony. The previously assumed partition factors are unchanged.

Tin-126 – No flowsheet data or other information was found to establish new partition factors for tin. The previously assumed partition factors are unchanged.

Iodine-129 – For the 1944 to 1949 campaign, an iodine DF of 60 is used for the extraction step (Dreher 1944). The extraction DF is assumed to apply to the first and second decontamination cycles.

For the 1950 to 1956 campaign, $HgNO_3$ is assumed to have been added to the dissolver and iodine partitions across the extraction step per the 1951 flowsheet (Schneider 1951).

Cesium-134, 137, and Barium-137m – No flowsheet data or other information was found to establish partition factors for cesium. Cesium is not precipitated by phosphate. Most of the soluble phosphates would have left the $BiPO_4$ process as metal waste during the extraction step. The results from the Bismuth Phosphate process laboratory simulation confirm this assessment. Because a high DF for cesium in the extraction step is expected, the iodine partition factors are assumed. Barium-137m is in equilibrium with cesium-137.

Samarium-151 – No flowsheet data or other information was found to establish new partition factors for samarium. In the discussion of bismuth phosphate process chemistry earlier in this attachment, lanthanum is identified as being phosphate-soluble. This would imply that other rare earths may also be phosphate-soluble and would generally exit with the metal waste. However significant amounts of samarium may have remained in the product until the 224 building LaF_3 precipitation. The laboratory simulation of the Bismuth Phosphate process indicates that approximately 25% of the Eu followed the Pu past the extraction step. It is likely that other lanthanides, including samarium behaved similarly. Based on the europium data, a DF of 4 is assumed for samarium in the extraction, first cycle, and second cycle separation steps.

Europium-152, 154, and 155 – The laboratory simulation of the Bismuth Phosphate process indicates a DF of approximately 4 in the extraction step. No flowsheet data or other information was found to establish new partition factors for europium. In the discussion of bismuth phosphate process chemistry earlier in this attachment, lanthanum is identified as being phosphate-soluble. This would imply that other rare earths may also be phosphate-soluble and would generally exit with the metal waste. However significant amounts of europium may have remained in the product until the 224 building LaF_3 precipitation. A DF of 4 is assumed for the extraction, first cycle, and second cycle separation steps.

Actinium-227 – No flowsheet or other data was found to establish the partition factors for actinium. The actinium partition factors are assumed to the same as the partition factors for americium and curium. The basis for this assumption is that actinium, americium and curium are all actinides.

Radium-226 and 228 – Radium is assumed to be phosphate soluble based on the phosphate chemistry of barium and strontium. However significant amounts of radium may have remained in the product until the 224 building where $BaSO_4$ precipitation was used. $BaSO_4$ is a classic carrier for precipitation of radium. The partition factors previously assumed by the HDW model are unchanged.

Protactinium-231 – No flowsheet or other data was found to establish the partition factors for protactinium. The laboratory simulation of the Bismuth Phosphate process indicates a low DF is obtained in the extraction step. The extraction step partition factor for ^{231}Pa is assumed to be the same as for plutonium as reported by the Schneider flowsheet and summarized in Table 5. The DFs for subsequent steps are assumed to be the same as americium and curium, a DF of 3.33 for the first cycle decontamination step and a DF of 3.0 for the second cycle decontamination step. The basis for this assumption is the protactinium, americium and curium will behave in a similar manner.

Thorium-229 and 232 – No flowsheet or other data was found to establish the partition factors for thorium. Using normalized results from the laboratory simulation of the Bismuth Phosphate process indicates that about 30% of the thorium leaves with the metal waste. The DFs for subsequent steps are assumed to be the same as americium and curium, a DF of 3.33 for the first cycle decontamination step and a DF of 3.0 for the second cycle decontamination step. The basis for this assumption is the protactinium, americium and curium will behave in a similar manner.

Uranium-232, 233, 234, 235, 236, 237, and 238 – Uranium partition factors are from the Schneider flowsheet and are summarized in Table 3.

Neptunium-237 – No flowsheet or other data was found to establish the partition factors for neptunium. The neptunium partition factors are assumed to the same as the partition factors for americium and curium. The basis for this assumption is that neptunium, americium and curium are all actinides. A statement in the *Hanford Works Technical Manual* that neptunium was recovered from one charge of metal solution implies that most of the neptunium partitioned to the metal waste (GE 1944). This observation is consistent with the assumed partition factors.

Plutonium-238, 239, 240, 241, 242 – Plutonium partition factors for the $BiPO_4$ process are from the Schneider flowsheet and are summarized in Table 3. The values in Tables 4 and 5 are adjusted to reflect removal of the Pu product. The DKPRO model will be used to simulate the separation of Pu. The process loss estimates from DKPRO will be interfaced with the HDW model and the HDW model will simulate the $BiPO_4$ waste streams.

Americium-241, 243, Curium-242, 243, and 244 – The americium - curium values from the Schneider flowsheet were used to develop the Am-Cm partition factors in Table 3.

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INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From: Inventory and Flowsheet Engineering 7G300-02-NWK-027
Phone: 376-5694
Date: August 5, 2002
Subject: STRONTIUM MODELING PARAMETERS FOR THE HANFORD DEFINED WASTE MODEL

To: J. G. Field R2-12

Copies: K. M. Bowen
N. W. Kirch NWK
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References:

1. Kupfer, M. J., A. L. Boldt, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC); M. D. LeClair (SAIC); G. L. Borsheim (BA); R. T. Winward (MA); B. A. Higley and R. M. Orme (NHC); N. G. Coulton (PNNL); S. L. Lambert and D. E. Place (Cogema); and W. W. Shulz (W2S), 1999, "Standard Inventories of Chemicals and Radionuclides in Hanford Tank Wastes," HNF-SD-WM-TI-740, Revision 0C, Lockheed Martin Hanford Company, Richland, Washington.

2. Abrams, R. B., 1956, "History: Metal Recovery Waste Scavenging Program," HW-43066, General Electric Company, Hanford Atomic Products Operation, Richland, Washington.

3. Stedwell, M. J., 1957, "Waste Scavenging Costs," HW-47832, General Electric Company, Hanford Atomic Products Operation, Richland, Washington.

The Hanford Defined Waste (HDW) model is being updated to reflect new information that has become available since Revision 4.0 of the model was published in January 1997. The current version of the HDW model does not reflect the usage of strontium nitrate as a ^{90}Sr scavenging agent or the presence of strontium as a process chemical impurity.

Strontium-90 Scavenging

The only known usage of strontium was as strontium nitrate for co-precipitation of $Sr_3(PO_4)_2$ to scavenge ^{90}Sr from Tributyl Phosphate process supernatant. Usage was limited to "in-plant" processing (reference 1).

Abrams (reference 2) indicates that a plant test with $Sr(NO_3)_2$ was initiated in August 1955, but that routine usage by the Tributyl Phosphate process did not start until December 30, 1955. Stedwell (reference 3) indicates that a total of 140,000 lb of $Sr(NO_3)_2$ (26,290kg Sr) was used by

the Uranium Recovery Plant. This value compares favorably to the 29,140kg of strontium reported to be used by the Uranium Recovery Plant in reference 1.

For purposes of modeling the PFeCN2 waste (ferrocyanide waste from in-plant scavenged supernatant, 1955-1958), the HDW model waste composition should be revised to account for $Sr(NO_3)_2$ usage by the Tributyl Phosphate process. Abrams (reference 2) indicates that the scavenging process flowsheet applied $Sr(NO_3)_2$ at the rate of 0.004*M*. Using this concentration and the volume of PFeCN2 waste assumed by the HDW model (20,537kgal) results in an estimate of 27,244kg of strontium. This value compares favorably with the values reported in references 1 and 3. The HDW model should be revised to include 0.004*M* $Sr(NO_3)_2$ in the PFeCN2 waste.

Fission Product And Process Chemical Impurities

Strontium was introduced to the waste as a radioisotope (^{90}Sr), a stable fission product (^{86}Sr, ^{87}Sr and ^{88}Sr) and as an impurity in process chemicals. Table 1 summarizes the isotopic distribution of strontium predicted by the ORIGEN2 code.

Table 1. Isotopic Distribution of Strontium by Separation Process (Decayed to January 1, 2001).

Isotope	Bismuth Phosphate Process (1944-1956)	REDOX Process (1952-1966)	PUREX Process (1956-1972)	PUREX Process (AZ-101)	PUREX Process (AZ-102)
	(grams)	(grams)	(grams)	(grams)	(grams)
^{86}Sr	1.648	13.1	55.8	4.841	2.54
^{87}Sr	0.042	0.293	1.26	0.2481	0.1351
^{88}Sr	34,600	188,000	695,000	40,230	22,450
^{90}Sr	16,617	111,739	452,883	40,252	23,414
Total Sr	48,219	299,752	1,147,940	80,487	45,867
^{90}Sr (wt%)	32.4 wt%	37.3 wt%	39.5 wt%	50.0 wt%	51.0 wt%

The total stable fission product strontium from Table 1 is 977kg. In addition to the strontium produced by the irradiation of fuel elements, the waste also contains strontium introduced as a contaminant in process chemicals. Reference 1 estimate that up to 1,000kg of strontium may have been introduced as an impurity in process chemicals. This estimate is thought to be overly conservative based on the quality of the strontium recovered by B Plant for encapsulation. Most of the ^{90}Sr recovered by B Plant was extracted from PUREX waste generated between 1956 and 1972, and the average ^{90}Sr content of the recovered strontium was 37.8 wt% ^{90}Sr (decayed to January 1, 2001). Although there is a large range in the ^{90}Sr content of individual strontium capsules, the small difference between the average quality of ^{90}Sr recovered by B Plant (37.8 wt%) and the quality of ^{90}Sr in the reactor fuel elements received by PUREX (39.5 wt%) indicates that the contribution of strontium impurities to the total strontium is small.

Table 2 provides the parameters to model total strontium based on ^{90}Sr. These modeling parameters were calculated using a ^{90}Sr specific activity of 138 Ci/g and a strontium atomic weight of 87.62g/mol. The values in Table 2 should be used for waste streams other than PFeCN2. The basis for modeling the PFeCN2 stream is explained in the first section of this letter.

Table 2. Total Strontium Modeling Parameters

Process	Mass Fraction ^{90}Sr (wt%)	Total Strontium Model Parameter (moles total strontium per curie ^{90}Sr)
Bismuth Phosphate Process (1944-1956)	32.4	2.553E-04
REDOX Process (1952-1966)	37.3	2.217E-04
PUREX Process (1956-1972)	39.5	2.094E-04
PUREX Process (Tank 241-AZ-101)	50.0	1.654E-04
PUREX Process (Tank 241-AZ-102)	50.1	1.651E-04

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Hanford Group, Inc.

From: Inventory and Flowsheet Engineering 7G300-02-NWK-028
Phone: 376-5694
Date: August 5, 2002
Subject: HANFORD DEFINED WASTE MODEL PARAMETERS FOR MANGANESE USED IN THE REDOX PROCESS

To: J. G. Field R2-12

Copies: K. M. Bowen
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References:

1. Kupfer, M. J., A. L. Boldt, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC); M. D. LeClair (SAIC); G. L. Borsheim (BA); R. T. Winward (MA); B. A. Higley and R. M. Orme (NHC); N. G. Coulton (PNNL); S. L. Lambert and D. E. Place (Cogema); and W. W. Shulz (W^2S), 1999, "Standard Inventories of Chemicals and Radionuclides in Hanford Tank Wastes", HNF-SD-WM-TI-740, Revision 0C, Lockheed Martin Hanford Company, Richland, Washington.

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The Hanford Defined Waste (HDW) model is being updated to reflect new information that has become available since Revision 4.0 of the model was published in January 1997. The current version of the HDW model does not include manganese use by the REDOX process. Manganese usage by REDOX is identified in reference 1.

The REDOX plant underwent several equipment and flowsheet changes over the plant's fifteen-year operating life. Six REDOX process flowsheets were issued (Nos. 4 through 9) between 1951 and 1966 (references 2-6). Manganese usage (as $KMnO_4$) is only shown in the first of these flowsheets. In the REDOX head-end process the nitric acid-irradiated fuel feed solution was treated with $KMnO_4$ to oxidize ruthenium in to the volatile tetroxide RuO_4. The RuO_4 was then removed from the dissolver solution by sparging with air or nitrogen.

REDOX 1952-1958 During the 1952 to 1958 campaign the REDOX process used potassium permanganate ($KMnO_4$) to oxidize ruthenium to the volatile tetraoxide RuO_4. The flowsheet in reference 2 indicates that 51lbs of $KMnO_4$ were added to each oxidizer batch of uranium (6,256lb U). The manganese would have left the REDOX Plant with the solvent extraction (R1) waste. Using parameters from the HDW model for the R1 waste stream, (11,905 short tons uranium, and 25,067kgal waste out), the $KMnO_4$ usage and concentration in the R1 waste stream can be calculated. The $KMnO_4$ usage is calculated to be 194,103lb or 557,106 moles $KMnO_4$ for the R1 waste. The concentration of $KMnO_4$ in the R1 waste stream is calculated as 0.00587*M*. This value should be added to the R1 waste "chemicals in" section in the HDW model.

REDOX 1959-1966 Reference 7 states that head-end permanganate oxidation of the feed stream was replaced with sodium dichromate and ozone oxidation in 1960. The exact date of this process change has not been determined. Based on this statement and fuel processing records, between 9 and 18 percent of the fuel processed by the REDOX Plant in the 1959-1966 campaign would have been treated with potassium permanganate. However, reference 1 states that permanganate oxidation ceased in September 1959, so as little as 6.4% of the fuel processed may have been treated with potassium permanganate. Since the volume of R2 waste treated with potassium permanganate is less than 20 percent of the total R2 waste generated, the $KMnO_4$ addition to the R2 waste stream will be ignored.

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From: Inventory and Flowsheet Engineering 7G300-02-NWK-030
Phone: 376-0176
Date: August 22, 2002
Subject: RECOMMENDED PROCESS DISTRIBUTIONS FOR CARBON-14

To: J. G. Field R2-12

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References:

1. Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, "Hanford Tank Chemical and Radionuclide Inventories", HDW Model Revision 4, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

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3. Mailen, J. C. and L. M. Troth, 1990, Chemistry of volatile fission product elements, in "Light Water Reactor Nuclear Fuel Cycle", Wymer, R. G. and B. L. Vondra, Eds, CRC Press, Boca Raton, Florida.

The Hanford Defined Waste (HDW) Model is being updated to reflect new information that has become available since Revision 4 (reference 1) was published in January 1997. The HDW model Revision 4 assumes that 100 percent of the carbon-14 present in the fuel elements is routed to the waste streams of the separation plants, and that only a small fraction (< 1%) is contained in cladding wastes. Literature sources (references 2 and 3) indicate that 99% of the carbon-14 would be evolved from the dissolvers as carbon dioxide during uranium dissolution. Evaluation of data for tanks 241-AZ-101 and 241-AZ-102 indicates that a large fraction of the carbon-14 is evolved from the dissolvers, but the fraction evolved as carbon dioxide is closer to 80%.

Preliminary data have been made available for new ORIGEN2 (reactor code) runs performed as part of the HDW model update. The ORIGEN2 runs incorporate updated cross sections for nitrogen-14 and time dependent changes in the nitrogen impurity level of the uranium metal, both of which have a significant effect on the carbon-14 generated. The quantities of carbon-14 associated with the PUREX processing during the generation of the HLW contained in tanks 241-AZ-101 and 241-AZ-102 were extracted from the ORIGEN2 output and are reported in the table below. Comparison with the sample-based Best-Basis Inventories for 241-AZ-101 and 241-AZ-102 indicate that the 17.7% of the carbon-14 reached the HLW tanks. The mechanism is unknown, but it is likely that a least some of the carbon-14 was not initially present as carbonate ion (possibly as an organic species or a metal carbide).

Waste Tank	Current Sample-Based BBI	ORIGEN2 Fuel Inventory	Units	Fraction Present in HLW	Comments
241-AZ-101	6.71	38.3	Ci	17.5 %	
241-AZ-102	3.65	20.5	Ci	17.8 %	
241-U-110 R1 Sludge	0.202	1.166[1]	Ci	17.3 %	Inventory estimated from HDW model Revision 4 concentration and density and BBI volume. Waste was generated in 1954, and the carbon-14 was increased by 30% to account for the ORIGEN2 nitrogen impurity level increase.

[1] R1 sludge layer inventory estimated from HDW model Rev. 4 data. See Comment.

A sample-based layer of HLW (R1 sludge) contained in tank 241-U-110 was also compared to a prediction made from HDW model Revision 4 data. The carbon-14 content of the Al -clad reactor fuels processed at Redox in 1954 is expected to increase by approximately 30% between HDW model revisions 4 and 5 based on the increase in the nitrogen impurity level from 50 ppm to 65 ppm. The comparison indicates approximately the same fraction of carbon-14 in the Redox HLW stream. This comparison of a waste layer is much less reliable than the direct comparison of the entire tank contents for the AZ waste tanks, but the comparison tends to support the presumption that partitioning of carbon-14 during fuel dissolution has remained relatively constant over the Hanford history.

Comparison of other carbon-14 analytical data to the HDW model Revision 4 predictions is not meaningful due to the magnitude of the changes in the ORIGEN2 carbon-14 predictions and proposed changes in partitioning with the HDW model Revision 5. These additional comparisons will be made once the HDW model Revision 5 has progressed to the point where the plant outputs can be distributed to individual waste tanks. Several recommendations can currently be made.

For the carbon-14 generated in the fuel cladding:

- A significant portion of the total carbon-14 is generated in the reactor fuel elements is generated in the fuel cladding. This fraction of the carbon-14 should be partitioned entirely to the cladding waste steams.

For the carbon-14 generated in the uranium metal:

- Eighteen percent of the carbon-14 generated in the uranium metal should be partitioned to the BiPO4 Plant, Redox and PUREX separation processes.

- A small percentage (say 0.5%) of the carbon-14 generated in the uranium metal should be routed to PUREX Organic Wash Wastes (defined waste types OWW1, OWW2, OWW3 and PL2) in the absence of specific data regarding the carbon-14 content of the solvent treatment wastes.

- The remaining 81.5% to 82% of the carbon-14 generated in the uranium metal should be partitioned to the atmosphere.

The total carbon-14 present in the underground tank waste predicted by the HDW model would be reduced from 4808 Ci (Revision 4) to approximately 900 Ci in Revision 5 as the result of the above changes.

David E. Place
Principal Engineer

jjs

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INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From:	Inventory and Flowsheet Engineering	7G300-02-NWK-034
Phone:	376-5694	
Date:	October 2, 2002	
Subject:	IODINE-129 PARTITION FACTORS FOR THE HANFORD DEFINED WASTE MODEL	
To:	J. G. Field	R2-12
Copies:	K. M. Bowen	R2-12
	N. W. Kirch NWK	R3-73
	D. E. Place	R3-23
	L. M. Sasaki	R2-12
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	BAH/LB	R3-73

The Hanford Defined Waste (HDW) Model is being updated to reflect new information that has become available since Revision 4.0 of the model was published in January 1997. Users of the Best-Basis Inventory are concerned that the model–based inventories for critical, mobile, long-lived radionuclides are unduly conservative and, therefore, designs for waste disposal may be unnecessarily conservative and expensive.

The current version of the HDW Model (Revision 4.0), assumes that all of the iodine-129 present in the irradiated fuel exited the separation plants in waste streams that were sent to the tank farms. This assumption is thought to be overly conservative, and that changes to the HDW Model should be made to account atmospheric emissions and direct discharges to the soil by the separation plants.

The attachment to this letter establishes iodine-129 atmospheric release, crib discharge to soil, and tank receipt partition factors of the fuel reprocessing plants for the next version of the Hanford Defined Waste Model. Subsequent releases from the tanks via leaks or discharges to cribs are already accounted for by the HDW Model. The approximate impact of the atmospheric and soil discharge partition factors will be a reduction in the tank iodine-129 inventory of 20%. This is in addition to a reduction of 23% obtained from updating the ORIGEN2 estimates.

B. A. Higley

B. A. Higley
Principal Engineer

sir

Attachment

7G300-NWK-034

Attachment 1

IODINE 129 – PLANT EMISSIONS

Consisting of 18 pages
Including cover page

IODINE 129 – PLANT EMISSIONS.

BACKGROUND

The HDW Model, Revision 4.0 currently assumes that all of the iodine-129 present in the irradiated fuel exited the separation plants in waste streams that were sent to the tank farms. This assumption is thought to be overly conservative. The separation plants are believed to have released significant fractions of the iodine to the atmosphere and to the soil. This attachment establishes iodine-129 atmospheric release, crib discharge to soil, and tank farm receipt partition factors of the fuel reprocessing plants for the next version of the Hanford Defined Waste Model. Releases from the tank farms via leaks or discharges to cribs are currently accounted for by the HDW Model.

The atmospheric release of iodine-131 during chemical processing has been studied since at least 1945. This assessment assumes that iodine-129 followed the same chemical paths through the separation processes that iodine-131 did. The two pathways of interest are atmospheric release via the fuel reprocessing plant stacks and direct discharges by the fuel reprocessing plants to soil.

ATMOSPHERIC RELEASES OF IODINE-129

A general discussion of the Hanford history of atmospheric release of iodine-131 is found in *Radionuclide Releases to the Atmosphere from Hanford Operations, 1944-1972* (Heeb 1994). The report summarizes iodine-131 release factors for the Hanford plants. The iodine-131 release factor is defined as the average curies of iodine-131 discharged to the atmosphere divided by the curies of iodine-131 in the reactor fuel slugs. Off-gas system decontamination factors (DF) are defined for iodine, as the moles of iodine entering a unit process divided by the moles of iodine exiting the unit process in the off-gas stream.

DISSOLVER CHEMISTRY

Iodine is a gaseous fission product produced during reactor fuel irradiation. The major solid form of iodine in the fuel is CsI (Pruett 1990). Iodides are readily dissolved and oxidized to elemental iodine in the hot nitric acid dissolver solutions. Iodine is then removed from solution by sparging with air. Iodine also reacts with organic materials present in the hot nitric acid to form organic iodides (Pruett 1990). Kane and Burns (1952) state that 80% of the iodine present in irradiated uranium is evolved during fuel dissolution. Raab and Van der Cook (1970) cite references for 50 and 85% iodine volatilization.

There is little discussion in the literature regarding the liberation of iodine during cladding removal. It is generally assumed that little or no iodine evolves during cladding removal. The alkalinity of the solutions used to remove aluminum and zirconium cladding would not cause iodine to evolve. Thus iodine in uranium metal dissolved during cladding removal is assumed to remain in the cladding waste.

SILVER REACTORS

An understanding of the operation of the silver reactors is key to estimating the release of iodine-129. The silver reactors consisted of columns loaded with silver nitrate coated ceramic saddles through which the plant off-gas stream is passed. Iodine in the off-gas stream reacts with the silver nitrate to form silver iodide or iodate. Iodine is removed from the off-gases by one or more of the following reactions.

$$6\ AgNO_3 + 3\ I_2 + 3\ H_2O \rightarrow 5\ AgI + AgIO_3 + 6\ HNO_3$$

$$6\ AgNO_3 + 3\ I_2 \rightarrow 5\ AgI + AgIO_3 + 6\ NO_2 + 3/2\ O_2$$

$$2\ AgNO_3 + I_2 \rightarrow 2\ AgI + 2\ NO_2 + O_2$$

$$2\ AgNO_3 + I_2 + 2\ O_2 \rightarrow 2\ AgIO_3 + 2\ NO_2$$

When in active operation the silver reactors are routinely regenerated by adding a fresh layer of silver nitrate (Raab and Van der Cook 1970). Typically, silver reactors associated with the dissolvers were regenerated when enough iodine had been charged to react half of the silver. If the silver reactors are not routinely regenerated, isotopic exchange may become an important mechanism. Isotopic exchange occurs when iodine from the off-gas exchanges with iodine from silver iodide (McClanahan 1956). When isotopic exchange is the controlling mechanism most of the iodine-131 decays before it migrates through the bed while essentially no iodine-129 decays before it migrates through. For this reason the silver reactor, after extended use has a greater decontamination factor (DF) for iodine-131 than it does for iodine-129. The impact of isotopic exchange on iodine-129 emissions for an active silver reactor, i.e., one that is routinely regenerated is unknown. After several regenerations, the flow resistance through the bed would increase from the accumulated silver salts. The reactors were then flushed to remove the salt buildup. Both water and a solution of 6 wt% NaOH and 24 wt% sodium thiosulfate ($Na_2S_2O_3$) were used in conjunction with steam sparging to flush the reactors. Based on PUREX operating records, flushing was required every two to three years (Walser 1994).

Early operating reports indicate that dissolver silver reactors were 99 to 99.9 per cent efficient at removing iodine-131 (DF of 100 to 1000) from dissolver off-gas. These values were determined by use of caustic scrubbers, which do not capture organic iodates. Later reports (1968 PUREX data) indicate 90 to 95 per cent iodine-131 removal (a DF of 10 to 20) with regenerated silver reactors and zirflex reprocessing (Raab and Van der Cook 1970). Not all of the reduction in performance is attributed to organic iodates. Poisoning with non-radioactive iodine (^{127}I) or chloride could also have contributed to the lower DF. Table 1 shows the relative abundance of iodine isotopes in irradiated fuel. Performance was also diminished when the reactors were allowed to fall below the 380 °F operating temperature.

Table 1. Iodine Content of Irradiated Fuel at Various Exposures.

Isotope	Half-life	Yield (g/MTU)
Iodine in Natural Uranium Metal at 250 MWd/MT and 60 days cooling (GE 1944).		
^{131}I	8.0207 d	0.002
Total Iodine	Not applicable	1.92
Iodine in Natural Uranium Metal at 640 MWd/MT and 90 days cooling (Buckingham 1967).		
^{131}I	8.0207 d	0.00078
Total Iodine	Not applicable	5.14
Iodine in 0.947% Enriched Uranium Metal at 900 MWd/MT and 90 days cooling (Buckingham 1967).		
^{131}I	8.0207 d	0.00093
Total Iodine	Not applicable	7.21
Iodine in 0.947% Enriched Uranium Metal at 1,000 MWd/MT and 120 days cooling (Buckingham 1967).		
^{131}I	8.0207 d	0.000074
Total Iodine	Not applicable	8.14
Iodine in N Reactor 6% Pu Fuel (80% Mark IV, 20% Mark 1A) at 1,145 MWd/MT and 120 days cooling (Hedengren 1985).		
^{127}I	Stable	1.557
^{129}I	1.57 E+07 yr	5.614
^{131}I	8.0207 d	7.776 E-05
Total Iodine	Not applicable	7.171

DISPLACEMENT OF IODINE BY CHLORIDE IN SILVER REACTORS

While PUREX was on stand-by between 1972 and 1983, the ceramic packing from two of the three fuel dissolver silver reactors were analyzed. These analyses showed that essentially all of the silver in these reactors had been converted to silver chloride. Very little iodine and essentially no iodine-129 remained on the packing (Strachan 1978). These findings indicate that either none of the iodine in the off-gas was trapped by the silver reactor or that iodine-127 and iodine-129 initially trapped was gradually released via a chloride replacement mechanism. The latter scenario is thought to be the most probable. Per the following reactions, AgCl is more thermodynamically stable than AgI.

$$2AgI + Cl_2\,(g) \rightarrow 2AgCl + I_2\,(g) \qquad \Delta G^0_{500\,K} = -64\ kJ$$

$$AgI + Cl_2\,(g) \rightarrow AgCl + ICl\,(g) \qquad \Delta G^0_{500\,K} = -49\ kJ$$

Negative Gibbs free energies are also obtained at room temperature (298 ^{0}K).

The most likely source of chloride is from trace chloride in process chemicals, process water, or recycled nitric acid. In the dissolver, chloride would have been converted to HCl or Cl_2, both of which are volatile.

MERCURIC NITRATE

During the June 1951 to December 1951 time period T and B Plants began using mercuric nitrate to suppress radioiodine emissions during the uranium dissolution step (Kupfer et. al. 1999, Kirkendall 1951). At REDOX the benefits of mercuric nitrate were mixed, although the peak emission was reduced, the overall emission of iodine-131 was not reduced (Cooper and Harmon 1960).

IODINE-129 PARTITION FACTORS FOR THE HANFORD DEFINED WASTE MODEL

Iodine-129 partition factors are discussed relative to the process campaigns defined by the Hanford Defined Waste model.

B and T Plant 1944-1949

Prior to the installation of emission control equipment in May 1948, the best estimate of the iodine release fraction is 0.905 (Heeb 1994). This release factor is assumed to be applicable to the release of iodine-129. The overall DF is 1.1. The net fraction sent to the tanks is 0.095.

During the six-month period between installation of water scrubbers in May 1948 and the installation of sand filters in December 1948 the iodine release factor was 0.285 (Heeb 1994). The water scrubbers were actually reflux condensers installed on the dissolvers. The ability to capture iodine was apparently variable, depending on the amount of water vapor being generated and the amount of reflux (Dreher 1945). Dreher (1945) reports that 70 to 80% of the iodine could be removed by reflux and the DF between the dissolver solution and product stream was about 60 (98.4% of iodine not evolved went to the metal waste). The release factor determined by Heeb (1994) is assumed to be applicable to the release of iodine-129. Therefore the DF of the reflux condenser is assumed to be 3.5. The net fraction sent to the tanks is 0.715 with 0.704 going to metal waste and 0.011 going to First Cycle (1C) waste. These splits do not include the coating waste (CW) split.

Addition of sand filters to B and T Plant in December 1948 lowered the iodine release factor to 0.25 (Heeb 1994). Although the iodine capture mechanism of the sand filters is unknown, this release factor is assumed to be applicable to the release of iodine-129. The overall iodine DF of this system is 4.0 with the effective DF of the sand filter being 1.14. The net fraction sent to the tanks in 1949 is 0.715, the sand filters captured 0.035. The most likely iodine removal mechanism for the sand filters was a surface capture mechanism. Because of its long half-life, it is likely that the iodine-129 captured by the sand filters subsequently released by chromatographic processes.

The mass weighted fraction of iodine-129 sent to the tanks from 1944 through 1949 is 0.336. Guidance on distribution of iodine-129 to plant waste streams is provided in Table 7 of *Bismuth Phosphate Process Radionuclide Partition Factors for the Hanford Defined Waste Model*, (Higley 2002). This letter says that of the iodine not released to the atmosphere, 98.333% goes to metal waste, 1.6389% goes to 1C waste, 0.02732% goes to 2C waste and 0.00046% goes to 224 waste.

B and T Plant 1950-1956

Addition of sand filters to B and T Plant in December 1948 lowered the iodine release factor to 0.25 (Heeb 1994). Although the iodine capture mechanism of the sand filters is unknown, this release factor is assumed to be applicable to the release of iodine-129. The overall iodine DF of this system is 4.0 with the effective DF of the sand filter being 1.14. The net fraction sent to the tanks is 0.715, the sand filters captured (and later released) 0.035.

Silver reactors were installed in T Plant on December 28, 1950 and B Plant on October 26, 1950. However they were not in continuous service until January 1951. The median iodine-131 release factor for silver reactors was 0.0125 based on 158 measurements taken at REDOX (Heeb 1994). Whereas the DF of the for the reflux condenser and sand filters are assumed to be identical for iodine-129 and iodine-131, the DFs for the silver reactor may be different due to isotopic exchange (McClanahan 1956). The overall iodine-131 DF of the T and B Plant off-gas systems is 80. Using a DF of 4.0 for the reflux and sand filter indicates an iodine-131 DF of 20 for the silver reactor. A DF of 10 to 20 for iodine-131 is consistent with the conclusions of Raab and Van der Cook (1970). It is assumed that routine regeneration of the silver reactors minimized isotopic exchange and that the DF for iodine-129 in the silver reactor was therefore the same as iodine-131. An overall release factor of 0.0125 is assumed for iodine-129. Volatile iodine captured by the silver reactors was returned to the tanks when the reactors were flushed. The net fraction sent to the tanks is 0.9875. The fraction captured by the sand filters is negligible (0.00175).

The mass weighted fraction of iodine-129 sent to the tanks from 1950 through 1956 is 0.933. Guidance on distribution of iodine-129 to plant waste streams is provided in Table 8 of *Bismuth Phosphate Process Radionuclide Partition Factors for the Hanford Defined Waste Model*, (Higley 2002). This table indicates that 88% of the iodine not released to the atmosphere went to metal waste and 12% went to 1C waste.

REDOX 1952-1958

REDOX was brought on line in January 1952. The REDOX off-gas treatment system consisted of a reflux condenser on the dissolver, followed by a silver reactor, an acid absorber, and a caustic scrubber. Heeb (1994) uses a generic iodine-131 release factor of 0.0125 based on 158 measurements taken at REDOX. Based on measurements made at the PUREX plant the quantity of iodine reaching the caustic scrubber was not likely to be significant (Warren 1961). It is assumed that routine regeneration of the silver reactors minimized isotopic exchange and that the DF for iodine-129 in the silver reactor was the same as iodine-131. Warren (1961) reports that the REDOX silver reactors were not flushed in the REDOX Plant, but were removed to the

T Plant Decontamination Facility for flushing. However engineers who worked at REDOX believe that a lower jumper was removed to allow in place flushing. A new prototype silver reactor was installed in A-cell in 1958 that could be regenerated in place (Warren 1961). However after installation of the prototype, REDOX processed mostly long-cooled fuel. It appears unlikely that REDOX was routinely regenerating the silver reactors after 1957. Warren (1961) notes that regeneration chemical costs for REDOX during 1958 to 1960 were abnormally low because of processing long-cooled E metal. For this assessment it is conservatively assumed that the silver reactors were eventually flushed and that the volatile iodine captured by the silver reactors was returned to the tanks. Iodine-129 captured in the acid absorbers was recycled to dissolver.

For the 1952-1958 time period an overall release factor of 0.0125 is assumed for iodine-129. The net fraction sent to the tanks is 0.9875. As previously discussed Kane and Burns (1952) state that 20% or 0.2 of the iodine-129 stays in the dissolved uranium metal feed solution. This iodine-129 did not extract into the organic phase and exited the REDOX Plant with the high-level waste. The disposition of the iodine-129 that was collected by the silver reactors is uncertain. This assessment assumes that silver reactors were flushed in place by removal of a lower jumper. The flush solution would have flowed to a cell sump and then to the waste concentrator where it was combined with high-level and other wastes and left the plant with the HLW stream. Thus all (100%) of the 0.9875 fractions should be routed to the REDOX HLW stream.

REDOX 1959-1966

A new prototype silver reactor was installed in A-cell in 1958 that could be regenerated in place (Warren 1961). This silver reactor included a valve on the bottom that could be opened by the crane operator allowing the prototype to be flushed in-place. Spent flush solution would drain to a sump from which it would be sent to the waste concentrator and then out of the REDOX Plant in the high-level waste stream. However after installation of the prototype, REDOX processed mostly long-cooled fuel. It appears unlikely that REDOX was routinely regenerating the silver reactors after 1957. Warren (1961) notes that regeneration chemical costs for REDOX during 1958 to 1960 were abnormally low because of processing long-cooled E metal. Kupfer (1999) reports that REDOX only consumed 91 lb. of $AgNO_3$ from 1965 through 1967. During the same time period PUREX consumed 2,313 lb. A review of fuel charging records indicates that REDOX rarely processed short cooled fuel (less than 150 days) after 1957. It is suspected that the performance of the REDOX silver reactors was degraded by infrequent regeneration. Although no substantiating evidence has been located, the experience at PUREX (1968-1972) suggests that about 5% of the iodine-131 was released via the stack for an overall off-gas system DF of 20. Jeppson (1976) assumes a DF of 10 for the acid absorbers, and calculates an effective DF of 2 for silver reactors in this condition. This calculation does not give any credit to the reflux condenser. It is possible that the silver reactors were never flushed after 1957. PUREX operating records indicate that the PUREX silver reactors were not flushed after regeneration was halted in 1968 (Wasler 1994). However for this assessment, it is conservatively assumed that the REDOX Plant silver reactors were eventually flushed and iodine captured by the silver reactors was returned to the tanks.

Based on Jeppson's data, an overall release factor of 0.05 is assumed for iodine-129. Iodine-129 captured in the acid absorbers was recycled to dissolver. The net fraction sent to the tanks is 0.95. It is assumed that 100% of the iodine flushed from the silver reactor plus the iodine captured by the acid absorbers eventually ended up in the waste concentrator and exited the REDOX Plant in the high-level.

PUREX 1956-1967

PUREX was brought on line in January 1956. Its iodine removal equipment included a reflux condenser, a silver reactor and fiberglass filters. Shortly after start-up, an acid absorber, and a caustic scrubber were added after the silver reactor. The caustic scrubber was later converted to a second acid absorber. In addition to the silver reactors on the dissolver off-gas, a silver reactor was also placed in the vessel vent system. As the last plant to be brought on line, the PUREX iodine-131 emission control system benefited from five years of operating experience with silver reactors in other plants. Based on 230 measurements, the median iodine-131 release fraction for PUREX was 0.002 (Heeb 1994). Iodine captured by the reflux condenser, silver reactor and acid absorber would have been discharged to the tanks. As a bounding analysis, a net fraction sent to the tanks of 0.988 will be applied up through 1966.

Based on PUREX operating records the silver reactors were initially flushed every two to three years with a caustic-thiosulfate solution. Flushing with caustic-thiosulfate was discontinued in the mid- 1960s, the A dissolver silver reactor was last flushed in August 1964, the B dissolver silver reactor in August 1966, and the C dissolver silver reactor in February 1964. Regeneration of the reactors with $AgNO_3$ was continued (Walser 1994). Silver reactors were regenerated two or three times a year. The fate of iodine-129 within the PUREX iodine suppression equipment is somewhat speculative. Unlike T and B Plant, the reflux condenser is generally given no credit for iodine suppression. This may be due to differences in the design or operation of the reflux condensers at these plants. Based on the conclusions of Raab and Van der Cook (1970), a minimum DF of 10 for a regenerated silver reactor and a DF of 50 for the acid absorber is assumed. These values result in a 0.9 fraction of the iodine-129 being retained on the silver reactor and a net fraction of 0.098 being recycled to the process and out to the tanks via the acid absorbers after 1966.

The mass weighted fraction of iodine-129 sent to the tanks from 1956 through 1967 is 0.901. The waste in three C Farm tanks (C-104, C-105, and C-107) known to have received cladding waste from PUREX exhibit relatively high iodine-129 and silver concentrations. This assessment is supported by discussions with former members of the PUREX engineering staff who confirmed that, because of piping limitations within PUREX, routing of the silver reactor flushes to the cladding waste would have been more convenient than routing to other waste streams. On this basis it is assumed that the silver reactor flushes were routed to the cladding waste tanks. However not all of the iodine left the PUREX Plant by this route. As discussed earlier, in the section on dissolver chemistry, 20% of the initial iodine-129 is thought to have remained in the solvent extraction feed. Most of the iodine was then extracted into the organic phase. The PUREX Technical Manual cites a study that concluded that up to 85% of the iodine was extracted into the organic phase (RHO 1980). Iodine in the organic solvent was removed into the organic wash waste. Based on these numbers, the iodine is distributed as follows; 3.33% of

the iodine stays in the HLW, 18.87% goes into the OWW, and the fraction added to the cladding waste is 77.80%.

PUREX 1968-1972

Because of increases in the fuel cooling time and the reduction in available iodine-131, the silver reactors became redundant for most of the 1968 to 1972 campaign. During the 1968 –1972 campaign, each PUREX silver reactor was only regenerated once, the A and C dissolver silver reactors in April 1968 and the B dissolver silver reactor in October 1968. Until 1968, regeneration of the silver reactors was based on response of the iodine-131 monitors or on samples results. Regeneration of the silver reactors was discontinued in 1968 as the minimum out of the reactor fuel cooling time for fuel being processed was increased to 180 days. In practice, the cooling time was controlled at a minimum of 200 days until shutdown of the plant in 1972. (Jeppson 1976, and Walser 1994). Based on PUREX operating records, the A dissolver was last flushed in August 1964, the B dissolver in August 1966, and the C dissolver in February 1964 (Walser 1994). In August 1972, iodine-131 stack release data from the processing of young fuel, indicates that about 5% of the iodine-131 was released via the stack for an overall off-gas system DF of 20. Jeppson (1976) assumes a DF of 10 for the acid absorbers, and calculates an effective DF of 2 for silver reactors in this condition. This calculation does not give any credit to the reflux condenser. It is speculated in the *Purex Technical Manual* that part of the iodine is believed to reflux to the dissolver during the initial acid dissolution then discharge to the condenser off-gas during the remainder of the dissolution. An overall release factor of 0.05 is assumed for iodine-129. Because the silver reactors were not flushed after 1964 (except for a water flush of B dissolver silver reactor in 1986), iodine collected by the silver reactors would remain on the reactor bed (assuming no chloride displacement). Iodine-129 captured in the acid absorbers was recycled to dissolver. Based on Jeppson's assumptions, the fraction retained by silver reactors is 0.5, the acid absorbers recycle 0.45 and 0.05 is released to the stack. The net fraction sent to the tanks is 0.45. However, the uncertainty in the effectiveness of the reflux condenser could change this number significantly. If the reflux condenser were assumed to have a DF of 2, the silver reactor a DF of 2, and the acid absorber a DF of 5, the net fraction sent to the tanks would be 0.70.

This assessment uses the Jeppson assumptions and concludes that the net fraction sent to the tanks was 0.45. This assessment will assume as previously discussed that 20% of the iodine in the fuel remains in the solvent extraction feed and is distributed 15/85 between the HLW and OWW. Thus iodine-129 is distributed as follows; 6.67% of the iodine stays in the HLW, 37.78% goes into the OWW, and the fraction added to the cladding waste is 55.55%.

PUREX 1983-1988

Jeppson (1976) discusses a proposal to not regenerate the silver reactors, but to collect and store the iodine-129 as solid waste (on the silver reactors). This would prevent release of iodine-129 from a future vitrification or calcination process. The *Purex Technical Manuel* indicates that silver reactors were periodically regenerated, but not flushed. When a reactor was no longer functional, it to be was replaced and sent to solid waste burial (RHO 1980). Prior to restart of PUREX in 1983 a decision was made to regenerate the silver reactors to control emissions of

iodine-129 to as low as reasonably achievable (ALARA). Because of the long half-life of iodine-129 (15.7 million years), more frequent regeneration based on metric tons of uranium (MTU) processed was required for control. A maximum regeneration interval of 350 MTU was established and enforced for the reactors in the dissolver off-gas systems. This interval was based on 50% loading of the silver with halogens (Walser 1994). During the 1983-1988 campaign, only the B dissolver silver reactor was flushed. Walser describes this event as a water flush but Reynolds (1987) states that the reactor was flushed with water and nitric acid. It is uncertain to what extent iodine was removed from the reactor by this procedure. Certainly $AgNO_3$ and possibly $AgIO_3$ would have dissolved in water. Silver iodide (AgI) and AgCl are not soluble in water but may have been physically removed by the water flush as particulates.

Table 2 compiles the iodine-129 emissions and iodine-129 processed from 1983 through 1992. The estimate of Iodine-129 in the fuel assumes a current fission product yield factor (0.543%).

Table 2. Comparison of Iodine-129 Emissions to Iodine-129 in the Fuel Processed.

Year	Iodine-129 in dissolved fuel (Ci)	Reported Iodine-129 Emitted to Air (Ci)	Calculated Release Fraction
1983	0.06439	0.02 (a)	0.31
1984	0.8319	0.08 (a)	0.096
1985	1.196	0.3 (b)	0.25
1986	0.6818	0.7 (b)	1.0
1987	0.2466	0.5 (c)	2.0
1988	0.3961	0.6 (d)	1.5
1989	0	0.1 (e)	Not calculated
1990	0	0.1 (e)	Not calculated
1992	0	0.05 (e)	Not calculated
1993	0	Not detected	

(a) Bihl et. al. 1985
(b) Howe et. al. 1987
(c) Coony et. al. 1988
(d) Coony et. al. 1989
(e) Coony et. al. 2002

Table 2 indicates a significant increase in the iodine-129 release factor between 1985 and 1986. A possible cause is the water flushing of the B dissolver silver reactor on June 8, 1986 (Walser 1994).

Table 3 calculates the release factors and off-gas system iodine-129 DFs for the 1983-1988 campaign using the data in Table 2.

Table 3. Release Factors Calculated from PUREX Operations 1983 through 1992.

Time Period	Iodine-129 in dissolved fuel (Ci)	Reported Iodine-129 Emitted to Air (Ci)	Calculated Release Fraction	Decontamination Factor (DF)
1983-1985	2.092	0.4	0.19	5.2
1986-1992	1.325	2.05	1.55	Not calculated
Overall 1983-1992	3.417	2.45	0.717	1.4

The PUREX Plant iodine-129 emissions, atmospheric release factors, and off-gas system DFs for the 1983-1989 campaign are mystifying since the nitric acid absorber was assumed to be capable of removing 90 to 99% of the iodine [DF from 10 to 100] (Jeppson 1976, and Raab and Van der Cook 1970). One explanation is that the iodine captured with the nitric acid recovery would just be evolved somewhere else in the PUREX process. A second explanation is that the iodine-129 measurements at the stack were biased because of a less than ideal stack sampler installation. However in terms of calculating the quantity of iodine-129 sent to the tanks these records are not particularly important since the silver reactors were not routinely flushed.

From 1983 through May 1986 fuel containing 2.56 Ci of iodine-129 was processed. After May 1986 the fuel processed contained 0.86 Ci of iodine-129. The ORIGEN2/DKPRO calculations assume that 5.09% of the iodine-129 exited the PUREX Plant directly with the cladding waste leaving 3.243 Ci to be distributed to other pathways. Twenty percent of the iodine is assumed to enter the solvent extraction system and 80% is assumed to volatilize during uranium dissolution. Based on the conclusions of Raab and Van der Cook (1970), a minimum DF of 10 for a regenerated silver reactor and a DF of 50 for the acid absorber is assumed. These values result in a 0.9 fraction of the iodine-129 being retained on the silver reactor and a net fraction of 0.098 being recycled to the process and out to the tanks via the acid absorbers. If all of the iodine captured on the B dissolver silver reactor was removed by the June 1986 water flush, 0.583 Ci were flushed to the tanks and 1.166 Ci would have remained on the silver reactors. The post May 1986 processing would have added an additional 0.586 Ci to the silver reactors. The acid absorbers would have captured 0.254 Ci and 0.00519 Ci would have been released to the air. The total iodine-129 entering the solvent extraction system from the solvent extraction feed and that via the acid absorbers is 0.903 Ci.

The fraction of iodine-129 from the ORIGEN2/DKPRO separations file that is sent to tank farms is 0.45816. This fraction is distributed as follows; 9.11% to HLW, 51.65% to the OWW, and the silver reactor flush is 39.24%. The silver reactor flush is added to the cladding waste stream.

PLANT DISCHARGES TO SOIL OF IODINE-129

B and T Plant

It is reported by Dreher (1945) in *The Evolution of Iodine During Metal Dissolution*, that in the separation of Metal Waste from 1st Decontamination By-Product, about 0.016 of the iodine-131 not evolved during metal dissolution is in the product stream. Schneider (1951) in *Flow Sheets and Flow Diagrams of Precipitation Separation Processes* indicates that the fraction in the product stream is 0.13. This may be because of the presence of Hg, which was being used in the process by that time. All waste streams from the $BiPO_4$ Process were neutralized with NaOH and routed directly to the tank farms without concentration. There were no direct discharges of waste or process condensates from the $BiPO_4$ Process to the soil.

REDOX

Iodine-131 behavior in the REDOX process was studied using laboratory bench top equipment and the results were reported in *Behavior of Iodine in the REDOX Process*, (Kane and Burns,

1952). Trace amounts of iodine-131 were left in the plutonium product (IBP) and uranium product (ICU) streams. A small fraction of iodine-131 was also found in the organic waste (ICW) stream. Waste concentration was also simulated. In the REDOX Process the condensate from the waste concentrator is combined with other condensates from other evaporators and is subjected to a second evaporation. The non-atmospheric iodine release fractions for the REDOX process are:

Stream	Fraction
Uranium Stream (ICU)	0.000002
Plutonium Stream (IBP)	0.000002
Organic Waste Stream (ICW)	0.00001
Condensate Evaporator Distillate	0.001
Total	0.001

PUREX

The routes for iodine out of the PUREX plant include, collection on silver reactors, cladding waste, off-gases, high-level waste, organic wash waste, ammonium scrubber waste, process condensates and uranium nitrate product. Loss fractions for several of these streams are discussed in *Program for Control of Iodine-129 During Zirconium Clad Fuel Reprocessing at PUREX* (Jeppson 1976). Cladding waste, high-level waste, organic wash waste and flushes from the silver reactors ended up in the underground waste storage tanks. Most of the iodine leaves in either the organic wash waste or the silver reactor flushes. Atmospheric releases, (off-gases), as discussed earlier are small. The remaining credible pathways are uranium nitrate product, ammonium scrubber waste, process condensate, and ventilation condensate. Although Jeppson provides an estimate of the fraction of iodine that leaves with the uranium nitrate product, data on the ammonium scrubber waste, and the process and ventilation condensates was not available. However, based on the ERDA 0524 Uncontrolled Release Guidelines, the iodine-129 release fractions are required to be small, less than 0.06% for the ammonia scrubber waste, and less than 0.02% for the process condensates. Unless these limits were routinely exceeded by at least a factor of 100, the impact on the tank iodine-129 inventory would not be significant. The non-atmospheric iodine release fractions for the PUREX process are:

Stream	Fraction
Uranium Nitrate Product	0.0003
Ammonia Scrubber Waste	< 0.0006 (a)
Process Condensate	< 0.0002 (a)
Ventilation Condensate	< 0.0002 (a)
Total	< 0.001

(a) these "<" values are the ERDA 0524 release limits and are not verified release fractions.

Reynolds (1987) cites a letter that reports 8% of the iodine entering PUREX being discharged to cribs. As this value may be a bounding assumption, and because the letter was not retrievable, it

will not be factored into the estimate of iodine sent to the tanks.

UNCERTAINTY IN IODINE-131 FISSION PRODUCT YIELD

Reports from the Hanford archives, in general, calculate release factors by comparing the measured iodine-131 in a waste stream to the iodine-131 in the reactor fuel elements at the time of separation. The iodine-131 in the fuel is calculated by the iodine-131 fission yield. The earliest reported iodine-131 fission yield values found by this author, were 0.019, reported in the Hanford Engineering Works Technical Manual (GE 1944), and 0.028 iodine-131 atoms per fission (Dreher 1945). A 1979 report states that "0.0288 is the current value" (Greager 1979). The ORIGEN2 data libraries from the 1980's use 0.02887, and the latest ENDF/B-VI reference has a fission yield of 0.02891 (Wootan 2002). Since the calculations of interest to this assessment occurred after 1945, the maximum possible error that may have been introduced by the differences in these values is about 3%. The actual bias that was introduced is not known since fission yield assumptions in use in the 1950's and 1960's were not reported. However the principal report of interest is the Heeb (1994) study which is based on ORIGEN2 estimates from the early 1990's, this error will be negligible.

IODINE VOLATILIZATION FROM TANK FARMS

In 1986 Tank Farm Operations observed an increase in iodine-129 in the tank vapor from AW Farm. The apparent source of the iodine was the water flush of the PUREX Plant B dissolver silver reactor in June 1986. The possible vapor species were I_2, CH_3I, and HOI (hypoiodous acid). For various reasons, the most probable species was HOI. The fraction of iodine that formed HOI is not known[1]. Several competing reactions were identified from the literature that could form insoluble iodine compounds (Reynolds 1987). These findings indicate that at some of the iodine that was discharged to the tank farms may have volatized from the waste and been released to the atmosphere. The estimated release from this occurrence was 0.00061 Ci iodine-129. The estimated iodine-129 contained in the flush ranged from 0.65 Ci to 4.0 Ci. Based on these values less than 0.1% of the iodine flushed from the reactor volatized and was released via the tank farm.

MODELING OF IODINE LOSS FACTORS BY THE HDW MODEL

Table 4 summarizes the iodine-129 partition factors for the various separation plant campaigns. Nearly all of the losses are due to atmospheric emission. Losses to the soil from aqueous discharges are negligible for tank inventory modeling purposes. Iodine that is removed from the fuel during cladding removal is assumed to remain with the cladding waste. From a tank inventory perspective, these factors are believed to be conservative. Prior to 1976 (Jeppson) there was little interest in the fate of iodine-129 in the separation processes. The iodine release factors for silver reactors and sand filters are believed to be conservative because they are based

[1] The equilibrium concentration of HOI in aqueous solutions is known to be low. In alkaline solutions the equilibrium concentration would be lower and the IO^- ion rapidly disproportionate to IO_3^- (Cotton and Wilkinson 1988).

on iodine-131. Much of the iodine-131 volatilized from the fuel is believed to have decayed before it migrated through the silver reactor beds. Essentially no iodine-129 decayed in the silver reactors due to the long iodine-129 half-life. Most of the iodine release factors derived in this paper are based on the total iodine-131 in the fuel.

Table 4. Summary of the Iodine-129 Fraction from the ORIGEN2/DKPRO uranium core file sent to Tank Waste.

Separation Plant Campaign	Net Fraction Sent to Tanks	Distribution (a)
T and B Plant 1944-1949	0.336	98.333% to MW, 1.6389% to 1C, 0.02732% to 2C, and 0.000463% to 224 waste. (Higley 2002, Table 7)
T and B Plant 1950-1956	0.933	88% to MW, 12% to 1C, 0% to 2C, and 0% to 224 waste. (Higley 2002, Table 8)
REDOX 1952-1958	0.9875	100% to HLW
REDOX 1959-1966	0.95	100% to HLW
PUREX 1956-1967	0.901	3.33% to HLW, 18.87% to OWW and 77.80% to added to the CW
PUREX 1968-1972	0.45	6.67% to HLW, 37.78% to OWW and 55.55% to added to the CW
PUREX 1983-1988	0.45816	9.11% to HLW, 51.65% to OWW, and 39.24% added to the CW

(a) These distributions are to be applied to the inventory of iodine in the ORIGEN2/DKPRO uranium core file. The curies of iodine-129 calculated by the CW fraction shown in this table are to be added to the curies of iodine-129 that are reported in the ORIGEN2/DKPRO cladding file.

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INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From:	Inventory and Flowsheet Engineering	7G300-02-NWK-036
Phone:	376-5694	
Date:	October 15, 2002	
Subject:	LEAD MODELING PARAMETERS FOR THE HANFORD DEFINED WASTE MODEL	
To:	J. G. Field	R2-12
Copies:	K. M. Bowen	S5-01
	N. W. Kirch NWK	R3-73
	D. E. Place	R3-73
	L. M. Sasaki	R2-12
	R. A. Watrous	R3-75
	BAH/LB	

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The Hanford Defined Waste (HDW) Model is being updated to reflect new information that has become available since Revision 4.0 of the model was published in January 1997, reference 1. The current version of the HDW Model, Revision 4.0, estimates a lead inventory of 279 MT. This estimate is substantially larger than the lead inventory reported by the Best-Basis Inventory (BBI). The BBI reports a total tank waste lead inventory of 84 MT.

A third estimate of the tank waste lead inventory is provided by reference 2. Reference 2 reports that there are two primary sources for lead in the tank waste. Most of the lead was introduced as part of the process to manufacture aluminum clad fuel. A smaller amount lead was used to recover crude ^{90}Sr by carrier precipitation in the PUREX and B plants. Reference 2 estimates a total lead inventory of 241,300 kg from these sources, 220,000 kg from fuel fabrication and 21,300 kg as a plant process chemical.

The intent of this letter is to establish new lead modeling assumptions for the HDW model. Most of the underlying assumptions for this update are discussed in reference 2. This letter makes additional assumptions regarding the routes of lead through the separations plants. All of the lead used in the aluminum clad fuel manufacturing process is assumed to exit the plants in the cladding waste. Lead used in the carrier precipitation processes is assumed to exit with the plant high-level waste (HLW) stream.

ALUMINUM CLAD FUEL

Aluminum clad fuel consisted of a uranium metal core surrounded by an aluminum jacket or can. An aluminum-silicon (Al-Si) braze between the uranium and aluminum components provided for a high thermal conduction and a strong metallurgical bond. To obtain a strong bond between the Al-Si braze and the uranium, it was necessary to coat the uranium core with either bronze and tin (triple dip fuel), or lead (lead dip fuel). Triple dip fabrication was used from 1944 to March 1954 after which lead dip aluminum clad fuel was fabricated. Of the 99,000 MT of fuel processed through the separation plants, 82,400 MT of the aluminum clad fuel was lead dip fuel.

The lead dip process resulted in the formation of a lead intermetallic layer in the fuel slugs. In reference 2, the intermetallic layer was determined to be 0.0025 cm thick and 100% lead. This yielded an estimate of 213,000 kg lead for the intermetallic layer. The thickness of the intermetallic layer is based on a single photomicrograph of the intermetallic layer from a sample found in reference 3. It is unknown to what extent this micrograph is representative of typical lead dip fuel. Reference 3 also states that the intermetallic layer consists of a UPb-UPb_3 compound. The ratio of UPb to UPb_3 was not determined. Traces of lead in the Al jacket and the Al-Si bond layer add another 2,180 kg of lead to this source.

During the three decades that aluminum clad fuel was used in the reactors, fuel slugs of various lengths and designs were made. The amount of lead (and aluminum) in the cladding waste, depends on the design of the fuel slug being processed by the separation plants. Table 1 shows the important characteristics of the four most prevalent fuel types. The mass of lead per metric ton of uranium (MTU) is based on the intermetallic layer being 0.0025 cm thick and 100% UPb_3.

Table 1. Design Characteristics of Common Aluminum Clad Fuel Slugs.

Uranium Enrichment	Natural	Enriched	Natural	Enriched
Uranium Core Shape	Hollow Core (I & E)[a]	Hollow Core (I & E)[a]	Solid Core	Solid Core
Nominal Length	8 inches	6 inches	8 inches	6 inches
Mass Aluminum per MTU (kg)	38.8	47.2	32.2	34.9
Mass Lead per MTU (kg)	2.03	2.10	1.40	1.39
Pb to Al ratio (kg/kg)	0.0524	0.0444	0.0436	0.0398
Pb to Al ratio (mole/mole)	0.00682	0.00578	0.00568	0.00518

(a) I & E, Internally and Externally cooled fuel elements.

B and T Plants 1944-1949

The initial fuel fabrication process used at Hanford did not use lead. Thus lead is not a constituent of B and T Plant cladding waste generated during this time period.

B and T Plants 1950-1956

Lead dip fabrication of aluminum clad fuel was not implemented until March 1954. However, because of fuel fabrication lead time, reactor residence days and fuel cooling days, processing of lead dip fuel would not have occurred before January 1, 1955. B Plant was shut down in 1952 and T Plant only processed 1,189 metric tons uranium (MTU) after January 1, 1955. This quantity of fuel is only 27% of the fuel processed by B and T Plants during 1950-1956 period and less than 1.5% of the total lead dip aluminum clad fuel processed. In addition, all of the fuel elements were solid core natural uranium. Relative to other fuel designs, the lead content of this fuel is low. Because the volume of lead dip fuel processed by T Plant after January 1, 1955 is small, the lead contribution to B and T Plant cladding waste (1950-1956) will be ignored.

REDOX Plant 1952-1960

The REDOX Plant continued to work off triple dip fuel into the month of July 1955, except for running lead dip fuel in the months of February and March 1955. From 1952 through 1958 nearly all of the fuel slugs were solid core natural uranium. Based on a review of fuel processing records and information documented in reference 2, 34% of the fuel was triple dip solid core natural uranium, 56% was lead dip solid core natural uranium, 1% was lead dip solid core enriched uranium and 9% was lead dip I & E core enriched uranium. Based on the

characteristics of these reactor fuels, the Pb to Al mole ratio of the CWR1 waste should be 0.003833. The aluminum concentration of CWR1 waste reported in Revision 4 of the HDW model is 2.0 mol/L. The lead concentration in the CWR1 stream should be changed to 0.00767 mol/L. The estimated lead inventory of the CWR1 stream is 12 MT.

REDOX Plant 1961-1966

During this time period almost all of the fuel processed by the REDOX Plant was the I & E design. Seven percent of the fuel was natural uranium and 93% was enriched fuel. Based on the characteristics of these reactor fuels, the Pb to Al mole ratio of the CWR2 waste should be 0.00584. The aluminum concentration of CWR2 waste reported in Revision 4 of the HDW model is 0.78 mol/L. The lead concentration in the CWR2 stream should be changed to 0.004551 mol/L. The estimated lead inventory of the CWR2 stream is 14 MT.

PUREX Plant 1956-1960

During this time period 74% of the fuel processed was solid core natural uranium. The rest of the fuel was I & E core natural uranium. Based on the characteristics of these reactor fuels, the Pb to Al mole ratio of the CWP1 waste should be 0.006021. The aluminum concentration of CWP1 waste reported in Revision 4 of the HDW model is 1.2 mol/L. The lead concentration in the CWP1 stream should be changed to 0.007225 mol/L. The estimated lead inventory of the CWP1 stream is 34 MT.

PUREX Plant 1961-1972

During this time period 84% of the fuel processed was I & E core natural uranium. The rest of the fuel was I & E core enriched uranium. Based on the characteristics of these reactor fuels, the Pb to Al mole ratio of the CWP2 waste should be 0.006627. The aluminum concentration of CWP2 waste reported in Revision 4 of the HDW model is 0.78 mol/L. The lead concentration in the CWP2 stream should be changed to 0.005169 mol/L. The estimated lead inventory of the CWP2 stream is 92 MT.

PUREX 1983-1988

All of the fuel processed by the PUREX Plant between 1983 and 1988 was Zircalloy clad. Zircalloy clad fuel contained only trace amounts of lead.

LEAD SULFATE CARRIER PRECIPITATION

Reference 2 discusses the use of lead sulfate to recover ^{90}Sr from PUREX HLW by carrier precipitation from 1961 through 1964. During the late 1960s, the lead sulfate carrier precipitation process was used in B Plant. The precipitate was acidified in the plants and the acid

solution was shipped to the Hot Semi-Works for final purification. Part of the lead was discharged in plant waste from PUREX and B Plant and part from the Hot Semi-Works. Essential material records report the total usage of lead by PUREX and B Plant (21,290 kg) but not its disposition. Revision 4 of the HDW model reports that 1,003 kgal of HS waste was generated with a lead concentration of 0.0034 mol/L for a total of 2,670 kg of lead. Although the HS waste contains lead, the Hot Semi-Works did not consume lead. The lead discharged from the Hot Semi-Works will be subtracted from the lead consumed by PUREX and B Plant inventory in proportion to the usage.

Hot Semi-Works 1962-1967

Revision 4 of the HDW model reports that 1,003 kgal of HS waste was generated with a lead concentration of 0.0034 mol/L for a total of 2,670 kg of lead. This letter does not change the lead concentration of HS waste.

PUREX 1956-1962

During 1961 and 1962 it is estimated that the lead sulfate carrier precipitation process consumed 2,650 kg of lead at the PUREX Plant (reference 2 appendix F). The estimated portion of lead carried over to the Hot Semi-Works process is 332 kg. Lead not shipped to the Hot Semi-Works was discharged from the PUREX Plant in the P1 waste. Revision 4 of the HDW model reports the volume of the P1 waste stream as 26,502 kgal. Based on the mass of lead (2,318 kg [2,650 kg minus 332 kg]) and the volume of the P1 stream, the average concentration of lead in the P1 waste is 1.115 E-04 mol/L.

PUREX 1963-1967

During 1963 and 1964 it is estimated that the lead sulfate carrier precipitation process consumed 8,640 kg of lead (reference 2 appendix F). A crude separation was obtained within PUREX by dissolving the strontium away from the lead. This crude strontium product shipped to the Hot Semi-Works for additional purification contained about 1,084 kg lead. The remainder of the lead (7,556 kg) was discharged with the P2 waste. Revision 4 of the HDW model reports the volume of the P2 waste stream as 10,208 kgal. Based on the mass of lead and the volume of the P2 stream, the average concentration of lead in the P2 waste is 9.439 E-04 mol/L.

B Plant 1967-1972

During the late 1960s, the lead sulfate carrier precipitation process was used in B Plant to recover "crude" ^{90}Sr. Reference 2 reports that 10,000 kg of lead was used for this purpose. The crude strontium product shipped to the Hot Semi-Works for additional purification contained about 1,254 kg lead. It is assumed that this lead left B Plant in the HLW stream. Given the volume of 'B' waste assumed by the Revision 4 of the HDW model (10,569 kgal), the average

concentration of lead in the B waste stream is 1.055 E-03 mol/L. This concentration is about 1,000 times larger than the existing concentration

SUMMARY

Table 2 summarizes the revised waste stream concentration for lead. The lead concentrations of other waste streams are not changed.

Table 2. Lead Concentrations Revisions for Updating the HDW Model.

Waste Stream	Revised Lead Concentrations (mol/L)
CWR1	0.00767
CWR2	0.004551
CWP1	0.007225
CWP2	0.005169
P1	0.0001115
P2	0.0009439
B	0.001055

These changes are expected to lower the total HDW model tank waste inventory estimate for lead from 279 MT to about 170 MT.

Bruce A Higley

Bruce. A. Higley
Principal Engineer

sir

INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From:	Inventory and Flowsheet Engineering	7G300-02-NWK-037
Phone:	376-0176	
Date:	October 29, 2002	
Subject:	EVALUATION OF SOLUBILITY LIMITS BASED THE TANK CHARACTERIZATION DATABASE	

To: J. G. Field R2-12

Copies:

K. M. Bowen	R2-12	L. M. Sasaki	R2-12
B. A. Higley	R3-73	R. A. Watrous	R3-73
N. W. Kirch NWK	R3-73	S. R. Wilmarth	R2-12
S. L. Lambert	R3-73	DEP File	
		NWK File/LB	

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2. Agnew, S. F. and J. G. Watkin, 1994, "Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernates," LAUR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

3. Correspondence FDNW-ENI-98-006, R. J. Puigh (FDNW) to J. W. Cammann (LMHC), September, 1998, "DKPRO Runs for Tank Inventories," Fluor Daniel Northwest, Richland, Washington.

4. Interoffice Memo, 7G300-02-JGF-010, S. R. Wilmarth to J. G. Field, October 21, 2002, "Solubility Calculations," CH2M HILL Hanford Group, Inc., Richland, Washington.

The Hanford Defined Waste (HDW) Model is being revised to incorporate information that has become available since Revision 4 (Reference 1) was published in January 1997, Revision 4 of the HDW model relies heavily on solubility estimates made in October 1994 (Reference 2) to partition chemicals and radionuclides between solid and liquid phases. One task in completing the Revision 5 update is to revaluate the solubility limits using newer analytical data (post 1989) that have improved analytical methods and Quality Assurance protocols.

The methodology employed in the Agnew and Watkin solubility document (Reference 2) is basically to compute the mean of the top 25% of available liquid concentrations for each analyte (75%-trimmed mean). The methodology assumes that the top 25% of rank-ordered data represents saturation for the analyte. This assumption is not always valid, however the method does provide an efficient method of prediction of the solubility limits for modeling. Due to time and budget constrains, no attempt was made to alter or improve this basic methodology. However, criteria for data selection were developed to assure that the best analytical methods

were used and that tanks waste conditions that would lead to concentrations outliers were excluded (i.e. low pH or high concentrations of complexants). The data for the highly complexed wastes (Total Organic Carbon > 30 g/L) were evaluated separately to provide waste-type specific estimates for use in the HDW model Revision. 5.

The criteria for analytical methods and data exclusion are provided in the attached Table 1. The older "Historical" analytical methods were excluded from consideration. Data for complexant tanks 241-AN-102, AN-107, U-105 and U-106 were segregated from other data based on Total Organic Carbon (TOC) concentrations exceeding 30g/L and high concentrations for normally insoluble metals and radionuclides. Other tank wastes exceeded 10 g/L TOC, however the effect on metal solubility was much less pronounced and sometimes indiscernible. Data for liquid wastes with a pH of less than 12 were also excluded (241-C-103, C-106 and C-110), as were data from double-shell tanks 241-AY-101 and AY-102 during periods when the hydroxide ion concentration was not within specification.

Liquid compositions available in the Tank Characterization Database representing unaltered sample analyses were downloaded, the primary and duplicate analyses were averaged and spreadsheet compatible files were created. The data selection rules outlined in Table 1 were implemented by entering the appropriate justification in a "Data Exclusion" column. The overall mean, the 50%-trimmed mean and the 75%-trimmed mean were calculated using S-Plus 2000[1] statistical software and the annotated spreadsheets. After an initial trial, the outliers showing comparatively high analyte concentrations were individually evaluated. Not all of the concentration outliers (high concentration tails in Figures 1 and 2) represent flawed or invalid data. For example, the high concentrations of cesium-137 for non-complexed wastes represent the higher inventories present the tank 241-AZ-101 and 241-AZ-102 high-level waste supernate. Seventy-one additional data points were excluded based on at these evaluations, usually as the result of inconsistency with data from nearby samples from the same tank. The seventy-one outliers were marked for data exclusion in the input data, and the means were recalculated using the S-Plus 2000 software. Additional information concerning the statistical treatment is available in Reference 4. The liquid concentration data used in this solubility limit evaluation are stored on the STDINV shared drive in HDW subdirectory.

The TCD did not contain usable data for several radionuclides, including ^{106}Ru, ^{113m}Cd, ^{125}Sb, ^{154}Eu and ^{155}Eu. However, the TCD does contain chemical concentration data for the associated chemical elements or elements which would be expected to exhibit similar solubility behavior (for example the solubility of europium should be similar to lanthanum since both are rare earth metals). The chemical solubility limits were converted to a radionuclide solubility limit by fuel processing plant using the ORIGEN2 isotopic distributions (Reference 3), which reports radionuclides as of January 1, 1994. Additionally, the solubility limits of ^{60}Co, ^{90}Sr and ^{154}Eu were baselined to January 1, 1994 to compensate for the changing isotopic distributions due to the relatively short half-lives (5.721, 28.78 and 8.593 years respectively).

[1] Statistical software manufactured by Data Analysis Product Division, Mathsoft, Inc., Seattle, Washington.

Plots of the included analytical data are provided in Figure 1 for non-complexed liquid waste and in Figure 2 for highly complexed waste. The overall, 50%-trimmed and 75%-trimmed means and the associated standard deviations were calculated using S-Plus 2000 software are provided in Table 2 (non-complexed) and Table 3 (highly complexed).

Final recommendations for partitioning chemicals and radionuclides between liquid and solid phases are provided in Table 4. Short-lived radionuclide concentrations in Table 4 have been decay corrected to January 1, 2001 to match the basis date for the HDW model Revision 5. The revised solubility limits and partitioning schemes will be evaluated by incorporation in a draft HDW model revision. Those that improve the accuracy of the HDW model estimates will be incorporated in the HDW model Rev. 5.

David E. Place

D. E. Place,
Principal Engineer

sir

Attachment

Table 1 Tank Characterization Database Solubility Data for HDW Model Rev. 5

Analyte	Liquid Analyses Available	Recommended Basis
Al	ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A.
Bi	ICP and ICP:A	Use ICP and ICP:A.
Ca	ICP, ICP:A, ICP:W, Hist. ICP and ICP:F.	Use ICP and ICP:A.
Cl	IC, IC:W and Hist. IC.	Use IC.
TIC as CO3	Acid decomposition, Hist. CO3, Hist. TIC/TOC, Persulfate Oxidation, TIC/TOC/TC:W.	Use Persulfate Oxidation.
Cr	ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A.
F	IC, IC:W and Hist. IC.	Use IC.
Fe	ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A.
Hg	AA (Hg), AA CLP (Hg), AA:A CLP (Hg), CVAA (Hg) and CVAA:A (Hg).	Use CVAA (Hg) and CVAA:A (Hg).
K	ICP, ICP:A, ICP/MS and Hist. ICP	Use ICP and ICP:A.
La	ICP, ICP:A, ICP/MS and ICP/MS:A.	Use ICP/MS and ICP/MS:A.
Ni	ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A.
Mn	ICP, ICP:A and Hist. ICP	Use ICP and ICP:A.
Na	ICP, ICP:A, ICP:W, ICP:F, ICP/MS and Hist. ICP	Use ICP and ICP:A.
NO2	IC, IC:W, Hist. IC, Spectrophotometric, Spectrophotometric:W.	Use IC.
NO3	IC, IC:W and Hist. IC.	Use IC.
OH	Hist. OH, OH, OH:W, OH Automatic and OH Automatic:W.	Use OH.
Pb	ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A.
PO4	Use phosphorus - ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A for phosphorus.
Si	ICP, ICP:A, ICP:W, ICP:F, and Hist. ICP	Use ICP and ICP:A.
SO4	Use sulfur ICP and ICP:A.	Use ICP and ICP:A for sulfur.
Sr	ICP, ICP:A, ICP:W and Hist. ICP	Use ICP and ICP:A.
TOC	TOC, Hist. TIC/TOC, Persulfate Oxidation, Furnace Oxidation, Furnace Oxidation:W and TIC/TOC/TC:W.	Use Persulfate Oxidation.
U	ICP, ICP:A, ICP:W, ICP/MS:A, Hist. ICP, Laser Fluorimetry (including :W, :A and :F) and Kinetic Phosphorescence (including :A)	Use Laser Fluorimetry, Laser Fluorimetry:A, Kinetic Phosphorescence and Kinetic Phosphorescence:A.
Zr	ICP, ICP:A, ICP:W, ICP:F and Hist. ICP	Use ICP and ICP:A.
3H	H3:A, Hist. LSC, Liquid Scintillation (including :A, :W and :F)	Use Liquid Scintillation and Liquid Scintillation:A.
14C	C14, Hist. LCS and Liquid Scintillation (including :A and :W)	Use ^{14}C and Liquid Scintillation.
59Ni		Use Ni analog.

Tank Characterization Database Solubility Data for HDW Model Rev. 5

Analyte	Liquid Analyses Available	Recommended Basis
60Co	GEA, GEA:A, GEA:W, Hist. GEA	Use GEA and GEA:A. Corrections required for isotopic abundance in newer wastes.
63Ni		Use Ni analog.
79Se	Se79, Se:79:W, Se79:A, Hist. LCS, Beta Rad:A, Liquid Scintillation and Liquid Scintillation:A.	Se79, Se79:A, Beta Rad:A, Liquid Scintillation and Liquid Scintillation:A.
90Sr	Hist. BPC, Coprecipitation/Beta Counting, GEA, Sr89/90 (including :A and :F) and Beta Rad:A.	Use Coprecipitation/Beta Counting, Sr89/90, Sr89/90:A and Beta Rad:A.
90Y	NA	Tie to 90Sr.
93Zr	No data.	Tie to Zr analog.
93mNb	No data - no obvious analog.	Use Zr as analog corrected for isotopic abundance.
99Tc	Hist. LSC, Bet Rad:A, ICP/MS, ICP/MS:A, Tc99 and Tc:99:A.	Use ICP/MS, ICP/MS:A, Tc99 and Tc:99:A.
106Ru	GEA, GEA:A, GEA:W, Hist. GEA. ICP, ICP:A, ICP:W, Hist. ICP, ICP/MS and ICP/MS:A.	All of the detected radiochemical data are suspect. Need to use ICP/MS and ICP/MS:A data corrected by approximate isotopic abundance.
113mCd	No radiochemical data. ICP, ICP:A and Hist. ICP available for Cd.	Use Cd analog (ICP and ICP:A) corrected for isotopic abundance (global since Cd added).
125Sb	GEA, GEA:A, and Hist. GEA. AA:A (Sb), GFAA:A. ICP, ICP:A, ICP:W, Hist. ICP, ICP/MS and ICP/MS:A for antimony.	No detected radiochemical data. Use ICP/MS and ICP/MS:A for antimony analog corrected for isotopic abundance.
126Sn	GEA:A, ICP/MS and ICP/MS:A. ICP and ICP:A for tin.	ICP/MS and ICP/MS:A.
129I	I129, I129:W, Hist. GEA, ICP/MS and ICP/MS:A.	I129, I129:W, ICP/MS and ICP/MS:A. Problem with varying isotopic abundance.
134Cs	GEA, GEA:W, GEA:A and Hist. GEA.	Use 137Cs analog that has a longer half-life and more data.
137Cs	GEA, GEA:W, GEA:A, GEA:F Hist. GEA, ICP/MS and ICP/MS:A.	GEA or GEA:A.
137mBa	Tied to 137Cs due to short half-life.	Tie to 137Cs.
151Sm	ICP, ICP:A, ICP/MS and ICP/MS:A for AMU-151 and Sm.	Use La rare earth analog corrected for isotopic abundance. AN-103 detect is not consistent with other data. T-107 data is suspect due to qualifications. AY-101 was not in pH control.
152Eu	GEA (no detects), ICP, ICP:A, ICP/MS or ICP/MS:A for Eu.	Use 154Eu analog.
154Eu	GEA, GEA:W, GEA:A, Hist. GEA, and ICP,-ICP:A, ICP/MS, ICP/MS:A for Eu.	GEA and GEA:A. Only good data is from SY-102 and SY-103.
155Eu	GEA, GEA:W, GEA:A, Hist. GEA, and ICP, ICP:A, ICP/MS, ICP/MS:A for Eu.	No good data, only detects were for CC in AN-107. Use 154Eu analog.

Tank Characterization Database Solubility Data for HDW Model Rev. 5

Analyte	Liquid Analyses Available	Recommended Basis
226Ra	Two detected values are suspect (inconsistent with surrounding data).	
227Ac	No data.	
228Ra	No data.	
229Th	GEA, ICP/MS and ICP/MS:A.	Use 232Th analog for SY-102 only.
231Pa	GEA, ICP/MS and ICP/MS:A.	Use ICP/MS and ICP/MS:A.
232Th	ICP, ICP:A, ICP:W, ICP/MS, ICP/MS:A and Hist. ICP	Use SY-102 only ICP/MS:A.
232U		Use U Total analog.
233U		Use U Total analog.
234U		Use U Total analog.
235U		Use U Total analog.
236U		Use U Total analog.
237Np	Alpha Rad:W, GEA, Hist. AEA, ICP/MS, ICP/MS:A, TIOA-TTA Extract/Alpha, TIOA-TTA Extract/Alpha:A and TIOA-TTA Extract/Alpha:F.	Use ICP/MS, ICP/MS:A, TIOA-TTA Extract/Alpha and TIOA-TTA Extract/Alpha:A.
238Pu	AEA, AEA:A, AEA:A (Am241), Alpha Rad:W, Alpha Spec, Alpha Spec:W, Alpha Spec:F, Hist. AEA, Pu239/240, Spectroscopy:A and Total Pu:A.	Use 239/240Pu analog, 238Pu results generally unreliable as very near detection limit.
238U		Use U Total analog.
239/240Pu	AEA, AEA:A, AEA:A (Am241), Alpha Rad:W, Alpha Spec, Alpha Spec:W, Alpha Spec:F, GEA, Hist. AEA, ICP/MS, ICP/MS:A, Liquid Scintillation, Pu239/240, Spectroscopy:A and Total Pu:A.	AEA, AEA:A , Spectroscopy:A and Pu239/240.
239Pu	ICP/MS, ICP/MS:A, Hist. AEA and Pu239/240.	Use 239/240Pu analog.
240Pu	ICP/MS, ICP/MS:A, and Hist. AEA	Use 239/240Pu analog - data for C-104 and AZ-101 only.
241Am	AEA, AEA:A (Am241), Alpha Rad:W, Alpha Spec, Alpha Spec:W, Alpha Spec:F, GEA, GEA:A, GEA:W, Hist. AEA, Hist. APC and Spectroscopy:A.	Use AEA, AEA:A (Am241), Alpha Spec and Spectroscopy:A.
241Pu	Historical Liquid Scintillation, Hist. AEA	Use 239/240Pu analog, data for 241Pu available for C-104 and AZ-101 only.
242Cm	Alpha Spec, Hist. AEA	Use 243/244Cm, only C-104 has detected 242Cm.
242Pu	No data including AMU-242	Use 239/240Pu analog.
243Am	No data (including AMU-243) - one detected value is outlier.	Use 241Am analog.
243/244Cm	AEA, AEA:A (AM241), Alpha Spec, Alpha Spec:W, GEA:A, Hist. AEA and Spectroscopy:A.	Use Alpha Spec and Spectroscopy:A.
243Cm	No data.	Use 243/244Cm analog.
244Cm	No detected results (including AMU-244).	Use 243/244Cm analog.

Tank Characterization Database Solubility Data for HDW Model Rev. 5

Non-BBI chemical analytes needed for radioisotopes: Cd, Ru, Sb and Eu.

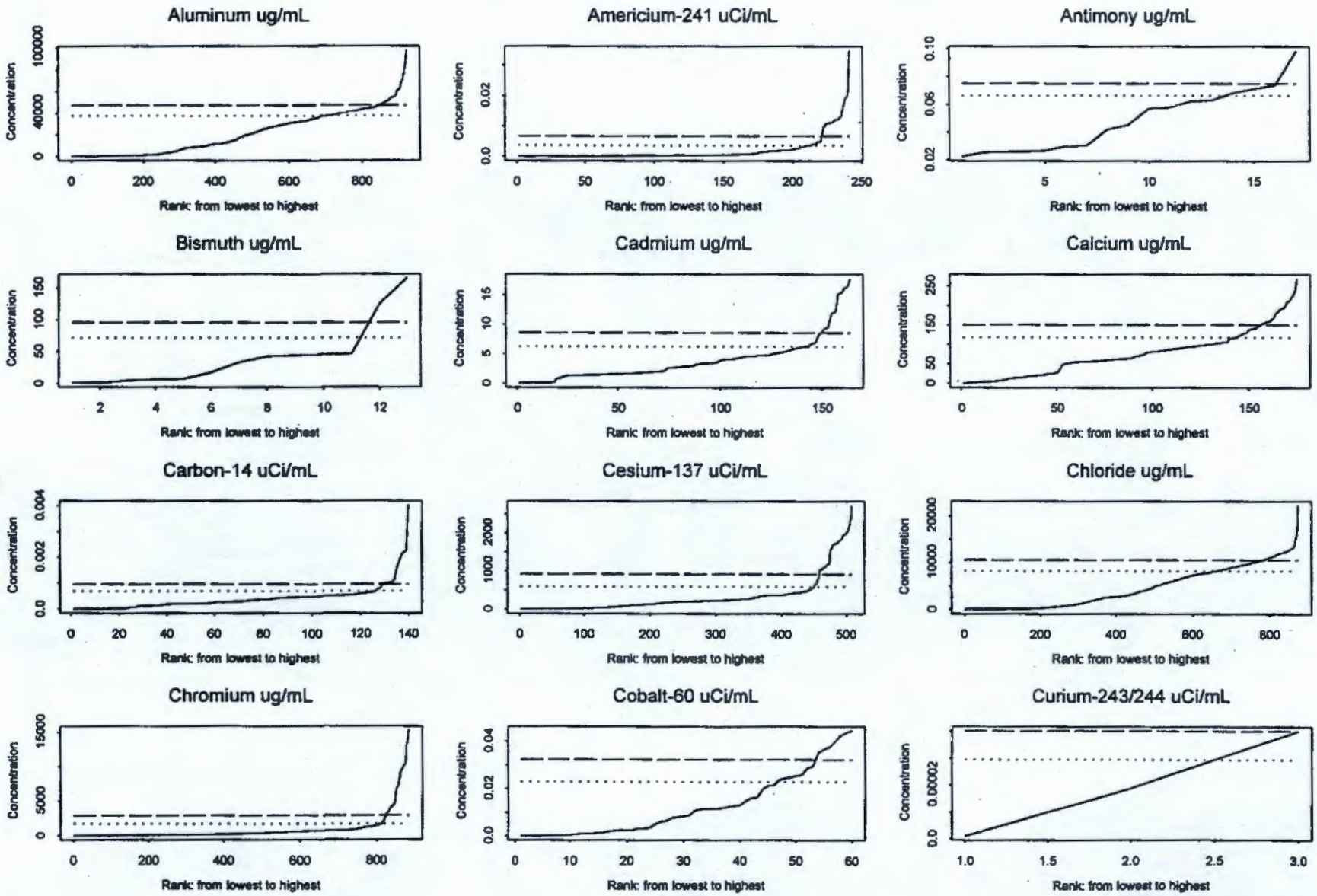
Data Selection Rules

Tank Exclusions:

AN-102	Complexant Concentrate
AN-107	Complexant Concentrate
U-105	Highly complexed waste
U-106	Highly complexed waste
C-103, C-106 and C-110.	Low pH
AY-101	Low pH prior to 1/1/2001. Also exclude drainable liquid analyses for 2002 samples that appear to include entrained solids based on comparison to centrifuged liquid analyses (to be marked Data Suspect per Data Review Committee action - see August 26, 2002 DRC Meeting Minutes).
AY-102	Data from some time periods reflect low pH condition.

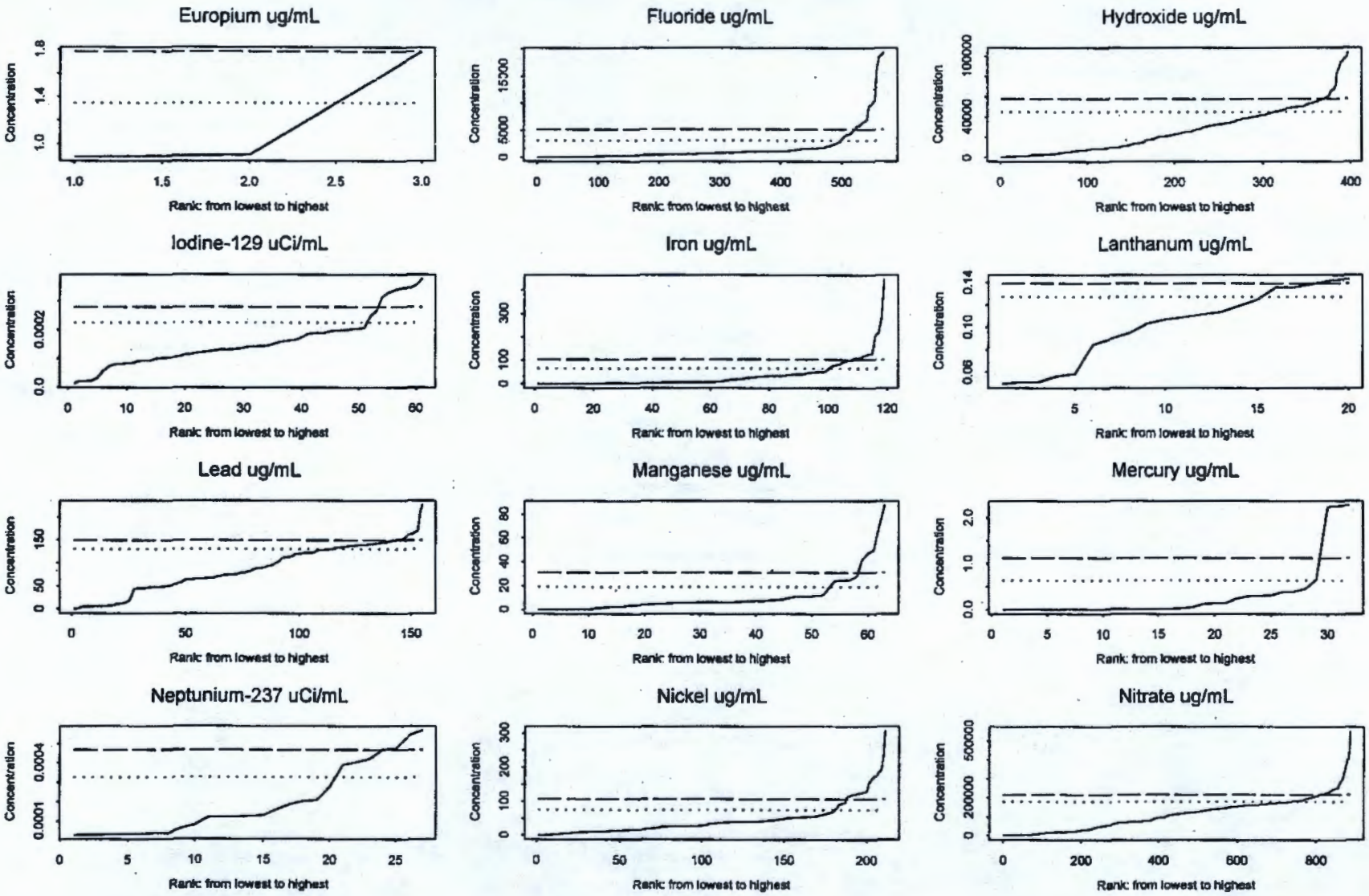
Other exclusions:
Solid data, liner liquid, QA or special samples, suspect data, detection limits, water and fusion digests for liquid samples and non-standard units (ug/g or uCi/g for liquid).

Figure 1 Liquid Concentration Data for Non-Complexed Waste



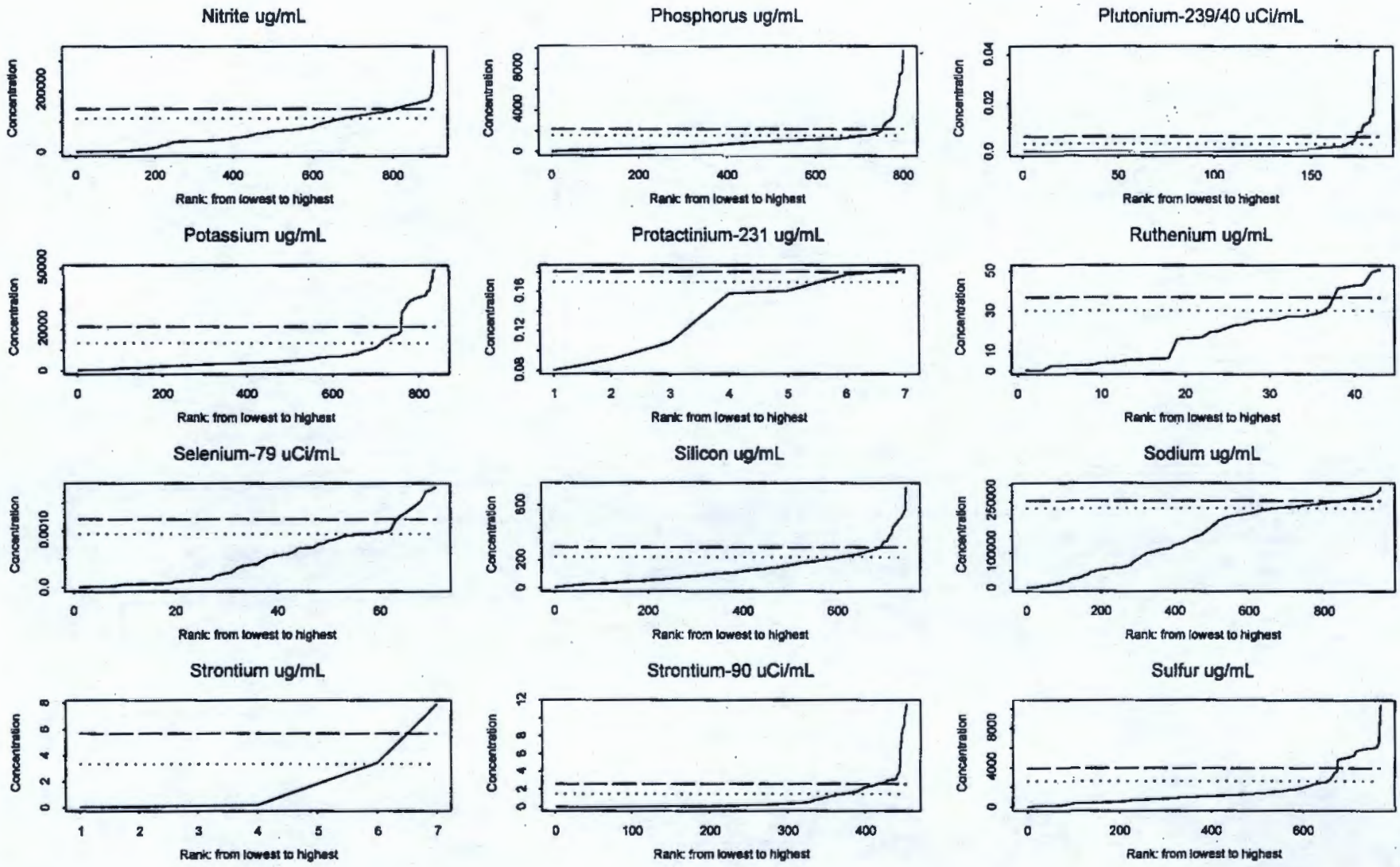
Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 1 Liquid Concentration Data for Non-Complexed Waste



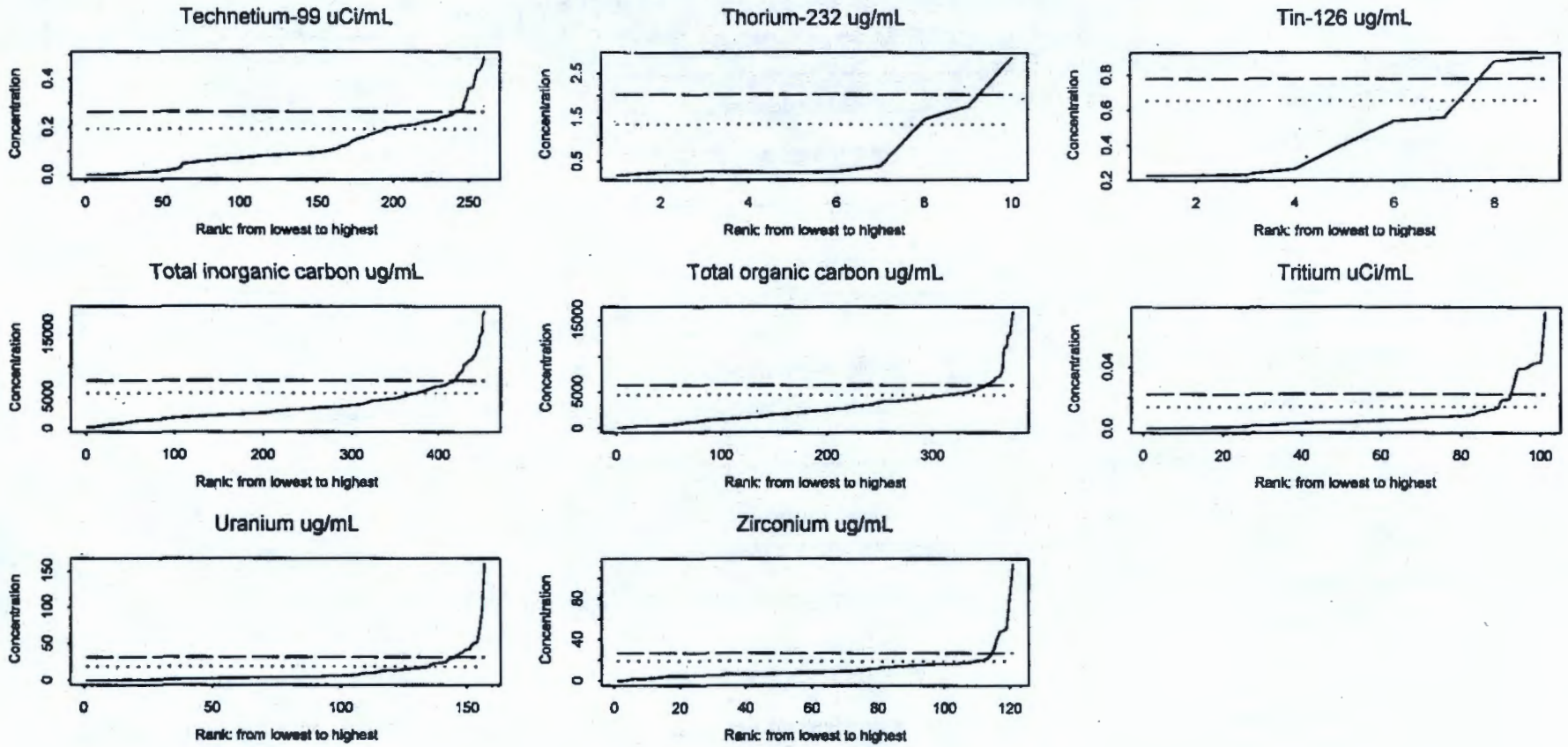
Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 1 Liquid Concentration Data for Non-Complexed Waste



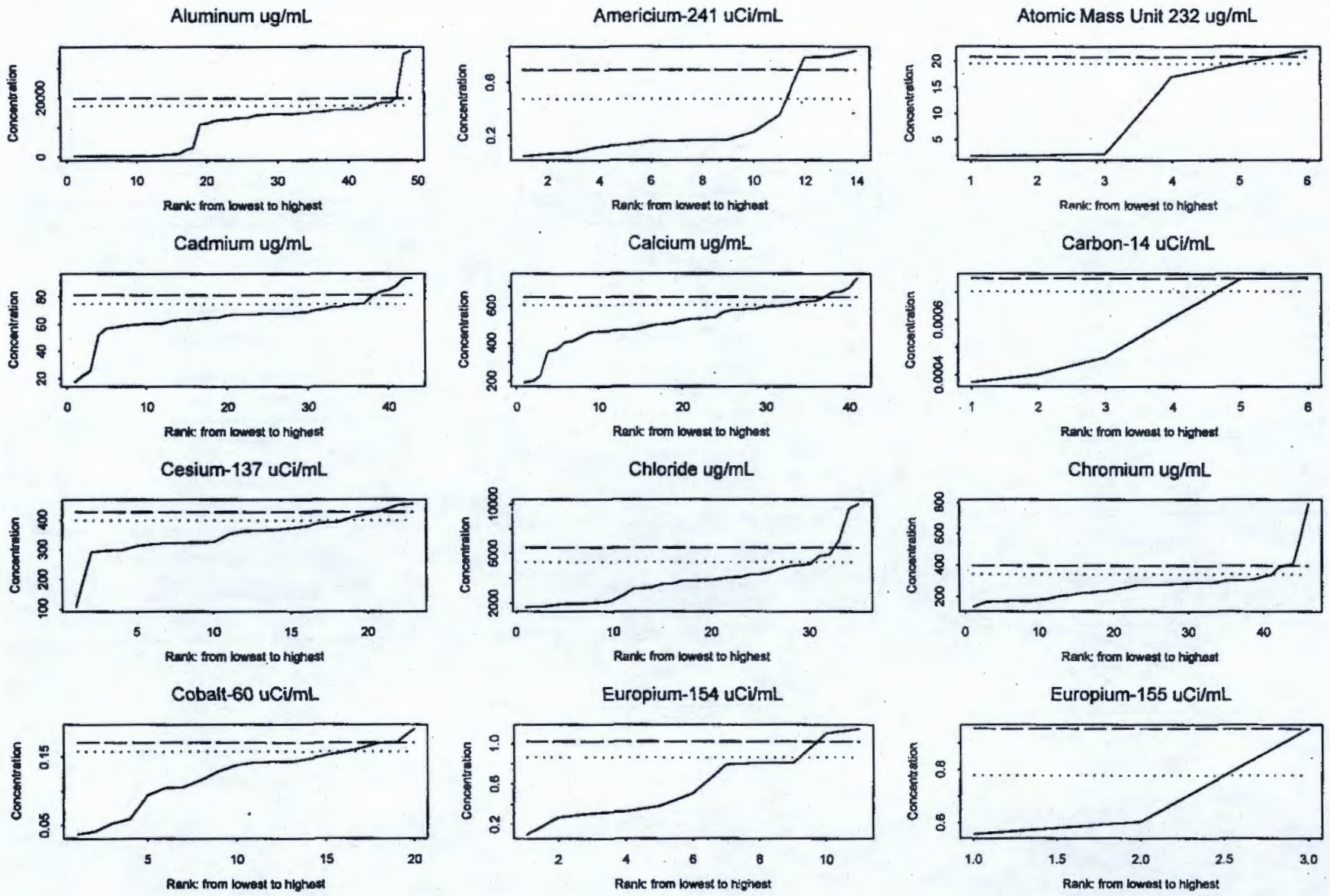
Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 1 Liquid Concentration Data for Non-Complexed Waste



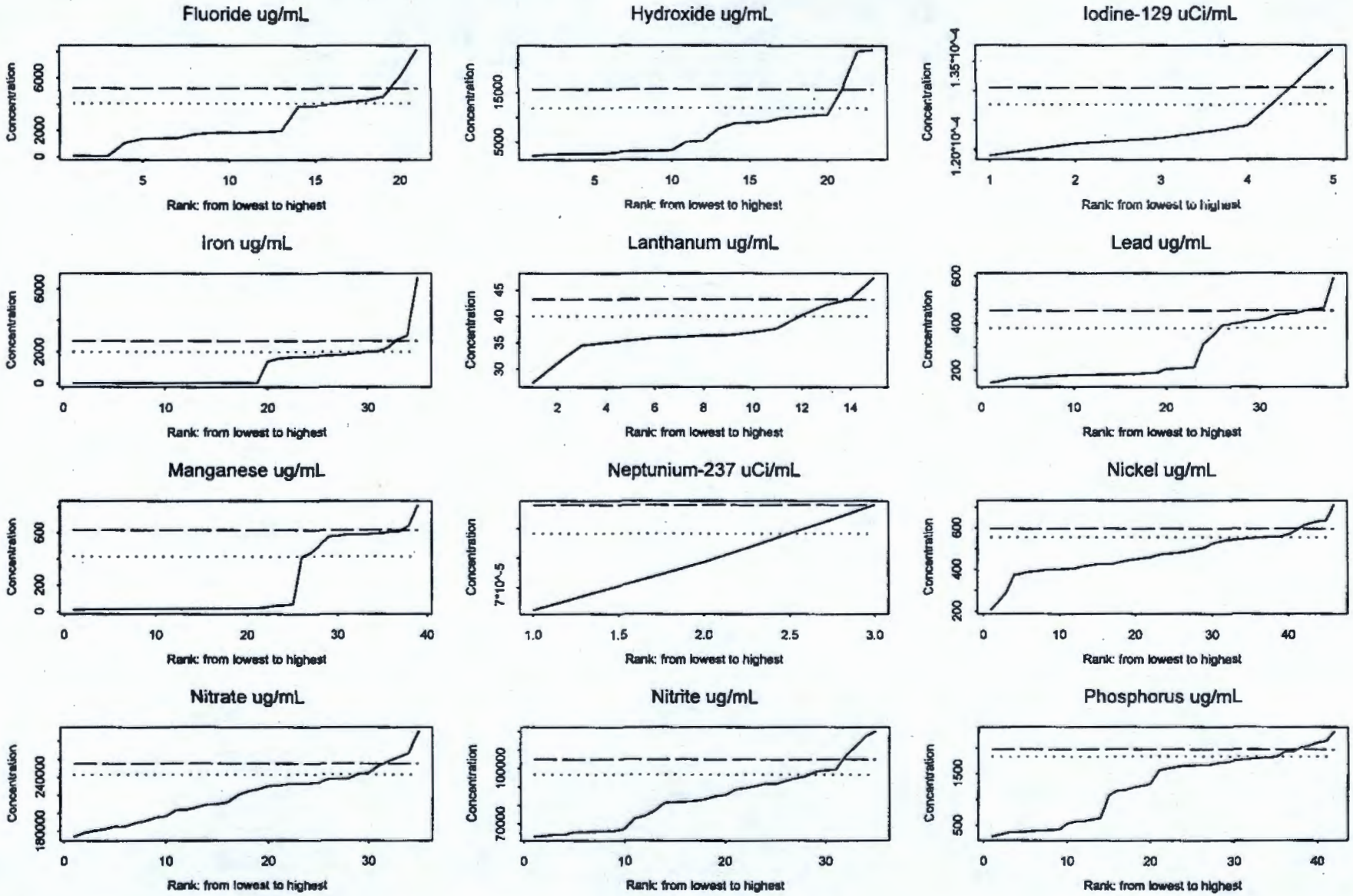
Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 2 Liquid Concentration Data for Highly Complexed Waste



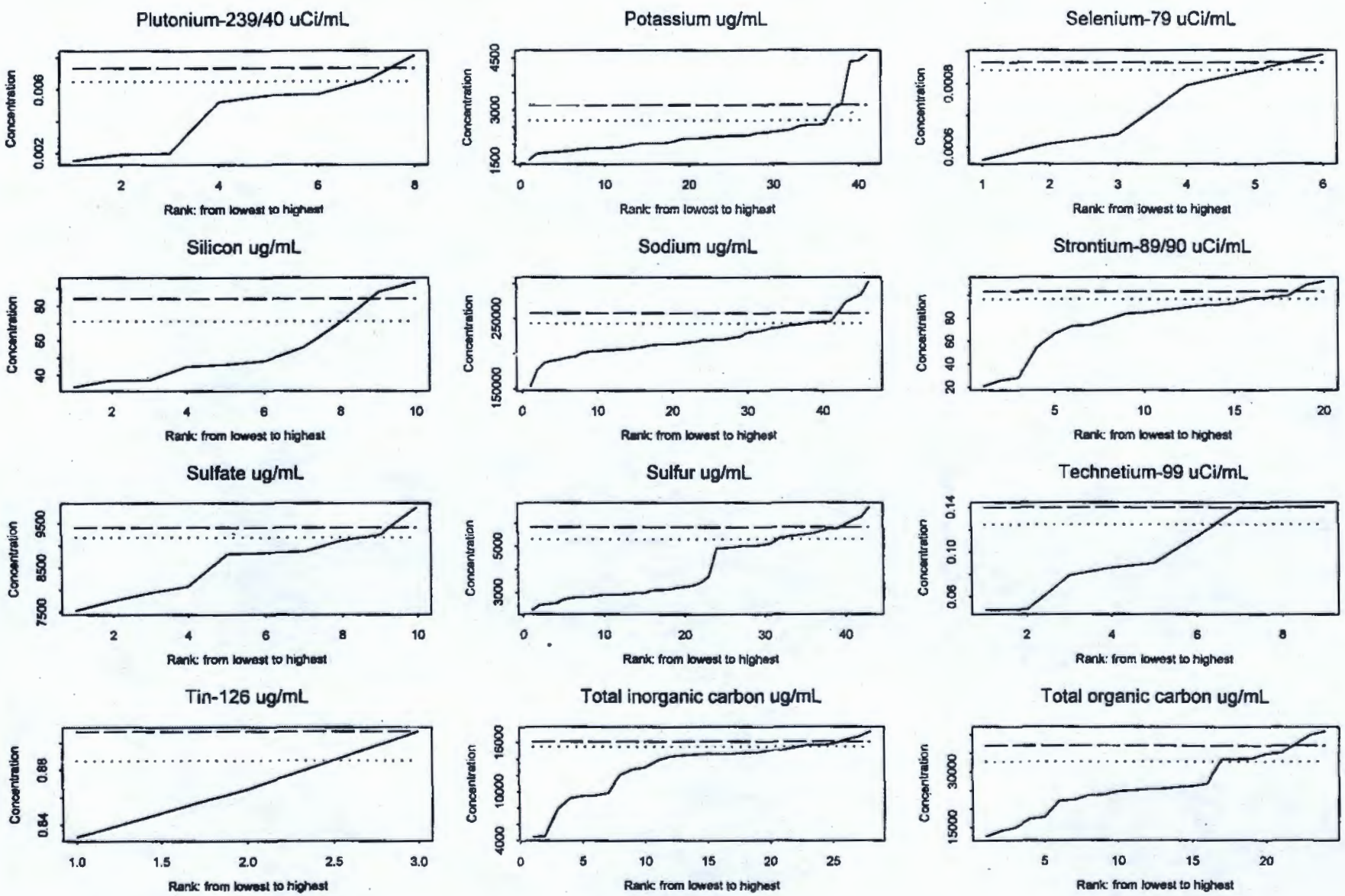
Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 2 Liquid Concentration Data for Highly Complexed Waste



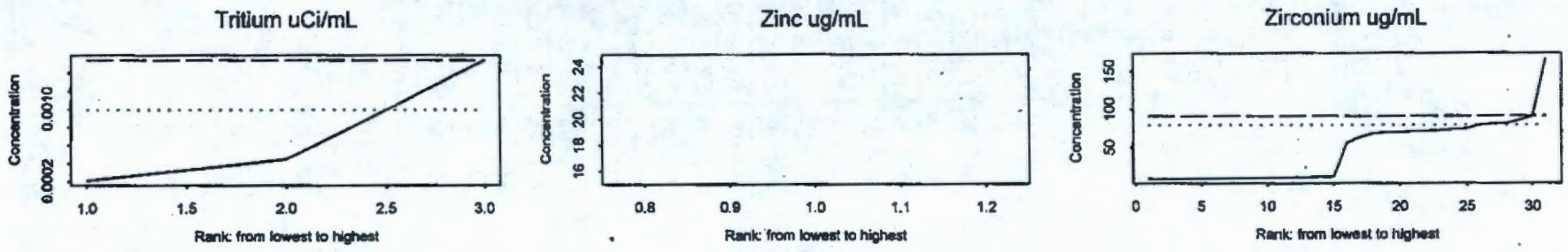
Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 2 Liquid Concentration Data for Highly Complexed Waste



Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Figure 2 Liquid Concentration Data for Highly Complexed Waste



Upper horizontal line = 75%-trimmed mean
Lower horizontal line = 50%-trimmed mean

Table 2 Statistics for Non-Complexed Waste

Constituent	Units	#Obs	Average	SD(Avg)	Avg50	SD(Avg50)	Avg75	SD(Avg75)
Aluminum	ug/mL	923	2.10E+04	6.35E+02	3.77E+04	5.97E+02	4.73E+04	7.03E+02
Americium-241	uCi/mL	241	1.95E-03	2.75E-04	3.71E-03	4.98E-04	6.73E-03	8.23E-04
Antimony	ug/mL	17	4.87E-02	5.46E-03	6.65E-02	4.95E-03	7.51E-02	6.17E-03
Bismuth	ug/mL	13	4.18E+01	1.39E+01	7.22E+01	1.95E+01	9.60E+01	2.98E+01
Cadmium	ug/mL	164	3.82E+00	2.83E-01	6.27E+00	4.08E-01	8.60E+00	6.26E-01
Calcium	ug/mL	175	7.47E+01	4.30E+00	1.19E+02	4.81E+00	1.50E+02	6.32E+00
Carbon-14	uCi/mL	140	4.12E-04	4.25E-05	6.91E-04	6.99E-05	9.59E-04	1.24E-04
Cesium-137	uCi/mL	508	3.32E+02	2.13E+01	5.96E+02	3.54E+01	9.25E+02	5.68E+01
Chloride	ug/mL	874	4.60E+03	1.44E+02	8.26E+03	1.40E+02	1.06E+04	1.33E+02
Chromium	ug/mL	886	8.91E+02	7.06E+01	1.69E+03	1.30E+02	2.88E+03	2.35E+02
Cobalt-60	uCi/mL	60	1.27E-02	1.70E-03	2.30E-02	2.07E-03	3.24E-02	2.11E-03
Curium-243/244	uCi/mL	3	NA	NA	NA	NA	NA	NA
Europium	ug/mL	3	NA	NA	NA	NA	NA	NA
Fluoride	ug/mL	568	1.73E+03	1.34E+02	3.13E+03	2.40E+02	5.20E+03	4.13E+02
Hydroxide	ug/mL	397	2.68E+04	1.13E+03	4.50E+04	1.24E+03	5.76E+04	1.62E+03
Iodine-129	uCi/mL	61	1.59E-04	1.16E-05	2.25E-04	1.39E-05	2.80E-04	1.74E-05
Iron	ug/mL	119	3.48E+01	5.55E+00	6.59E+01	9.44E+00	1.05E+02	1.52E+01
Lanthanum	ug/mL	20	1.01E-01	7.34E-03	1.27E-01	4.20E-03	1.39E-01	1.51E-03
Lead	ug/mL	155	8.69E+01	4.11E+00	1.30E+02	2.92E+00	1.49E+02	3.03E+00
Manganese	ug/mL	63	1.09E+01	2.08E+00	1.91E+01	3.54E+00	3.11E+01	5.71E+00
Mercury	ug/mL	35	3.25E-01	1.15E-01	6.40E-01	2.04E-01	1.12E+00	3.35E-01
Neptunium-237	uCi/mL	27	1.97E-04	3.46E-05	3.27E-04	4.25E-05	4.69E-04	2.61E-05
Nickel	ug/mL	211	4.56E+01	3.22E+00	7.50E+01	4.88E+00	1.07E+02	7.54E+00
Nitrate	ug/mL	887	1.12E+05	2.81E+03	1.80E+05	2.82E+03	2.17E+05	4.24E+03
Nitrite	ug/mL	903	6.68E+04	1.77E+03	1.11E+05	1.75E+03	1.42E+05	1.62E+03
Phosphorus	ug/mL	800	9.52E+02	4.04E+01	1.58E+03	6.70E+01	2.19E+03	1.19E+02
Plutonium-239/40	uCi/mL	185	1.68E-03	4.23E-04	3.29E-03	8.10E-04	6.25E-03	1.49E-03
Potassium	ug/mL	839	7.68E+03	3.56E+02	1.33E+04	5.93E+02	2.14E+04	8.80E+02
Protactinium-231	ug/mL	7	1.37E-01	1.61E-02	1.70E-01	6.12E-03	1.80E-01	2.75E-03
Ruthenium	ug/mL	43	1.83E+01	2.26E+00	3.05E+01	2.14E+00	3.70E+01	2.63E+00
Selenium-79	uCi/mL	71	5.40E-04	5.94E-05	9.50E-04	6.16E-05	1.21E-03	7.14E-05
Silicon	ug/mL	745	1.39E+02	4.19E+00	2.23E+02	5.40E+00	2.95E+02	7.62E+00
Sodium	ug/mL	950	1.49E+05	2.96E+03	2.32E+05	1.22E+03	2.52E+05	7.79E+02
Strontium	ug/mL	7	1.93E+00	1.11E+00	3.33E+00	1.67E+00	5.66E+00	2.26E+00
Strontium-90	uCi/mL	454	7.55E-01	7.04E-02	1.46E+00	1.24E-01	2.57E+00	1.98E-01
Sulfur	ug/mL	767	1.59E+03	6.12E+01	2.64E+03	9.49E+01	3.96E+03	1.31E+02
Technetium-99	uCi/mL	260	1.17E-01	6.41E-03	1.94E-01	8.08E-03	2.64E-01	9.65E-03
Thorium-232	ug/mL	10	7.94E-01	2.92E-01	1.35E+00	4.79E-01	2.03E+00	4.27E-01
Tin-126	ug/mL	9	4.70E-01	8.99E-02	6.56E-01	9.83E-02	7.78E-01	1.10E-01
Total inorganic carbon	ug/mL	453	3.67E+03	1.40E+02	5.66E+03	2.02E+02	7.67E+03	2.97E+02
Total organic carbon	ug/mL	377	2.87E+03	1.27E+02	4.59E+03	1.71E+02	5.98E+03	2.72E+02
Tritium	uCi/mL	101	8.11E-03	1.22E-03	1.42E-02	2.09E-03	2.23E-02	3.42E-03
Uranium	ug/mL	158	1.03E+01	1.47E+00	1.87E+01	2.57E+00	3.10E+01	4.34E+00
Zirconium	ug/mL	121	1.21E+01	1.31E+00	1.91E+01	2.26E+00	2.68E+01	3.98E+00

Table 3 Statistics for Highly Complexed Waste

Constituent	Units	#Obs	Average	SD(Avg)	Avg50	SD(Avg50)	Avg75	SD(Avg75)
Aluminum	ug/mL	49	1.06E+04	1.26E+03	1.73E+04	1.14E+03	1.99E+04	1.95E+03
Americium-241	uCi/mL	14	2.92E-01	7.77E-02	4.77E-01	1.20E-01	6.96E-01	1.14E-01
Atomic Mass Unit 232	ug/mL	6	1.08E+01	3.98E+00	1.96E+01	1.43E+00	2.08E+01	1.21E+00
Cadmium	ug/mL	43	6.56E+01	2.34E+00	7.50E+01	1.84E+00	8.14E+01	2.43E+00
Calcium	ug/mL	41	5.13E+02	1.93E+01	6.04E+02	1.25E+01	6.44E+02	1.41E+01
Carbon-14	uCi/mL	6	5.58E-04	6.95E-05	7.04E-04	4.70E-05	7.51E-04	2.00E-06
Cesium-137	uCi/mL	23	3.51E+02	1.50E+01	3.99E+02	9.71E+00	4.27E+02	9.91E+00
Chloride	ug/mL	35	3.93E+03	3.40E+02	5.30E+03	4.41E+02	6.50E+03	6.75E+02
Chromium	ug/mL	46	2.72E+02	1.68E+01	3.43E+02	2.52E+01	3.98E+02	4.31E+01
Cobalt-60	uCi/mL	20	1.23E-01	1.02E-02	1.58E-01	5.16E-03	1.71E-01	5.83E-03
Europium-154	uCi/mL	11	5.98E-01	1.06E-01	8.62E-01	9.55E-02	1.02E+00	1.06E-01
Europium-155	uCi/mL	3	NA	NA	NA	NA	NA	NA
Fluoride	ug/mL	21	2.67E+03	4.54E+02	4.08E+03	5.65E+02	5.23E+03	6.63E+02
Hydroxide	ug/mL	23	7.66E+03	1.29E+03	1.19E+04	1.71E+03	1.56E+04	2.63E+03
Iodine-129	uCi/mL	5	1.25E-04	3.20E-06	1.28E-04	4.70E-06	1.31E-04	6.50E-06
Iron	ug/mL	35	1.05E+03	2.35E+02	1.99E+03	3.25E+02	2.70E+03	5.18E+02
Lanthanum	ug/mL	15	3.70E+01	1.25E+00	4.00E+01	1.40E+00	4.32E+01	1.50E+00
Lead	ug/mL	38	2.79E+02	2.06E+01	3.81E+02	2.42E+01	4.54E+02	1.66E+01
Manganese	ug/mL	39	2.26E+02	4.42E+01	4.20E+02	5.97E+01	6.23E+02	2.26E+01
Neptunium-237	uCi/mL	3	NA	NA	NA	NA	NA	NA
Nickel	ug/mL	46	4.75E+02	1.49E+01	5.55E+02	1.23E+01	5.95E+02	1.43E+01
Nitrate	ug/mL	35	2.20E+05	4.84E+03	2.43E+05	4.02E+03	2.55E+05	5.63E+03
Nitrite	ug/mL	35	8.43E+04	2.73E+03	9.69E+04	2.57E+03	1.05E+05	3.20E+03
Phosphorus	ug/mL	42	1.28E+03	9.97E+01	1.84E+03	4.26E+01	1.98E+03	5.11E+01
Plutonium-239/40	uCi/mL	8	4.58E-03	8.72E-04	6.51E-03	5.84E-04	7.35E-03	7.95E-04
Potassium	ug/mL	41	2.31E+03	1.08E+02	2.68E+03	1.63E+02	3.13E+03	2.67E+02
Selenium-79	uCi/mL	6	7.24E-04	5.57E-05	8.43E-04	2.77E-05	8.67E-04	2.45E-05
Silicon	ug/mL	10	5.55E+01	6.79E+00	7.12E+01	8.80E+00	8.41E+01	6.88E+00
Sodium	ug/mL	46	2.21E+05	4.17E+03	2.42E+05	4.69E+03	2.57E+05	6.15E+03
Strontium-89/90	uCi/mL	20	7.79E+01	5.93E+00	9.67E+01	2.64E+00	1.03E+02	3.06E+00
Sulfate	ug/mL	10	8.61E+03	2.37E+02	9.19E+03	1.87E+02	9.41E+03	2.32E+02
Sulfur	ug/mL	43	4.10E+03	2.07E+02	5.30E+03	1.58E+02	5.82E+03	1.19E+02
Technetium-99	uCi/mL	9	9.84E-02	1.24E-02	1.25E-01	1.00E-02	1.40E-01	4.66E-04
Tin-126	ug/mL	3	NA	NA	NA	NA	NA	NA
Total inorganic carbon	ug/mL	28	1.30E+04	6.52E+02	1.54E+04	2.29E+02	1.61E+04	2.74E+02
Total organic carbon	ug/mL	24	2.65E+04	1.65E+03	3.28E+04	1.59E+03	3.70E+04	1.23E+03
Tritium	uCi/mL	3	NA	NA	NA	NA	NA	NA
Zinc	ug/mL	1	NA	NA	NA	NA	NA	NA
Zirconium	ug/mL	31	4.55E+01	7.14E+00	7.95E+01	6.24E+00	9.15E+01	1.10E+01

Table 4 Recommended Solubility Limits for HDW Model Rev. 5 Trials

Analyte	Recommended Solubility Limit for Non-Complexed Liquid Waste (ug/mL or uCi/mL)	Recommended Solubility Limit for Highly Complexed Liquid Waste (ug/mL or uCi/mL)	HDW Model Rev. 4 as of 1/1/94 (ug/mL or uCi/mL)	Discussion
Al	4.73E+04	1.99E+04	4.32E+04	75%-trimmed means. Note that a simple solubility limit is unlikely to accurately predict Al precipitation due to dependencies on temperature and hydroxide concentrations.
Bi	9.60E+01	9.60E+01	8.36E+02	75%-trimmed mean. No data were available for highly complexed liquid.
Ca	1.50E+02	6.44E+02	3.61E+02	75%-trimmed means.
Cl	No solubility limit	No solubility limit	6.03E+03	Chloride salts are extremely soluble.
CO_3	3.84E+04	8.04E+04	2.45E+04	75%-trimmed means.
Cr	2.88E+03	3.98E+02	6.24E+03	75%-trimmed means.
F	5.20E+03	5.23E+03	4.56E+03	75%-trimmed means.
Fe	1.05E+02	2.70E+03	1.12E+02	75%-trimmed means.
Hg	3.25E-01	3.25E-01	2.01E-03	Overall mean. No data available for highly complexed waste.
K	No solubility limit	No solubility limit	NR	Potassium salts are more soluble than the corresponding sodium salts.
La	1.39E-01	4.32E+01	0.00E+00	75%-trimmed means.
Ni	1.07E+02	5.95E+02	1.06E+02	75%-trimmed means.
Mn	3.11E+01	6.23E+02	4.94E+02	75%-trimmed means.
Na	2.32E+05	2.42E+05	2.28E+05	50%-trimmed means. Plots indicate sodium saturation for ~50% of data.
NO_2	1.42E+05	1.05E+05	1.43E+05	75%-trimmed means.
NO_3	2.17E+05	2.55E+05	1.74E+05	75%-trimmed means.
OH	No solubility limit	No solubility limit	NR	Sodium hydroxide is soluble to > 20 molar.
Pb	1.49E+02	4.54E+02	3.32E+02	75%-trimmed means.
PO_4	6.71E+03	6.05E+03	1.46E+04	75%-trimmed means based on ICP phosphorus analyses.
Si	2.95E+02	8.41E+01	9.55E+02	75%-trimmed means.
SO_4	1.19E+04	1.75E+04	3.33E+04	75%-trimmed means based on ICP sulfur analyses.
Sr	5.66E+00	2.27E+02	1.75E+02	75%-trimmed mean. No detected results for highly complexed wastes. The solubility increase resulting from complexants was estimated from 90Sr data.
TOC	5.98E+03	3.70E+04	NR	Probably not useful for HDW model. Solubility is species dependent.
U-Total	3.10E+01	3.10E+01	9.52E+02	75%-trimmed mean. No detected results for highly complexed wastes.
Zr	2.68E+01	9.15E+01	2.74E+02	75%-trimmed means.
H-3	No solubility limit	No solubility limit	NR	Use water balance for tritium partitioning.

Table 4 Recommended Solubility Limits for HDW Model Rev. 5 Trials

Analyte	Recommended Solubility Limit for Non-Complexed Liquid Waste (ug/mL or uCi/mL)	Recommended Solubility Limit for Highly Complexed Liquid Waste (ug/mL or uCi/mL)	HDW Model Rev. 4 as of 1/1/94 (ug/mL or uCi/mL)	Discussion
C-14	Partition per carbonate	Partition per carbonate	NR	Partition with carbonate ion.
Ni-59	Partition per chemical nickel	Partition per chemical nickel	NR	Partition with chemical nickel.
Co-60	2.40E-02	1.34E-01	3.98E-02	75%-trimmed means. Decay corrected to 1/1/01.
Ni-63	Partition per chemical nickel	Partition per chemical nickel	NR	Partition with chemical nickel.
Se-79	1.21E-03	8.67E-04	2.00E-03	75%-trimmed means.
Sr-90	2.48E+00	9.97E+01	3.09E+01	Decay corrected to 1/1/01. Recommend reducing strontium-90 solubility by a further factor of 10 for FeCN waste types due to isotopic dilution with natural Sr and/or co precipitation with added calcium.
Y-90	Partition per strontium-90	Partition per strontium-90	NR	Short-lived daughter of strontium-90.
Zr-93	Partition per chemical Zr	Partition per chemical Zr	1.00E-02	Partition with chemical zirconium.
Nb-93m	Partition per chemical Zr	Partition per chemical Zr	7.00E-03	Partition with chemical zirconium. Daughter of zirconium-93 will eventually reach secular equilibrium with parent.
Tc-99	No solubility limit	No solubility limit	NR	Treat as entirely soluble. Water insoluble technetium-99 has been found in tanks A-101 and AN-103, but mechanism is not currently understood and precipitation is not predictable.
Ru-106	Use plant specific estimate	NR	4.06E-08	Decay corrected to 1/1/01.
Cd-113m	Use plant specific estimate	NR	4.30E-02	Decay corrected to 1/1/01.
Sb-125	Use plant specific estimate	NR	3.30E+00	Decay corrected to 1/1/01.
Sn-126	8.83E-03	9.85E-03	3.00E-03	75%-trimmed mean for non-complexed waste and overall mean (three data points) for complexed wastes.
I-129	2.80E-04	1.31E-04	NR	75%-trimmed means.
Cs-134	Partition per cesium-137	Partition per cesium-137	NR	
Cs-137	No solubility limit	No solubility limit	NR	
Ba-137m	Partition per cesium-137	Partition per cesium-137	NR	
Sm-151	Partition per europium-154	Partition per europium-154	6.63E+00	Solubility behavior would be expected to be similar to europium and lanthanum, which are also rare earth elements. Decay corrected to 1/1/01.
Eu-152	Partition per europium-154	Partition per europium-154	NR	
Eu-154	Use plant specific estimate	8.54E-01	2.84E-01	Europium-154 measurements are more reliable than the other europium isotopes due to reactor yields and the and high energy gamma emissions. Decay corrected to 1/1/01.

Table 4 Recommended Solubility Limits for HDW Model Rev. 5 Trials

Analyte	Recommended Solubility Limit for Non-Complexed Liquid Waste (ug/mL or uCi/mL)	Recommended Solubility Limit for Highly Complexed Liquid Waste (ug/mL or uCi/mL)	HDW Model Rev. 4 as of 1/1/94 (ug/mL or uCi/mL)	Discussion
Eu-155	Partition per europium-154	Partition per europium-154	NR	
Ra-226	NR	NR	6.20E-08	
Ac-227	NR	NR	3.60E-07	
Ra-228	NR	NR	NR	
Th-229	Partition per thorium-232	Partition per thorium-232	NR	
Pa-231	8.51E-03	NR	2.00E-06	75%-trimmed mean.
Th-232	2.23E-07	2.28E-06	7.00E-04	75%-trimmed means.
U-232	Partition per chemical uranium.	Partition per chemical uranium.	NR	
U-233	Partition per chemical uranium.	Partition per chemical uranium.	NR	
U-234	Partition per chemical uranium.	Partition per chemical uranium.	NR	
U-235	Partition per chemical uranium.	Partition per chemical uranium.	NR	
U-236	Partition per chemical uranium.	Partition per chemical uranium.	NR	
Np-237	4.69E-04	7.19E-05	NR	75%-trimmed mean for non-complexed waste and overall mean (three data points) for complexed wastes.
Pu-238	Partition per plutonium-239/240	Partition per plutonium-239/240	NR	
U-238	Partition per chemical uranium.	Partition per chemical uranium.	NR	
Pu-239/240	6.25E-03	7.35E-03	1.06E-02	Plutonium-239/240 measurements are the most reliable since they encompass > 99% of the plutonium mass and > 90% of the plutonium alpha activity.
Pu-239	Partition per plutonium-239/240	Partition per plutonium-239/240	NR	
Pu-240	Partition per plutonium-239/240	Partition per plutonium-239/240	NR	
Am-241	6.73E-03	6.96E-01	3.00E-02	75%-trimmed means.
Pu-241	Partition per plutonium-239/240	Partition per plutonium-239/240	NR	
Cm-242	Partition per curium-243/244	Partition per curium-243/244	NR	

Table 4 Recommended Solubility Limits for HDW Model Rev. 5 Trials

Analyte	Recommended Solubility Limit for Non-Complexed Liquid Waste (ug/mL or uCi/mL)	Recommended Solubility Limit for Highly Complexed Liquid Waste (ug/mL or uCi/mL)	HDW Model Rev. 4 as of 1/1/94 (ug/mL or uCi/mL)	Discussion
Pu-242	Partition per plutonium-239/240	Partition per plutonium-239/240	NR	
Am-243	Partition per americium-241	Partition per americium-241	NR	
Cm-243/244	2.00E-05	2.00E-05	NR	Average of three data points for non-complexed waste. No data available for highly complexed waste. Note that activity of pair is ~ 96% from curium-244.
Cm-243	Partition per curium-243/244	Partition per curium-243/244	NR	
Cm-244	Partition per curium-243/244	Partition per curium-243/244	1.00E-04	

Radionuclide solubility limits are as of 1/1/2001.

Table 4 Recommended Solubility Limits for HDW Model Rev. 5 Trials

Plant Specific Solubility Estimates for Short-Live Nuclides in Non-Complexed Wastes

Process	Europium-154	Ruthenium-106	Antimony-125	Cadmium-113m	uCi/mL
BiPO4	1.08E-02	3.37E-11	2.82E-04	5.46E-02	uCi/mL
Redox	4.83E-02	5.11E-08	3.30E-03	1.29E-01	uCi/mL
Early PUREX	8.16E-02	5.11E-08	8.74E-03	NR	uCi/mL
AZ-101	5.79E-01	6.13E-02	6.78E-01	NR	uCi/mL
AZ-102	5.88E-01	2.33E-01	1.11E+00	NR	uCi/mL

Based on measured solubility of chemical species or chemical analog and ORIGEN2 isotopic distribution. Decay corrected to 1/1/01.
Note: PUREX used substantial amounts of cadmium nitrate as a neutron poison for recycle of plutonium. This usage alters the isotopic distribution for PUREX wastes.
Isotopic Data is from Correspondence FDNW-ENI-98-006, December 29, 1997, David W. Wootan (FDNW) to Robert A. Watrous (LMHC), "DKPRO Runs for Tank Inventories", Fluor Daniel Northwest, Richland Washington.

INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From:	Inventory & Flowsheet Engineeering	7G300-03-NWK-001
Phone:	376-2380	
Date:	January 7, 2003	
Subject:	RECOMMENDED SEPARATION FACTORS FOR TECHNETIUM-99	

To: J. G. Field R2-12

Copies:				
	K. M. Bowen	K8-98	D. E. Place	R3-73
	B. A. Higley	R3-73	L. M. Sasaki	R2-12
	T. E. Jones	E6-35	LB File	R3-73
	N. W. Kirch	R3-73		

The purpose of this memo is to present information on technetium (Tc) partitioning during Hanford fuel reprocessing so that new Tc extraction factors can be incorporated into the Hanford Defined Waste (HDW) model. Mr. R. A. Watrous compiled the information prior to his retirement.

If you have any questions, please contact Mr. B. A. Higley or me at 376-5694.

NWKirch

N. W. Kirch
Manager

sir

Enclosure

7G300-03-NWK-001

Enclosure

RECOMMENDED SEPARATION FACTORS FOR TECHNETIUM-99

Consisting of 9 pages
including cover page

Recommended Separation Factors for TECHNETIUM-99

Background

Since the early laboratory work of Campbell (1961) and Siddall (1959) and the more recent work of Pruett (1984), it has been predicted that Tc is partially extracted along with uranium in the Plutonium-Uranium Extraction (PUREX) separation process. Siddall predicted that technetium (Tc) extraction might range from 4% to 40%, depending on the acidity of the PUREX extraction contactor aqueous phase.

Roberts (1971) determined from measurement of Hanford PUREX process streams that 20% of the Tc was extracting with the uranium product. However, subsequent measurements for Tc in the PUREX uranyl nitrate or uranium trioxide (UO_3) Plant products were not routinely made. For the Reduction - Oxidation (REDOX) process theoretical prediction and direct measurement of Tc extraction behavior is even more lacking. No data has been found that reflect the behavior of Tc extraction in the "Uranium Recovery Process" operated during the 1950s.

Colby and Petersen (1995) analyzed the available data (Tc measurements on U product and waste samples), comparing them to the then current ORIGEN2 code predictions for irradiated fuel. In this comparison there was uncertainty as to whether the limited number of UO_3 lots analyzed were representative of all fuels processed in PUREX during the 1980s or only representative of a portion of these fuels (i.e., low exposure or high exposure fuels). Furthermore, the ORIGEN2 model of fission product activities in Hanford irradiated fuels has been recently improved, possibly invalidating previous estimates of Tc extraction behavior.

Also, as a result of an extensive data review for a 2000 report on recycled uranium and its impurities (DOE/RL 2000-43), additional data on levels of Tc in uranium products were uncovered, particularly, uranyl nitrate hexahydrate (UNH) from the REDOX process. Tc measurements on uranium ingots being recycled to Hanford fuel fabrication operations were also found, suggesting that a small but not insignificant quantity of Tc (3 ppm, ave.) was present in pre-irradiated fuels. (Note, that ORIGEN2 code predictions of Tc activity in irradiated fuels need to be corrected for the presence of Tc in the pre-irradiated fuel.)

Thus, there is need to recalculate our factors for Tc extraction behavior in the various Hanford separations plants and introduce these new factors into the Hanford Defined Waste (HDW) model. Output from the HDW model is to be used to update waste type template definitions in support of the Best Basis Inventory effort.

Objective

The objective of this study is to analyze the now larger pool of uranium product and waste sample measurements for Tc, and by comparison to updated ORIGEN2 code predictions for the levels of Tc in irradiated fuels, determine new Tc extraction factors. Accounting for the presence of Tc in recycled, pre-irradiated fuels is also an objective.

Method of Determining Tc Extraction

For this analysis, the determination of Tc extraction behavior has been done by three methods:

1. a comparison of measured levels of Tc in UO_3 product to the ORIGEN code predictions of Tc in corresponding spent Hanford reactor fuels,
2. a comparison of measured levels of Tc in REDOX and PUREX plant UNH products to ORIGEN code predictions of Tc in corresponding spent reactor fuels, and
3. a comparison of Tc and Cs-137 measured in high-level waste supernates to predicted levels of Tc and Cs-137 in Hanford fuels. In this method the Cs-137 is used as a "tie" component to relate high-level waste solutions to reactor fuels. Once the fraction of Tc reporting to tank waste is determined, the fraction extracted is calculated by difference.

Comparison to UO_3 Measurements

Predictions of Tc in spent Hanford reactor fuels (the "input values" to the PUREX process and the basis for calculating Tc extraction behavior) are reported by Watrous (2002), for 1276 batches (generally monthly composites) of fuel.

Measurements of Tc in Hanford recycle UO_3 (parts Tc per million parts of U) have been made at both the Fernald metal reduction plant and the Paducah gaseous diffusion plant. Measurements at Fernald were made on recycled "enriched reactor tails" (ERT) received after 1985 and are reported in DOE/RL 2000-43 "Review of Generation and Flow of Recycled Uranium at Hanford." These data are repeated here, in Appendix A. Measurements at Paducah (Smith 1984) were made on both "normal" reactor tails (hundreds of measurements on UO_3 received between 1959 and 1973) and "enriched" reactor tails (five measurements on enriched reactor tails received 1971 through 1973).

These UO_3 measurements only reflect on the Tc extraction behavior of the PUREX plant since measurements were not made during the time that the REDOX process was operating and sending its UO_3 product to the Fernald or Paducah sites.

Comparison of UO_3 product lot measurements and "fuel batch data" (ORIGEN code predictions) and the calculation of "percent Tc extracted" is presented in Table 1. The use of Tc concentrations from discrete lots of UO_3 is problematic unless the

TABLE 1 -- Tc Extraction by Comparison to U Product Measurements

Comparison Case #	Plant	Fuel Batch Data (from ORIGEN/DKPRO) Separation Dates	MTU Sum	ppm Tc in Unirrd. U	Tc-99 Generated by Irrd. (Ci)	Calculated Ave. Tc (ppmpU)	UO3 Lot Data Lot #	ppm Tc	Ref #	Calculated % Tc Extracted
1	PUREX	2/86 to 3/86	315.1	3	164.92	33.9	86-05, 86-16	11	(a)	32.49
2	PUREX	7/85 to 8/85 (e)	121.7	3	73.9	38.8	85-18,19,20	7	(a)	18.04
3	PUREX	1/84 thru 4/85	1710.5	3	873.3	33.1	various	7	(b)	21.15
4	PUREX	1/70 thru 8/72 (f)	2742	3	1595.8	37.3	various	16	(b)	42.88
							UNH Sample Data Tc (d/m/g U)	ppm Tc	Ref #	
5	PUREX	1/63 thru 12/63	5023	3	1625.9	22.1	1.74E+05	4.62	(c)	20.92
6	REDOX	1/63 thru 8/64	2011	3	840.5	27.6	2.90E+04	0.77	(d)	2.79

References:

a DOE/RL-2000-43, "Review of Generation and Flow of Recycled Uranium at Hanford", Section 4, Tab. 4-4.

b Smith, R.F., "Historical Impact of Reactor Tails on the Paducah Cascade," KY/L-1239, March 1984, Martin Merietta Energy systems, Inc., -- pg. 11.

c Christy, 1964. Letter: J.T. Christy, USAEC-RL to T.R. Workinger, USAEC-HQ, "UNH Product Specifications," Nov. 12, 1964.
[Tc-99 measured 1.74E+5 d/m/gram of U in PUREX UNH. This is equivalent to 4.62 ppm.]

d Christy, 1964. Letter: J.T. Christy, USAEC-RL to T.R. Workinger, USAEC-HQ, "UNH Product Specifications," Nov. 12, 1964.
[Tc-99 measured 2.9E+4 d/m/gram of U in REDOX UNH. This is equivalent to 0.77 ppm.]

e Consecutive fuel keys: 14221, 14400, 14358, 14306, 14680, and 14756.

g Only enriched fuel types: i.e., Al-0.94U, Zr-0.94U, and Zr-1.1U.

corresponding batches of spent fuel (and their fuel type and burn-up) can be determined. For this reason, data from only a few selected lots of UO_3 have been compared, where a positive material match could be made. The best comparison between UO_3 measurements and their corresponding spent fuel is provided in comparison cases 1 and 2. Here, the measurement of both Tc and U-235 on discrete UO_3 lots allows the corresponding batches of fuel to be determined on the basis of the burned-out U-235 percentage. As shown on Table 1, the comparisons for cases 1 and 2 indicate that Tc extraction ranged from 18% to 32%. (Note, that these material balance calculations assumed the presence of 3 ppm Tc in pre-irradiated uranium.) The comparisons of cases 3 and 4 are based on Paducah data where only long-term average behavior was reported. While the result for case 3 (21% Tc extracted) agrees well with case 2 and the previous determination by Roberts (1971) of 20% extraction, the result for case 4 (43% extracted) appears to be higher than previously predicted.

Comparison to UNH Product Measurements

During the 1960s a couple of measurements for Tc ("new" data points) were made on the UNH product stream from both the REDOX and PUREX plants (Christy 1964). This data is listed in Table 1 as comparison cases #5 and #6. The comparison to the average Tc concentration in fuels processed around the time of the sampling indicates that 20.9% of the Tc extracted in the PUREX process while only 2.8% of the Tc extracted via the REDOX process.

The result for PUREX is in good agreement with the results determined from most of the UO_3 measurements. However; the result from the REDOX UNH measurement is much lower than the extraction percentage (37%) previously predicted by Colby (1995). The disparity between the two REDOX factors, may be diminished by re-examining the Oak Ridge National Laboratory (ORNL) experimental data, from which Colby derived the 37% prediction. In the ORNL experiment, a Hanford irradiated fuel element was processed through a laboratory-scale simulation of the REDOX separation process (hexone solvent extraction). Tc-99 and Cs-137 (and other components) were measured in the extraction waste stream. By using Cs-137 as a "tie component," and comparing the Tc/Cs ratio for the experiment waste (grams Tc per curie Cs-137) to the Tc/Cs ratio for average fuels processed through REDOX in the mid-1950s, one can calculate that the ORNL test extracted 12% of the feed Tc as opposed to the value of 37% that was derived from a more convoluted conversion and analysis of the same experimental data.

Thus, the Tc extraction percentage derived from UNH measurements as reported by Christy (2.8%) may not be so far from the truth. Additional comparisons based on tank supernate analyses also predict an extraction percentage value that is in the range of 12% to 24%, see below.

Comparisons Using Tank Waste Measurements

The fraction of Tc routed to waste supernatant solutions can be determined using Cs-137 as a "tie component" which is known to report quantitatively to waste and remain there in solution. However, the determination of Tc extraction behavior from tank waste analyses is problematic for several reasons:

- the difficulty in finding waste supernates that are known to come from a single source such as the REDOX plant,
- the need to find waste supernate samples that have not been through a Cs separation process such as the B-plant Cs removal process (so Cs may serve as a meaningful "tie component,")
- the error that results if not all Tc reports to the supernate, and
- the inaccuracy that comes from determining "Tc extraction" as the difference between two similarly large numbers.

(Note, that in this method, if Tc does not all remain in solution, the effect is to predict an extraction percentage value that is greater than actual.)

Several tanks containing REDOX wastes were sampled during the late 1960s and analyzed for Tc and Cs-137. Unfortunately this data has been separated from their original documentation and data quality cannot be easily verified.

Recognizing these various problems, data from tanks 241-S-102 and S-110 (for REDOX waste) and tank C-103 (for PUREX cladding waste) has been summarized in Table 2. Data from an ORNL laboratory-scale REDOX process test as reported by Colby (1995) is also summarized in Table 2.

In these four waste samples the Tc/Cs-137 ratio measured in the waste is compared to the Tc/Cs-137 ratio calculated by the ORIGEN2 code for the irradiated fuel processed during the filling of the tank in question. As in the method of Table 1, the questionable level of Tc contained in recycled uranium prior to irradiation at Hanford is accounted for in calculating the Tc/Cs-137 ratio for post-irradiated fuel. Note, that for the low-exposure reactor fuels of the early REDOX processing years, (compare cases 12a and 12b) the presence of an assumed 3 ppm Tc in recycled uranium entering Hanford reactors can make as much as a factor of two impact on the calculated Tc extraction factor.

Table 2 indicates that in tank S-102 more Tc is found in the tank waste than was estimated to be in the corresponding fuel. (This result may be due to analytical error, waste contamination, or it may be an indication that Tc extraction was very low.)

Comparison cases 12a and 12b for S-110 indicate that 12 % to 24% of the Tc was extracted, depending on whether there was zero or 3 ppm of Tc in pre-irradiated uranium. (Note, that tank S-110 was filled in the early 1950s when the uranium recycle program was just

TABLE 2 -- Tc Extraction Implied by Tank Samples and Material Balance.

Comparison Case #	Plant	Tank Fill Dates	MTU Sum	Fuel Batch Data (from ORIGEN/DKPRO): ppm Tc in Unirrd. U	Tc-99 Generated by Irrd. (Ci)	Cs-137 Generated by Irrd. (Ci @1/1/01)	Calculated Ave. Tc (g Tc/Ci Cs-137)	Tank Supernate Assay (g Tc/Ci Cs-137 @ 1/1/01): Tank		Ref. #	Calculated % Tc Extracted (g)
11a	REDOX	7/53 thru 9/55	3734.2	3	1016.3	2.44E+06	2.92E-02	S-102	4.356E-02	(d)	-49.32
11b	REDOX	7/53 thru 9/55	3734.2	0	1016.3	2.44E+06	2.46E-02	S-102	4.356E-02	(d)	-77.24
12a	REDOX	7/52 thru 3/53	768	3	235.3	5.42E+05	2.98E-02	S-110	2.255E-02	(d)	24.42
12b	REDOX	7/52 thru 3/53	768	0	235.3	5.42E+05	2.58E-02	S-110	2.255E-02	(d)	11.87
13a	PUREX	1/60 thru 12/60	5597.6	3	1934.96	5.33E+06	2.46E-02	C-103	1.720E-02	(e)	29.97
13b	PUREX	1/60 thru 12/60	5597.6	0	1934.96	5.33E+06	2.14E-02	C-103	1.720E-02	(e)	19.67
								ORNL Ext'n Waste Ratio (g Tc/Ci Cs-137 @ 1/1/01)		Ref. #	
14a	REDOX	1/57 thru 12/57	1658.6	3	470.1	1.20E+06	2.72E-02		2.020E-02	(f)	25.67
14b	REDOX	1/57 thru 12/57	1658.6	0	470.1	1.20E+06	2.30E-02		2.020E-02	(f)	12.33

Notes:

(d) Data from analysis of waste supernate samples taken in late 60's - early 70's. Cs-137 activity corrected to 1/1/01. Original documentation unavailable.

(e) Data from Roberts (1971), page 3. Cs-137 activity corrected to 1/1/01.

(f) Data from Colby (1995), pages 18, 19, - Cs-137 activity corrected to 1/1/01.

(g) Equation:

[% Tc Extracted] = (1 - [Rsupernate]/[Rfuel])*100

Where:

[Rsupernate] is the ratio of Tc to a "tie component," Cs-137, both measured in high-level waste supernates (units: g Tc/Ci Cs-137), and

[Rfuel] is the ratio of Tc to the "tie component," Cs-137, both calculated for typical reactor spent fuel (units: g Tc/Ci Cs-137).

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Page 6

beginning. It is, therefore uncertain whether the corresponding reactor fuel contained zero or 3 ppm of Tc impurity prior to irradiation.) These shaky results appear to be a confirmation of the equally shaky ORNL laboratory-scale process test, described above and summarized as case 14, in which 12% to 26% of the feed Tc is calculated to have extracted.

Average Tc Extraction Factor for PUREX

For the purpose of determining a single Tc extraction factor for the PUREX process, an average of cases 1, 2, 3, 4, 5, and 13a is suggested (see both Tables 1 and 2). The average of these six extraction values is calculated to be 28%.

Average Tc Extraction Factor for REDOX

The average of cases 6, 12b, and 14a (the ORNL laboratory-scale test) are suggested for determining a single extraction factor for the REDOX process. The average of these three values (2.8%, 11.9%, and 25.7%) is calculated to be 13%.

The variance of extraction percentage values for cases 6, 12b, and 14a is large and may imply an equally large error band for the 13% average value. On the other hand, these three vastly different extraction values may reflect actual changes in REDOX plant extraction performance as a result of the significant flowsheet changes that occurred over the years.

Average Tc Extraction Factor for Uranium Recovery Operations

As mentioned above, no data has been found which is a direct indication of the Tc extraction behavior in the uranium recovery (U Plant) operation. Since the U Plant process employed the same solvent as the PUREX process, it is suggested that a Tc extraction factor of 28% be assumed.

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7G300-03-NWK-001

Appendix A

CONTAMINANTS IN RECYCLED URANIUM
Excepted from DOE/RL 2000-43,
'REVIEW OF GENERATION AND FLOW OF
RECYCLED URAHIUM AT HANFORD

Consisting of 2 pages
including cover page

Contaminants in Recycled Uranium

Table 4-4 Analyses of UO_3 Produced In/After 1984 at Hanford

Lot No.	Date	Pu ppb	Np * ppb	Tc ppm	^{106}Ru+^{106}Rh uCi/lb U	^{95}Zr/Nb uCi/lb U	^{234}Th/Pa uCi/lb U	^{234}U wt %	^{235}U wt %	^{236}U wt%	^{238}U wt %
84-08	6/11/84	2	N/A	N/A	<5	<3	<10	0.008	0.884	0.060	99.088
85-11	6/21/85	<0.5			<8	<6	<10	0.008	0.845	0.065	99.082
85-12	6/25/85	<5			<6	<8	<10	0.010	0.849	0.068	99.073
85-13	6/26/85	<5			<6	<8	<10	0.011	0.852	0.070	99.067
85-14	7/16/85	<5			<6	<8	<10	0.009	0.846	0.068	99.077
85-15	7/16/85	<5			<6	<8	<10	0.009	0.849	0.071	99.071
85-16	7/19/85	<5			<4	<6	<10	0.008	0.848	0.066	99.078
85-17	7/19/85	<5			<4	<6	<10	0.009	0.848	0.067	99.076
85-18	9/30/85	<5	<1000	7	<8	<6	<1	0.009	0.924	0.076	98.991
85-19	9/30/85	<5	<1000	7	<8	<6	<1	0.010	0.942	0.074	98.974
85-20	9/30/85	<5	<1000	7	<8	<6	<2	0.010	0.940	0.072	98.978
86-05	5/6/86	<2	490	12	<6	<4	<31	0.011	0.807	0.080	99.102
86-16	9/22/86	1	400	10	<6	<4	6	0.010	0.873	0.073	99.044
86-23	11/17/86	1	300	8	<6	<4	6	0.011	0.957	0.075	98.957
88-1	3/17/88	2	40	4	<6	<4	9	0.008	0.819	0.074	99.099
88-2	3/17/88	2	120	4	<6	<4	8	0.008	0.950	0.074	99.068
88-3	3/17/88	<1	160	3	<6	<4	10	0.009	0.818	0.073	99.100

Data retrieved from Analytical Data Sheets

* Limited additional ^{237}Np data preceding 1985 are provided in Section 4.5.4, 4.5.5, and Table 4-7.

INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From:	Inventory and Flowsheet Engineering	7G300-03-NWK-011
Phone:	376-5694	
Date:	February 26, 2003	
Subject:	RADIONUCLIDE PARTITION FACTORS FOR THE HANFORD DEFINED WASTE MODEL - PLUTONIUM URANIUM EXTRACTION PROCESS	

To:	J. G. Field	R2-12
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The Hanford Defined Waste (HDW) Model is being updated to reflect new information that became available since Revision 4.0 of the model was published in January 1997. The Plutonium-Uranium Extraction (PUREX) process radionuclide partition factors used by the HDW model are suspect for a number of reasons.

Radionuclide partition factors are used by the HDW Model to simulate the major PUREX process waste streams. These streams include the high-level waste, organic wash waste, and the miscellaneous low-level waste (collected in PUREX tanks F18, U3 and U4). The partition factors used in Revision 4.0 of the HDW Model overly simplify the PUREX process by routing 100% of the fission products to the high-level waste. Revision 4.0 of the HDW Model only distributes isotopes of Pu and U to these three streams. In addition the partition factors used in Revision 4.0 of the HDW Model are not referenced nor are they traceable to a PUREX process flowsheet.

The attachment to this letter establishes new PUREX process radionuclide partition factors for the next version of the HDW Model. These revised partition factors will distribute the radionuclides between the tanks that received waste from the PUREX process and are not expected to change the total inventory of the underground storage tanks.

B. A. Higley

B. A. Higley,
Chemical Engineer

sir

Attachment

7G300-03-NWK-011

Attachment

PLUTONIUM-URANIUM EXTRACTION PROCESS RADIONUCLIDE PARTITION FACTORS

Consisting of 6 pages
including coversheet

Plutonium-Uranium Extraction Process Radionuclide Partition Factors

The Plutonium-Uranium Extraction (PUREX) generated three primary waste streams that were sent to tank farms, the solvent extraction waste from the first and subsequent cycles high-level waste (HLW), organic wash waste (OWW), and miscellaneous low level waste (F18 LLW) stream collected via building sumps. The LLW waste collection tanks included PUREX tanks U3 and U4; however, the vast majority of the LLW radioactivity was associated the tank F18 located in the PUREX canyon. The solvent extraction waste (HLW) contained the highest fission product activity and the OWW generally contained the lowest activity. The fission product content of F18 LLW was variable as leaks, spills, and equipment flushes were the primary source of activity in this waste stream.

For most fission products the first PUREX solvent extraction cycle (HA column) had a decontamination factor of about 100 at the feed point. Additional decontamination of the uranium and plutonium products occurred in subsequent solvent extraction cycles. Only Tc, I, Pa, Th, U, Np, and Pu were extracted in quantity by the PUREX organic solvent.

Technetium was partially extracted by the organic solvent and exited with the HA column raffinate (high-level waste), uranyl nitrate hexahydrate (UNH) product and the organic wash waste. Iodine was also partially extracted by the organic solvent and was partitioned to the HLW, and organic wash waste. Iodine also volatilizes during metal dissolution. Most of the gaseous iodine was captured by the silver reactors and was subsequently flushed to the cladding waste tanks or disposed of as solid waste.

Thorium, protactinium uranium and plutonium were extracted almost completely by the organic solvent. Subsequent solvent extraction cycles returned most of the thorium and protactinium to the high-level waste stream. Neptunium (or neptunium losses during periods of neptunium recovery) would also be included in the high-level waste stream.

Table 1 summarizes the radionuclide partition factors for modeling of the PUREX process by the HDW Model. Most of the radionuclide partition factors in this table are from the "Extraction Split Factors for the PUREX Plant," published by Kupfer et al. 1999, Table G-4. New uranium and plutonium losses factors were calculated from a recent PUREX process flowsheet (Jacobs and Allen 1985). Notes to the table identify the specific basis for each partition factor.

Table 1. Radionuclide Partition Factors for PUREX

Isotope	HLW	OWW	F18 LLW	Basis
H-3	9.870E-01	2.321E-03	1.071E-02	(1)
C-14	9.714E-01	2.698E-02	1.619E-03	(2)
Ni-59	9.996E-01	6.500E-05	3.000E-04	(3)
Ni-63	9.996E-01	6.500E-05	3.000E-04	(3)
Co-60	9.996E-01	6.500E-05	3.000E-04	(3)
Se-79	9.996E-01	6.500E-05	3.000E-04	(3)
Sr-90	9.996E-01	6.500E-05	3.000E-04	(3)
Y-90	9.996E-01	6.500E-05	3.000E-04	(3)
Zr-93	9.996E-01	6.500E-05	3.000E-04	(3)
Nb-93m	9.996E-01	6.500E-05	3.000E-04	(3)

Isotope	HLW	OWW	F18 LLW	Basis
Nb-93m	9.996E-01	6.500E-05	3.000E-04	(3)
Tc-99	9.995E-01	9.028E-05	4.167E-04	(4)
Ru-106	9.996E-01	6.500E-05	3.000E-04	(3)
Cd-113m	9.996E-01	6.500E-05	3.000E-04	(3)
Sb-125	9.996E-01	6.500E-05	3.000E-04	(3)
Sn-126	9.996E-01	6.500E-05	3.000E-04	(3)
I-129	See note 5	See note 5	0.0	The fractions for distribution of ^{129}I to CW, HLW, and OWW are reported in note 5.
Cs-134	9.996E-01	6.500E-05	3.000E-04	(3)
Cs-137	9.996E-01	6.500E-05	3.000E-04	(3)
Ba-137m	9.996E-01	6.500E-05	3.000E-04	(3)
Sm-151	9.996E-01	6.500E-05	3.000E-04	(3)
Eu-152	9.996E-01	6.500E-05	3.000E-04	(3)
Eu-154	9.996E-01	6.500E-05	3.000E-04	(3)
Eu-155	9.996E-01	6.500E-05	3.000E-04	(3)
Ra-226	9.996E-01	6.500E-05	3.000E-04	(3)
Ra-228	9.996E-01	6.500E-05	3.000E-04	(3)
Ac-227	9.996E-01	6.500E-05	3.000E-04	(3)
Pa-231	9.996E-01	6.500E-05	3.000E-04	(3)
Th-229	9.996E-01	6.500E-05	3.000E-04	(7)
Th-232	9.996E-01	6.500E-05	3.000E-04	(7)
U-232	3.57E-01	1.64E-01	4.79E-01	(6)
U-233	3.57E-01	1.64E-01	4.79E-01	(6)
U-234	3.57E-01	1.64E-01	4.79E-01	(6)
U-235	3.57E-01	1.64E-01	4.79E-01	(6)
U-236	3.57E-01	1.64E-01	4.79E-01	(6)
U-238	3.57E-01	1.64E-01	4.79E-01	(6)
U-Total	3.57E-01	1.64E-01	4.79E-01	(6)
Np-237	9.996E-01	6.500E-05	3.000E-04	(7)
Pu-238	6.26E-01	3.8E-02	3.36E-01	(6)
Pu-239	6.26E-01	3.8E-02	3.36E-01	(6)
Pu-240	6.26E-01	3.8E-02	3.36E-01	(6)
Pu-241	6.26E-01	3.8E-02	3.36E-01	(6)
Pu-242	6.26E-01	3.8E-02	3.36E-01	(6)
Pu-Total	6.26E-01	3.8E-02	3.36E-01	(6)
Am-241	9.996E-01	6.500E-05	3.000E-04	(3)
Am-243	9.996E-01	6.500E-05	3.000E-04	(3)
Cm-242	9.996E-01	6.500E-05	3.000E-04	(3)
Cm-243	9.996E-01	6.500E-05	3.000E-04	(3)
Cm-244	9.996E-01	6.500E-05	3.000E-04	(3)

(1) Normalized distribution of 2.8% of the tritium entering the solvent extraction system (Higley 2002a) with assumed losses of 0.0065% to OWW, and 0.03% via TK-F18 (Kupfer, et al., 1999, Table G-4).
(2) Normalized distribution of 18% of the ^{14}C to HLW, 0.5% loss to OWW (Place 2002), and 0.03% loss via TK-F18. (Kupfer, et al., 1999, Table G-4).
(3) Kupfer, et al., 1999, Table G-4
(4) Normalized distribution of ^{99}Tc entering the solvent extraction system, 28% loss to UNH (Kirch 2003), 0.0065% loss to OWW, 0.03% loss via TK-F18, (Kupfer, et al., 1999, Table G-4), and the balance to HLW.
(5) The distribution factors for iodine are reported in Higley 2002b, Table 4.
(6) Jacobs and Allen 1985, PUREX Flowsheet - Reprocessing N Reactor Fuels
(7) Thorium and neptunium are assumed to be partitioned in a ratio similar to the majority of the fission products.

Waste streams from the PUREX Plant were segregated in the tank farms as boiling and non-boiling wastes based on fission product activity. Prior to 1983, high activity wastes were sent to boiling waste tanks in A and AX Farm for self concentration and low activity wastes were sent to non-boiling waste tanks in C Farm. Table 2 provides a crosswalk between the PUREX flowsheet waste streams and the HDW Model waste types. During some periods, the LLW went to the same tanks as the HLW.

Table 2. Crosswalk from PUREX Flowsheet Waste Streams to HDW Model Waste Types

PUREX Waste Stream	HDW Model Waste Type	Comment
PUREX 1956-1962		
HLW	P1	
OWW	OWW1	
F18 LLW	OWW1	Non-boiling waste. Assumed disposition. (WSTRS reports PL waste being sent to A Farm 1958-1960)
PUREX 1963-1967		
HLW	P2	
OWW	OWW2	
F18 LLW	OWW2	Non-boiling waste. Assumed disposition.
PUREX 1968-1972		
HLW	P2	
OWW	OWW3	
F18 LLW	PL1	Non-boiling waste. (WSTRS reports PL1 waste sent to AX Farm in 1968-1969, to A-101 in 1973 and to C-104 in 1970 -1976)
PUREX 1983-1988		
HLW	P3	
OWW	PL2	OWW and F18 LLW wastes were a combined waste stream
F18 LLW	PL2	OWW and F18 LLW wastes were a combined waste stream. (WSTRS reports PL2 generation as early as 1981 and as late as 1993)

The partition factors in Table 1 are applicable to the modeling of plutonium production but are not applicable to thorium production campaigns.

The thorium campaign reports include mass balance data for ^{233}U and Th to the HLW, OWW and F18 LLW streams. The 1966 thorium campaign report notes that because of a shortage of non-boiling tank space, low salt – low fission product waste, and high salt – high fission product waste was routed to boiling tanks (A and AX Farms) for self-concentration. Only high salt – low fission product waste went to non-boiling tanks (C Farm). See Isochem 1967, pages III-52 and III-53. Process wastes from the thorium campaign would fit in the high salt – low fission product category. There is no direct evidence from sample reports that A and AX Farms received a significant fraction of the ^{233}U and Th in the wastes from the 1966 thorium campaign. It is believed that nearly all of the thorium-bearing waste was disposed of in a single C Farm non-boiling tank (tank 241-C-102).

For the 1970 thoria campaign Tables IX and X of the campaign report indicate that all of the thorium bearing wastes (HLW, OWW, and F18 LLW) went to non-boiling tanks (Jackson and Walser 1970). These wastes were also disposed of in a single C Farm tank (tank 241-C-104).

The HDW Model should use a value of one for all of the radionuclide partition factors associated with the thorium campaigns.

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Kupfer, M. J., A. L. Boldt, K. M. Hodgson, L. M. Shelton, B. C. Simpson, and R. A. Watrous (LMHC); M. D. LeClair (SAIC); G. I. Borsheim (BA); R. T. Winward (MA); B. A. Higley and R. M. Orme (NHC); N. G. Colton (PNNL); S. L. Lambert and D. E. Place (Cogema); and W. W. Schulz (W^2S), 1999, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0C, Lockheed Martin Hanford Company, Richland, Washington.

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INTEROFFICE MEMO

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Hanford Group, Inc.

From:	Inventory and Flowsheet Engineering	7G300-03-NWK-012
Phone:	376-5694	
Date:	March 19, 2003	
Subject:	HANFORD DEFINED WASTE MODEL - CORRECTION OF ORIGEN 2 MODEL TRITIUM ESTIMATE	

To:	J. G. Field	R2-12
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	L. M. Sasaki	R2-12
	BAH File	
	LB File	

The Hanford Defined Waste (HDW) Model is being updated to reflect new information that became available since Revision 4.0 of the model was published in January 1997. As part of this update a new simulation of reactor operations was prepared using the Oak Ridge Isotope Generation and Depletion Code, ORIGEN2. The ORIGEN2 results created for Revision 4.0 of he HDW Model were based on nuclear data developed in the 1980s and early 1990s. For the new ORIGEN2 simulation, the following parameters were updated to the current or best-available information:

- Neutron capture cross-sections for actinides and important activation products.
- Fission product half-lives and specific activities.
- Fission product yield values.
- Fuel and cladding impurity history.

As a result of this update of the ORIGEN2 simulation the estimate for tritium in the irradiated fuel increased from 160,000 Ci tritium to 1,100,000 Ci tritium, (indexed to January 1, 2001). The change in modeling parameters that resulted in this increase in the tritium estimate is that lithium, present as an impurity in the aluminum used for fuel cladding, was added to the simulation. This change did not effect simulation of zirconium clad fuel.

For the recent ORIGEN2 simulation the lithium content of the aluminum cladding was modeled at the procurement specification maximum value of 80 ppm. Records of the lithium content of the aluminum cladding are not available and the 80 ppm value is suspected of being excessively conservative. The attachment to this letter concludes that a lithium concentration of 80 ppm and thus a tritium inventory of 1,100,000 Ci are unlikely.

The attachment to this letter establishes a tritium inventory correction factor for use in the updated HDW Model. The correction factor is derived from the measured tritium concentration of cladding waste samples from several tanks and the tritium concentration predictions of a draft version of the updated HDW (Rev. 5) model. The conclusion of the attached analysis is that the lithium content of aluminum cladding is much smaller than the procurement specification. Based on the lithium estimated from tritium assays of 5 tank samples, the REML (Restricted Maximum Likelihood) mean is 1.62 ppm with lower and upper confidence limits of 0.37 and 2.86 ppm respectively. Based on the REML mean value a correction factor of 0.023 should be applied to

the tritium inventory of HDW Model aluminum cladding wastes streams. This correction is expected to result in a total tritium estimate of 185,000 Ci in the irradiated fuel, a 16% increase from Revision 4 of the HDW Model. Using the upper confidence limit results in a tritium estimate of 202,000 Ci.

Although this tritium estimate is based on best available information, the number of cladding waste samples are limited and that in addition to the statistical uncertainty, the calculation method used is sensitive to uncertainties with respect to knowledge of the waste types and volumes. Direct measurements of lithium in the aluminum alloys are not available to verify this estimated lithium concentration. This estimate is derived from a draft version of the HDW Rev. 5 Model and will be reviewed prior to publication of the model update.

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Attachment

7G300-03-NWK-012

Attachment

HANFORD DEFINED WASTE MODELL - CORRECTION OF ORIGEN2 MODEL TRITIUM ESTIMATE

Consisting of 8 pages
including cover page

HANFORD DEFINED WASTE MODEL
CORRECTION OF ORIGEN2 MODEL TRITIUM ESTIMATE

BACKGROUND

The Hanford Defined Waste (HDW) Model is being updated to reflect new information that became available since Revision 4.0 of the model that was published in January 1997 (Agnew et al. 1997). As part of this update a new simulation of reactor operations was prepared using the Oak Ridge Isotope Generation and Depletion Code, ORIGEN2 (Watrous et al. 2002). The ORIGEN2 results created for Revision 4.0 of the HDW Model were based on nuclear data developed in the 1980s and early 1990s (Watrous et al. 1997). For the new ORIGEN2 simulation, the following parameters were updated to the current or best-available information:

- Neutron capture cross-sections for actinides and important activation products.
- Fission product half-lives and specific activities.
- Fission product yield values.
- Fuel and cladding impurity history.

As a result of this update of the ORIGEN2 simulation the estimate for tritium in the irradiated fuel increased from 160,000 Ci tritium to 1,100,000 Ci tritium, indexed to January 1, 2001. The change in modeling parameters that resulted in this increase in the tritium estimate is that lithium, present as an impurity in the aluminum used for fuel cladding, was added to the simulation. This change did not effect simulation of zirconium clad fuel.

Two aluminum alloys, 1245 (C-64) and X-8001 (M-388) were used at Hanford as cladding for the aluminum clad fuel (Weakley 1958). Fuel fabrication operations changed from using the 1245 alloy to the X-8001 alloy between 1957 and 1960 (Kupfer et al. 1999). Based on metric tons of uranium, approximately 30% of the aluminum clad fuel was made with the 1245 alloy and 70% was made with the X-8001 alloy. Lithium is an impurity that may be present in these alloys and both of these aluminum alloys have a maximum allowable lithium concentration of 80 ppm (Weakley 1958). The aluminum cladding consists of two components, an aluminum metal can and an Al-Si intermetalic layer. For the ORIGEN2 simulation of the aluminum cladding layer, the lithium content of the cladding layer was modeled as 70 ppm to allow for the intermetalic Al-Si bond layer used in the fuel fabrication process.

Because the estimate of tritium formed in the fuel cladding is sensitive to the lithium content of the cladding, knowledge of the lithium content of the aluminum alloys used is important. Several avenues were explored to determine the lithium content of these aluminum alloys. These included a search of the Hanford Site documents and records, queries to the Savannah River Plant, and queries to Alcoa Inc. The Savannah River Site also used X-8001 aluminum for fuel cladding and Alcoa supplied X-8001 aluminum tubing to both the Hanford and Savannah River Sites. None of these pathways were successful at determining the lithium content of the aluminum cladding.

BASIS FOR DETERMINING THE LITHIUM CONTENT OF ALUMINUM CLADDING FROM CLADDING WASTE SAMPLES

The lithium content of the aluminum cladding can be estimated from tank sample data. All of the tritium in the cladding is expected to have left the plants in the cladding waste stream without

losses to other waste streams. Once in the tanks, evaporation would cause tritium to separate from the cladding waste in direct proportion to the amount of water evaporated. Thus the tritium concentration remains constant through evaporation, and the lithium content of the cladding can be determined by comparing the tritium concentration of cladding waste samples to the tritium concentration predicted to be in the cladding waste by the HDW Model. An enabling assumption for this calculation is that all of the tritium in the cladding is due to the presence of lithium. This assumption is based on the knowledge that the tritium associated with uranium losses to the cladding waste is small, about 125 Ci. The basis for comparison of tritium concentrations is micro curies tritium per gram water. A draft version of the Rev. 5 HDW Model with recent ORIGEN2 estimates was used for this comparison (draft model HDW346a.xls).

Ideally a tritium assay from a pure cladding waste sample would be preferred. However in the tank farms cladding wastes were frequently stored with other wastes. Commingling with other wastes could mask or bias the tritium contribution from cladding waste. Cladding waste generated by the Bismuth Phosphate process is an exception to this concern. The Bismuth Phosphate plants commingled 1st cycle waste with cladding waste to neutralize 1st cycle waste before shipping the waste to tank farms. Tritium formed in the uranium metal partitioned with water to the metal waste during the Bismuth Phosphate process extraction step leaving the 1st cycle waste nearly free of tritium. Essentially all of the tritium to be found in the 1st cycle / cladding waste came from the aluminum cladding.

EVALUATION OF SAMPLE DATA

For those tanks with reported tritium results in the TWINS database, only twelve are known to contain cladding waste (241-BX-107, 241-C-104, 241-C-107, 241,C-109, 241-C-110, 241-C-112, 241-S-104, 241-T-102, 241-T-104, 241-T-105, 241-T-107, and 241-U-110).

The lithium content of the aluminum was determined by the following calculations:

(1) The tank history was reviewed to establish that the sample recovered from the tank was representative of cladding waste and was not adulterated by other waste types. The initial list of twelve tanks was reduced to five by this screening.
(2) Tritium assays from the tank were decayed to January 1, 2001 and adjusted to a water basis (μCi per gram water) using the wt% water content of the sample. A mean concentration was calculated for each tank.
(3) Estimated tritium concentrations for cladding wastes were obtained from a working draft of the HDW Model that included ORIGEN2 predictions based on 70 ppm lithium in the aluminum cladding. The draft model is decayed to January 1, 2001.
(4) The estimated tritium assays from the HDW Model were adjusted to a water basis (μCi per gram water).
(5) For those tanks, which contained cladding wastes from more than one source, a waste volume weighted mean tritium concentration was calculated for each tank from the HDW Model predictions.
(6) Lithium was estimated by the ratio of the tritium concentrations and the lithium concentration modeled in ORIGEN2, i.e.,

Actual lithium in the cladding (ppm) =

$$\frac{[\text{Lithium in ORIGEN2 (70 ppm)}][\text{Tank Waste Tritium Concentration}]}{[\text{HDW Model Tritium Concentration}]}$$

The following paragraphs summarize the screening of each of the twelve tanks that were identified as having both tritium assays and cladding waste layers. For those five tanks that pass the screening, estimation of the lithium concentration in the cladding is discussed.

Tank 241-BX-107. Tank 241-BX-107 is believed to contain only Bismuth Phosphate 1st cycle waste. The 1st cycle waste accumulated in the tank prior to 1958 and is representative of aluminum 1245 alloy. Two core samples were collected in 1992. The sample assay date is not reported in the Tank Characterization Database (TCD), radionuclide decay calculations are based on the October 1, 1992 assay date used by the Best-Basis Inventory (BBI). The mean tritium concentration of two composite sludge samples is 6.40E-04 μCi/g water decayed to January 1, 2001. The tritium concentration predicted by the HDW Model with 70 ppm lithium in the cladding is 3.16E-02 μCi/g water. The ratio of these values implies that the actual lithium content of the cladding is 1.42 ppm. The composite samples were made from all recovered segments for each core.

Tank 241-C-104. The *Tank Interpretive* Report for tank 241-C-104 indicates that this tank contains 23 kgal PUREX zirconium cladding waste, 27 kgal organic wash waste, 148 kgal PUREX aluminum cladding waste, 21 kgal of thoria waste, and 40 kgal of what is classified as other wastes. The other wastes include Bismuth Phosphate metal waste, REDOX cladding waste, PUREX high-level waste, PUREX low-level waste, strontium recovery waste, and 242-A evaporator saltcake. The tritium assays for this tank are from composite samples. Because of the large number of waste types in this tank, determining the contribution of the aluminum cladding waste layers to the tritium assay is not possible.

Tank 241-C-107. Tank 241-C-107 is believed to contain 135 kgal Bismuth Phosphate 1st cycle waste, 24 kgal PUREX cladding waste and 90 kgal of strontium recovery waste. This assessment is based on the analytical results from 5 core segments. Segments 1 and 2 contain 7 and 14 times more ^{90}Sr and total alpha, respectively, than the lower segments, 3 through 5. Elevated ^{90}Sr and total alpha concentrations are characteristic of SRR waste. Tritium assays for this tank are only available for composite samples. Less than two-thirds of the sludge in tank 241-C-107 is from cladding waste. The large fraction of SRR waste present in the composite sample invalidates estimation of the lithium present in the cladding waste due to unknown impact of tritium from the SRR waste on the sample.

Tank 241-C-109. Tank 241-C-109 is believed to contain 23 kgal of PUREX cladding waste, 7 kgal of hot semi-works waste, 24 kgal of Ferro cyanide waste, and 10 kgal of Bismuth Phosphate 1st cycle waste. All of the tritium assays for this tank are from composite samples. It is not possible to distinguish the contribution of cladding waste to the tritium assay from tritium contributed by other waste types present in this tank.

Tank 241-C-110. Tank 241-C-110 contains only Bismuth Phosphate 1st cycle waste (177 kgal sludge and 1 kgal supernatant). All of the tritium in this tank would have come from cladding waste. The 1st cycle waste accumulated in the tank prior to 1958 and is representative of aluminum 1245 alloy. The sample assay date is not reported by the TCD; therefore radionuclide decay calculations are based on the October 1, 1992 assay date used by the BBI. The mean tritium concentration of three composite sludge samples is 1.00E-03 μCi/g water decayed to January 1, 2001. The tritium concentration predicted by the HDW Model with 70 ppm lithium in the cladding is 2.21E-02 μCi/g water. The ratio of these values indicates that the actual lithium content of the cladding is 3.18 ppm.

Tank 241-C-112. Tank 241-C-112 contains from top to bottom the following waste layers, 17 kgal of PUREX cladding waste, 72 kgal of Ferro cyanide scavenging waste, and 15 kgal of Bismuth Phosphate 1st cycle waste. Segment data for tritium is only available for the scavenging waste region of the tank. The only tritium data that includes the cladding waste layers are composite samples. Since these samples are likely to be biased by the tritium in the scavenging waste layer estimation of the lithium present in the cladding waste from these samples is not possible.

Tank 241-S-104. Tank 241-S-104 contains from top to bottom the following waste types, 119 kgal of REDOX saltcake, 108 kgal of REDOX high-level waste, and 24 kgal of REDOX cladding waste. All of the tritium assay data for this tank are on composite samples. These samples are likely to be biased by the tritium in the high-level waste and saltcake. Estimation of the lithium present in the cladding waste layer from these samples is not possible.

Tank 241-T-102. Tank 241-T-102 is believed to contain 13 kgal of supernatant from cesium removal, 17 kgal of PUREX cladding waste, and 2 kgal of metal waste. Although the tritium assay for this tank is from a composite sample, only cladding waste is believed to be represented in the sample. The PUREX cladding waste accumulated in the tank after 1960 and is representative of aluminum X-8001 alloy. The sample assay date reported by the TCD (August 27, 1993) was used for radionuclide decay calculations. The mean tritium concentration of one composite sludge sample is 1.67E-02 μCi/g water decayed to January 1, 2001. The tritium concentration predicted by the HDW Model with 70 ppm lithium in the cladding is 9.14E-01 μCi/g water. The ratio of these values indicates that the actual lithium content of the cladding is 1.28 ppm.

Tank 241-T-104. Tank 241-T-104 contains only Bismuth Phosphate 1st cycle waste (317 kgal). The 1st cycle waste accumulated in the tank prior to 1958 and is representative of aluminum 1245 alloy. The tritium assay data for this tank is from two core samples. The samples were composited for analysis. All of he results were below the detection limit. The sample assay date is not reported by the TCD; therefore radionuclide decay calculations are based on the March 18, 1993 assay date used by the BBI. The mean tritium detection limit concentration of two composite sludge samples is 3.08E-04 μCi/g water decayed to January 1, 2001. The tritium concentration predicted by the HDW Model with 70 ppm lithium in the cladding is 3.64E-02 μCi/g water. The ratio of these values indicates that the actual lithium content of the cladding is only 0.59 ppm.

Tank 241-T-105. Tank 241-T-105 contains from top to bottom, 12 kgal of REDOX high-level waste, 12 kgal of REDOX cladding waste, 2 kgal of Bismuth Phosphate 1st cycle waste and 72 kgal of Bismuth Phosphate 2nd cycle waste. All of the tritium assay data available for this tank is from the top core segments. The high-level waste layer will bias this segment data. The lithium present in the cladding waste cannot be estimated from this sample.

Tank 241-T-107. Tank 241-T-107 contains from top to bottom, 8 kgal of PUREX cladding waste, 17 kgal of Tributyl phosphate waste, and 148 kgal of Bismuth Phosphate 1st cycle waste. The Tank Interpretive Report bases the designation of the upper waste layers on process knowledge. Three cores, 50, 51, and 52 were collected from this tank. Each core consisted of four segments, however the top segments contained little waste. There is no clear confirmation of the upper waste layers from the core sample results. The intrusion of hydrostatic head fluid into the drainable liquid samples cannot be determined since the hydrostatic head fluid did not contain LiBr tracer. Both solids composite and drainable liquid composite samples are available for this tank. Several of the sludge samples were free of drainable liquid, indicating that the

intrusion of hydrostatic fluid was unlikely. Since only ten percent of the waste in this tank (and perhaps less) is thought to be Tributyl phosphate waste, the potential bias to the tritium concentration is believed to be small. The 1st cycle waste accumulated in the tank prior to 1958 is representative of aluminum 1245 alloy. The PUREX cladding waste accumulated after 1960 is representative of X-8001 aluminum. The sample assay date is not reported by the TCD; therefore radionuclide decay calculations are based on the April 7, 1993 assay date used by the BBI. The mean tritium concentration of two composite sludge samples is 1.40E-03 μCi/g water decayed to January 1, 2001. The tritium concentration predicted by the HDW Model with 70 ppm lithium in the cladding is 6.15E-02 μCi/g water. The ratio of these values implies that the actual lithium content of the cladding is 1.59 ppm.

Tank 241-U-110. Tank 241-U-110 contains from top to bottom, 39 kgal of REDOX cladding waste, 105 kgal of REDOX high-level waste, and 32 kgal of Bismuth Phosphate 1st cycle waste. These waste layers are established in the Tank Interpretive Report by process knowledge and were confirmed by the core profiles. Only the bottom segment (#4) contained 1C waste, as indicated by elevated concentrations of Bi, PO_4, and Na. Six cores were collected from this tank. All of the cores were conposited for tritium assay. The large fraction of REDOX high-level waste in this tank (> 70%) significantly biases the tritium inventory for this tank. The lithium present in the cladding waste cannot be estimated from this sample.

CONCLUSION

The lithium concentration in the aluminum cladding is estimated from tritium assays from five tanks believed to contain cladding waste that have little or no adulteration from other sources of tritium. Three of these samples (tanks 241-BX-107, 241-C-110, and 241-T-104) are representative of 1245 aluminum and one (tank 241-T-102) is representative of X-8001 aluminum. Tank 241-T-107 contains cladding waste from both alloys. The results of these lithium estimates do not indicate a difference in the lithium content of the 1245 and X-8001 aluminum alloys. The REML (Restricted Maximum Likelihood) mean of lithium in the aluminum cladding for these five samples is 1.62 ppm with a standard deviation of 0.4494. Using a t-value (0.975, 4) of 2.776 to compute a 95% confidence interval, the lower and upper confidence limits are 0.37 ppm and 2.86 ppm lithium respectively.

For the purpose of modeling the tritium generated in Hanford irradiated reactor fuel, it is assumed as an enabling assumption that the lithium content of X-8001 aluminum is identical to 1245. The value of 1.62 ppm lithium in the cladding is well below the lithium value used in the ORIGEN2 estimates. Changing the lithium content of the aluminum cladding from 70 ppm to 1.62 ppm will reduce the tritium estimate to 185,000 Ci. This is an increase of 16% from the 160,000 Ci estimated in Revision 4 of the HDW Model. Using the upper confidence limit results in a tritium inventory of 202,000 Ci. A tritium inventory of 1,100,000 Ci is unlikely.

For this update of the HDW Model, the tritium inventory estimated by recent ORIGEN2 simulations of aluminum cladding should be corrected by the following ratio (1.62 ppm / 70 ppm) = 0.023. This correction is expected to result in a total tritium inventory estimate of about 185,000 Ci in the irradiated fuel of which 163,000 Ci are from tritium formed in the uranium metal portion of the fuel and 22,000 Ci are formed in the aluminum cladding.

Although this tritium estimate is based on best available information, the number of cladding waste samples are limited and in addition to the statistical uncertainty, the calculation method used is sensitive to uncertainties with respect to knowledge of the waste types and volumes. Direct measurements of lithium in the aluminum alloys are not available to verify this estimated

lithium concentration. This estimate is derived from a draft version of the HDW Rev. 5 Model and will be reviewed prior to publication of the model.

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INTEROFFICE MEMO

CH2MHILL
Hanford Group, Inc.

From: Process Analysis 7G400-03-SMM-003
Phone: 372-3628
Date: April 22, 2003
Subject: SHIPMENTS OF CESIUM-137 AND STRONTIUM-90 FROM THE HANFORD SITE (1961 THROUGH 1977)

To: B. A. Higley R3-73

Copies: M. E. Johnson
N. W. Kirch
S. M. Mackay

The Hanford Defined Waste Model is being updated to include new information. As part of the model update, a review was conducted to verify the quantities of fission products that were shipped from the Hanford site to Oak Ridge National Laboratory (ORNL), Pacific Northwest National Laboratory (PNNL), Hanford Laboratories (HLO), or Martin Marietta Company in Quehanna, Pennsylvania.

Monthly reports issued from 1961 through 1977 by the Atomic Energy Commission, Richland Office and the site contractors (General Electric Company, ISOCHEM Inc., and Atlantic Richfield Hanford Company) were reviewed to determine the quantities of fission products that were transferred from the Hanford site processing plants and underground storage tanks to offsite users. The quantities of cerium-144, cesium-137, promethium-147, and strontium-90 that were transferred offsite from January 1961 through December 1972 are summarized in Tables 1 through 5. No offsite shipments were made from December 1972 through May 1977. Also noted in these tables are return shipments of fission product waste from PNNL.

The shipments of fission products to HLO, ORNL and Martin Marietta Company were conducted by loading the fission product solutions onto ion exchange materials that were contained in shield casks transported by railcar. The fission products shipped to PNNL were liquid solutions contained in shielded casks transported by a semi-truck and trailer. Facilities that were used to conduct loading of the shielded casks were:

Facility	Service Dates
212-A cask station (located on south side of PUREX plant) [1]	January 1961 to October 1969
201-C Strontium Semiworks Cask Station	July 1961 to August 1969
241-C-801 Cask Station (located adjacent tank 241-C-103)	February 1963 to January 1968
B Plant Cell 4 cask station	April 1968 to March 1969
212-B cask station (located on south side of B Plant) [2]	May 1969 to November 1972

[1] 212-A cask station was also used in August 1967 to February 1969 to receive casks containing fission product waste from PNNL.
[2] 212-B cask station also received casks containing fission product waste from PNNL from April 1970 through May 1977.

The inventories of cerium-144, cesium-137, promethium-147, and strontium-90 that were transferred offsite from January 1961 through December 1972 were approximately 79MCi, 5.2MCi, 31.3MCi, and 11.2MCi, respectively. These inventories have not been decay corrected and represent the inventory of each fission product at the time of the shipment date.

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Process Analysis

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Attachments

Table 1. 212-B Cask Station Fission Products Shipment Information

Date	Inventory Shipped (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
May 1977					To tank 241-AY-102	16 casks of HLW received from PNNL at 212-B cask station. Transferred 130,000-gallons of waste from B Plant to AR Vault and then to tank 241-AY-102. Received 35 casks during preparation for the Commercial Nuclear Waste Vitrification Program and waste transfers proceeding [ARH-LD-229-B, page 31].
April 1977					To tank 241-AY-102	PNNL HLW sent from B Plant to AR Vault and then to tank 241-AY-102 [ARH-LD-228-B, page 26].
March 1977						The 212-B cask load-out facility was successfully reactivated after five-years of standby. Began unloading PNNL casks from the Commercial Nuclear Waste Vitrification Program at B Plant. The first cask was received on March 24, 1977 and the contents stored for reprocessing in B Plant [ARH-LD-227-B, page 25 and 27].
January – December 1974	None	None	None	None	None	Reviewed ARH-3034 RD and determined that no cask shipments conducted in 1974. ARH-3034 RD, page 22 notes that a 100-ml bulk sample of strontium product was delivered to PNNL in May 1974 for studies relating to WESF.
January – December 1973	None	None	None	None	None	Reviewed ARH-2416 RD and determined that no cask shipments conducted in 1973.
November 7, 1972	330				To PNNL	Loaded bowling ball cask with 65-gallons of strontium nitrate (330kCi) and shipped to PNNL [ARH-2441 RD, page 55 and 56 and PPD-493-11-DEL, page AIV-14].
October					None	No shipments [PPD-493-10-DEL].
September					None	No shipments [PPD-493-9-DEL].
August					None	No shipments [PPD-493-8-DEL].
July					None	No shipments [PPD-493-7-DEL].
June 7, 1972		100			To PNNL	Loaded cask with 24.5-gallons of cesium product (~100kCi) and shipped to PNNL [ARH-2441 RD, page 29 and 30 and PPD-493-6-DEL, page AIV-22].
May 18, 1972	9				To PNNL	Shipped 2.25-gallons of purified strontium-90 solution to PNNL [ARH-2441 RD, page 25 and PPD-493-5-DEL, page AIV-21].
May 1972					From PNNL	Received bowling ball cask with waste. Waste was combined with other low-level waste and transferred to tank farms [ARH-2441 RD, page 23 and PPD-493-5-DEL, page AIV-15].
April 1972					None	No shipments [PPD-493-4-DEL].
March 1972					None	No shipments [PPD-493-3-DEL].
February 1972					None	No shipments [PPD-493-2-DEL].
January 1972					None	No shipments [PPD-493-1-DEL].
December 1971					None	No shipments in December 1971 [PPD-489-DEL].
November 30, 1971	640				To ORNL	Shipped HAPO-IB cask [PPD-485-DEL, page AIV-14].

Table 1. 212-B Cask Station Fission Products Shipment Information

Date	Inventory Shipped (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
November 1971			6,185	2,883	To PNNL	Shipped (Pm-FY-72-25 thru Pm-FY-72-30) six bowling ball casks November 1 thru 8. Completes Pm-147 recovery program [PPD-485-DEL, page AIV-14 and AIV-19].
October 1971			4,440	2,040	To PNNL	Shipped (Pm-FY-72-21 thru Pm-FY-72-24) four bowling ball casks October 26 thru 29 [PPD-478-DEL, page AIV-13 and AIV-19].
October 6, 1971		14.2			To PNNL	A cask containing 8-gallons of cesium product solution from B Plant tank 37-1 was shipped to PNNL for process development and final purification for encapsulation [PPD-478-DEL, page AIV-13 and AIV-19].
September 1971			9,250	3,682	To PNNL	Shipped (Pm-FY-72-12 thru Pm-FY-72-20) nine bowling ball casks September 2 thru 27 [PPD-471-DEL, page AIV-15 and AIV-20].
September 27, 1971	None	None			From PNNL	Received PNNL waste at 212-B cask station in a 20-ton bowling ball cask. Waste was blended with CAW solutions for processing to recover Cs-137 and Sr-90. Waste contained 0.15curies Eu-154, 52.8-grams Pu-239, and 1.1 curies Zr-Nb-95 [PPD-471-DEL, page AIV-16].
September 2, 1971	2.31	2.54			From PNNL	Received PNNL waste at 212-B cask station in a 20-ton bowling ball cask. Waste was blended with CAW solutions for processing to recover Cs-137 and Sr-90. Waste contained 1.67kCi Ce-Pr-144, 0.4kCi Cs-134, 2.54kCi Cs-137, 4.1-grams Pu-239, 1.03kCi Ru-Rh-106, and 2.31kCi Sr-89 + 90 [PPD-471-DEL, page AIV-16].
August 6, 1971			630	150	To PNNL	Shipped (Pm-FY-72-11) bowling ball cask [PPD-463-DEL, page AIV-14 and AIV-19].
August 4, 1971			800	240	To PNNL	Shipped (Pm-FY-72-10) bowling ball cask [PPD-463-DEL, page AIV-14 and AIV-19].
August 9, 1971		380			To ORNL	Shipped HAPO-1C-1 cask [PPD-463-DEL, page AIV-15]. ORNL reported receiving 414kCi Cs-137 [PPD-478-DEL, page AIV-16].
July 1971					To ORNL	Loaded HAPO-1C-1 cask with 3780kCi of Cs-137 for shipment to ORNL after railroad strike is resolved [PPD-458-DEL, page AIV-13].
July 1971					From PNNL	Received a 20-ton bowling ball cask containing 133-gallons of waste from PNNL. Waste was processed with CAW to recover cesium and strontium [PPD-458-DEL, page AIV-13].
July 1971			14,790	2,120	To PNNL	Conducted nine shipments (FY-72-1 thru FY-72-9) of Pm product to PNNL during July 1971 using 20-ton bowling ball cask [PPD-458-DEL, page AIV-12].
June 1971			8,380	3,340	To PNNL	Shipped eight 20-ton bowling ball cask (FY-71-1 thru FY-71-8) with Pm product separated during current acid waste batch 71-2. Shipments made from June 2 thru 24 [PPD-445-DEL, page AIV-14 and PPD-453-DEL, page AIV-14 and AIV-21].

Table 1. 212-B Cask Station Fission Products Shipment Information

Date	Inventory Shipped (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
May 4, 1971	594		3		To ORNL	HAPO-IB cask shipper [PPD-438-DEL, page AIV-14 and PPD-445-DEL, page AIV-15].
March 17, 1971					To ORNL	Loaded HAPO 1B-1 cask with ~93kCi Sr-90 for shipment to ORNL [ARH-1895 1, page 128 and ARH-1895 1, page 134]. Cask unloaded by eluting with 1M nitric acid solution and reloaded in May 1971 [PPD-438-DEL, page AIV-14].
February 5, 1971	Not reported				From PNNL	Unloaded high strontium waste from PNNL on February 4, 1971. Transferred to AR Vault on February 7, 1971 [ARH-1895 1, page 61].
January 20, 1971	11.2				To PNNL	Four-gallons of purified strontium solution transferred to PNNL [ARH-1895 1, page 24 and PPD-413-DEL, page AIV-13].
January 19, 1971	Not reported	Not reported	Not reported	Not reported	From PNNL	Received and unloaded waste cask from PNNL [ARH-1895 1, page 24].
January 15, 1971	Not reported	Not reported	Not reported	Not reported	From PNNL	ARH-1895 1, page 20
January 14, 1971	Not reported	Not reported	Not reported	Not reported	From PNNL	Unloaded 276-gallons of waste from 30 ton cask [ARH-1895 1, page 16].
November 2, 1970		425			To ORNL	ARH-1205-RD-DEL, October 1970, page 4 and PR-REPORT-NOV70-DEL, page AIV-7]
September 1970			1,290		To PNNL	Shipped cask that was loaded on August 24, 1970 [PR-REPORT-SEP70-DEL, page AIV-6]
August 20, 1970			1,290		To PNNL	A 30-ton bowling ball cask containing 157-gallons of cerium was shipped to PNNL. The second and last scheduled cerium cask shipment was loaded on August 24, 1970, but not shipped due to leak in cask cell [PR-REPORT-AUG70-DEL, page AIV-4 and AIV-6]. First fission product load-out via 212-B cask station conducted August 18, 1970. [ARH-1205-RD-DEL, August 1970, page 8] Note: 7MCi of Ce-144 had been separated from the May and June CAW campaigns in B Plant. PNNL decreased order to 2MCi of Ce-144. Remainder discarded to tanks. [ARH-1205-RD-DEL, August 1970, page 4]

Table 1. 212-B Cask Station Fission Products Shipment Information

Date	Inventory Shipped (kilocuries)					Reference
	Sr-90	Cs-137	Ce-144	Pm-147	Destination	
July 1970	None	None	None	None	None	"In the future, the 212-B cask facility will be the sole load-out site for fission products. This decision was reached as a matter of policy to standardize cask loading and unloading procedures and thus enhance the safety aspects of cask work. ... *Cerium, that was in position to be loaded out via the former Cell 4 cask* station will be moved down the canyon and loaded out on a priority basis for shipment to Battelle. ... All of these changes in priorities and facilities will mean a 4 to 6-month delay in delivery of strontium to ORNL (originally request for late FY1970)." [ARH-1205-RD-DEL, July 1970, page 2]
June 1970	None	None	None	None	None	212-B cask station clean up completed and returned to normal condition. [ARH-1205-RD-DEL, June 1970, page 11]
May 1970	None	None	None	None	None	" Authorization has been received from AEC-RL to ship to ORNL the approximately 690 kilocuries of strontium-90 which were previously purified in the Semiworks. This material is presently stored at B Plant." [ARH-1205-RD-DEL, May 1970, page 3]
April 1970				Not reported	From PNNL	Three operators received exposure to high-level radiation while attempting to unload cask from PNNL that contained Pm-147 waste on April 18, 1970. [ARH-1205-RD-DEL, April 1970, page 13]
April 1970			3,160		To PNNL	Concentrated cerium solution in Cell 5 evaporator in B Plant for shipment to PNNL. Made Three shipments of Ce-144 solution to PNNL on April 21, April 23, and April 27 [PR-REPORT-APR70-DEL, page AIV-4 and AIV-6].
March 23, 1970	54				To PNNL	Corrected March 1970 shipment record from 2 to 54kCi Sr-90 [PR-REPORT-MAR70-DEL, page AIV-5 and PR-REPORT-APR70-DEL, page AIV-6].
March 1970					To PNNL	A 30-gallon sample of cesium ion exchange waste was obtained from tank 241-BX-110 and processed through a 4-inch diameter by 48-inch tall AW-500 ion exchange column located in the 212-B cask station to remove residual cesium. The content of Rhodium, Palladium, and technetium in the sample was 0.04 gm/gallon, 0.03 grams/gallon, and 0.09 grams/gallon, respectively [PR-REPORT-MAR70-DEL, page AIV-5].
October 1969			5,400		To PNNL	Loaded and shipped four, 30-ton casks with cerium-144 that had been separated in the solvent extraction battery and concentrated in cell 5 within B Plant [PR-REPORT-OCT69-DEL, page AIV-4 and ARH-1023-4-DEL, pages 18 to 23].
August 1969	699				From Sr Semiworks	The 699kCi of purified Sr-90 were transferred from tank E-4 in the Strontium Semiworks to B Plant tank 35-1 for temporary storage. The Strontium Semiworks was placed in layaway status [PR-REPORT-AUG69-DEL, page AIV-3].

Table 1. 212-B Cask Station Fission Products Shipment Information

Date	Inventory Shipped (kilocuries)					Reference
	Sr-90	Cs-137	Ce-144	Pm-147	Destination	
August 22, 1969					From PNNL	Unloaded one waste cask at 212-B [ARH-1023-4-DEL, page 16].
August 5, 1969					From PNNL	Unloaded one 200-gallon bowling ball cask at 212-B [ARH-1023-3-DEL, page 49].
July 31, 1969					From PNNL	Unloaded one cask [ARH-1023-3-DEL, page 34].
July 30, 1969					From PNNL	Unloaded one 500-gallon cask at 212-B [ARH-1023-3-DEL, page 33].
July 1969			5,300		To PNNL	Conducted four cask shipments of Ce-144 from July 1 through July 7 [ARH-1023-3-DEL, pages 1 to 7].
May 2, 1969				Unknown	From PNNL	"First use of the new (212-B) cask station was made May 9, when a 500-gallon bowling ball cask containing aged promethium process recovery waste from Pacific Northwest Laboratory was transferred to Tank 35-2. Two casks were unloaded this month." [PR-REPORT-MAY69-DEL, page AIII-4].

Table 2. B Plant Cell 4 Cask Station Fission Products Shipment Information

Date	Inventory Shipped (kilocuries)					Reference
	Sr-90	Cs-137	Ce-144	Pm-147	Destination	
April 9, 1968 April 11, 1968			3,000		To PNNL	Shipped two bowling ball casks. Cerium was separated in B Plant during first solvent extraction run conducted in March 1968 [HAN-100127-DEL, page AIII-3, HAN-100357-DEL, page AIII-3, and ARH-458-DEL, page 13 and 17].
July 1968			8,000	260	To PNNL	Shipped six casks containing Ce-144 and two casks containing Pm-147 [PR-REPORT-JUL68-DEL, page AIII-3, ARH-647-DEL, pages 17 to 29, ARH-647-DEL, pages 39 and 43].
September 1968				12,300	To PNNL	Shipped five Promethium casks [ARH-N-82, page 7 and ARH-647-DEL, pages 43, 56, 60, 61, and 64].
December 1968			1,050		To PNNL	Shipped cask number 8 to PNNL [PR-REPORT-DEC68, page AIII-4].
January 16, 1969			1,490		To PNNL	Shipped cask that had been sitting on B Plant canyon deck since November 20, 1968 [ARH-1023-DEL, page 21].
March 1969		Unknown			To PNNL	Approximately 5-gallons of cesium product solution from tanks 37-1 and 31-3 were shipped to PNNL for use in encapsulation and PAS flowsheet studies. No inventory reported [PR-REPORT-MAR69-DEL, page AIII-3].
March 24, 1969	Unknown				To PNNL	Shipped 2,5-gallons of PUREX Acidified Sludge feed sample to PNNL for experimental lab work [ARH-1023-DEL, page 141].

Table 3. 241-C-801 Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
February 1968		None				Received notification to discontinue Cs-137 shipments to ORNL for remainder of fiscal year 1968[HAN-99880-DEL, page AIII-3].
January 1968		100			To ORNL	Shipment to ORNL [HAN-99604-DEL, page AIII-3].
November 1967		106			To ORNL	Shipped two STT casks [HAN-99196-DEL, page AIII-3].
September 18, 1967		112			To ORNL	Shipped STT casks 45A and 46 [HAN-98749-DEL, page AIII-3].
March 20, 1967		113			To ORNL	Shipped STT casks 44 and 47 [HAN-97066-DEL, page AIII-4]
February 27, 1967		82			To ORNL	Shipped STT cask 48 and Model III [HAN-96805-DEL, page AIII-4].
January 27, 1967		104			To ORNL	Shipped STT casks 45A and 46 [HAN-96590-DEL, page AIII-5].
January 3, 1967		120			To ORNL	Shipped STT casks 44 and 47 [HAN-96590-DEL, page AIII-5].
December 1967						Monthly report for December 1967 (HAN-93551-DEL) does not report a shipment in December 1967; only loading of the STT casks. However, ARH-N-82, page 4 reports that 120kCi of Cs-137 were shipped on 12-5-1966 to ORNL. However, ARH-N-82 page 6 reports the same 120kCi of Cs-137 shipped in January 3, 1967
October 31, 1966		109			To ORNL	Shipped STT casks 45A and 47 [HAN-95918-DEL, page AIII-4].
October 10, 1966		112			To ORNL	Shipped STT casks 44 and 46 [HAN-95918-DEL, page AIII-4].
September 12, 1966		100			To ORNL	Shipped STT 45A and 48 [HAN-95695-DEL, page AIII-4].
July 7, 1966		120			To ORNL	Shipped two STT casks [HAN-95284-DEL, page 13].
June 13, 1966		74			To ORNL	Shipped STT casks 45A and 46 [HAN-95105-DEL, page 15].
May 8, 1966		83			To ORNL	Shipped STT casks 44 and 48 [HAN-94842-DEL, page 18]. Inventory from ARH-N-82.
April 8, 1966		85			To ORNL	Shipped STT cask 46 and 47 [HAN-94591-DEL, page 14].
March 4, 1966		120			To ORNL	Shipped STT casks 44 and 45A [HAN-94330-DEL, page 15].
February 7, 1966		99			To ORNL	Shipped STT casks 47 and 48 [HAN-94040-DEL, page 15].
January 4, 1966		99			To ORNL	Shipped STT casks 44 and 45A [HAN-93802-DEL, page 13].
October 18, 1965		45			To ORNL	Shipped STT casks 47 and 48 [HAN-92954-DEL, page 14].
September 13, 1965		68			To ORNL	Shipped two STT casks [HAN-92750-DEL, page 14].
April 26, 1965		215			To ORNL	Shipped four STT casks [HAN-91499-DEL, page 15].
January 18, 1965		218			To ORNL	Shipped four STT casks [HAN-90650-DEL, page 14].
September 25, 1964		185			To ORNL	Shipped SSTs casks [HW-84354, page A-3 and B-2]
May 4, 1964		211			To ORNL	Four SSTs casks shipped [HW-82526, page B-1].
November 29, 1963		189			To ORNL	Four SSTs casks shipped [HW-79768, page B-1].
August 2, 1963		210			To ORNL	Four SST casks shipped [HW-78817, page 5 and A-3].

Table 3. 241-C-801 Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
May 24, 1963		188			To ORNL	Four SST casks shipped [HW-77795, page 5 and A-3].
March 1963		200				No record of shipment in March monthly report (HAN-84757-DEL). ARH-N-82, page 2 reports shipment of 200kCi of CS-137 to ORNL on March 8, 1963.
February 23, 1963						New cesium loading station placed in service at C-Farm (241-C-801) on February 23, 1963. Loaded four SST casks each with 50kCi of Cs-137 [HW-76848, page G-2].

Table 4. Strontium Semiworks Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
August 1969	699				To B Plant	The 699kCi of purified Sr-90 were transferred from tank E-4 in the Strontium Semiworks to B Plant tank 35-1 for temporary storage. The Strontium Semiworks was placed in layaway status [PR-REPORT-AUG69-DEL, page AIV-3].
February 27, 1969	28				To PNNL	Shipped cask containing 40-liters of strontium product to PNNL [PR-REPORT-FEB69-DEL, page AIII-3 and ARH-1023-DEL, page 93].
January 1968	60				To PNNL	Shipment to PNNL [HAN-99604-DEL, page AIII-3].
October 1967	None	None	None	None		Strontium Semiworks shutdown. Washed solvent was transferred to tank 14-2 at REDOX using a PNNL trailer [ISO-651 RD, page 256].
September 18, 1967			150	200	To PNNL	Shippingport Am/Cm/Rare Earth material recovered at REDOX and semi-purified at Semiworks was transferred in a cask to PNNL. Approximately 2,820 curies Am-241, 4,830 curies Cm-244, 1,000 curies Eu-154 recovered along with Ce-144 and Pm-147 [ISO-651 RD, page 245 – 247].
July 1967			~1,200		To PNNL	Loaded two 200-gallon bowling ball casks with cerium product for delivery to PNNL [ISO-651 RD, page 180 and HAN-98343-DEL, page AIII-3].
June 1967	~35				To PNNL	About 35kCi of Sr-90 sent to PNNL in a 40-gallon sample cask [ISO-651 RD, page 141 and HAN-98163-DEL, page AIII-4].
May 1967			324		To PNNL	Loaded three 40-gallon PNNL casks with cerium and rare earth product [ISO-651 RD, page 113 and HAN-97845-DEL, page AIII-4].
November 1966			300		From PNNL	Received 6 casks, each containing 200-gallons of Ce waste and unloaded to tank 011 in 244-CR Vault [HAN-96143-DEL, page AIII-4].
October 1966	2.65				To PNNL	3.5-gallons of strontium-90 solution at approximately 200 Ci/l were loaded into a 11-gallon PNNL sample cask [ISO-75 RD, page 163].

Table 4. Strontium Semiworks Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
June 10, 1966	390				To ORNL	Shipped HAPO-IB-3 cask [HAN-95105-DEL, page 15].
May 2, 1966	490				To ORNL	Shipped HAPO-II-2 and HAPO-IB-1 casks [HAN-94842-DEL, page 18].
May 1966				1,080	To PNNL	Two Pm-147 shipments to PNNL [HAN-94842-DEL, page 18].
April 1966				1,800	To PNNL	Two casks loaded and shipped [HAN-94591-DEL, page 14].
March 18, 1966	180				To Quehanna, PA	Shipped HAPO-II-1 cask [HAN-94330-DEL, page 15].
March 18, 1966				730	To PNNL	Shipped 200-gallon bowling ball cask [HAN-94330-DEL, page 15].
February 21, 1966	330				To ORNL	Sipped HAPO-IB-3 cask [HAN-94040-DEL, page 15].
February 4, 1966	160				To Quehanna, PA	Shipped HAPO-II-2 cask [HAN-94040-DEL, page 15].
January 3, 1966	170				To Quehanna, PA	Shipped HAPO-II-1 cask [HAN-93802-DEL, page 13].
December 13, 1965	430				To ORNL	Shipped HAPO-IB-1 cask [HAN-93551-DEL, page 13].
December 10, 1965				195	To PNNL	Shipped 200-gallon cask [HAN-93551-DEL, page 13].
November 29, 1965			420		To ORNL	Shipped HAPO-IB-2 cask [HAN-93300-DEL, page 13].
November 18, 1965	150				To Quehanna, PA	Shipped HAPO-II-2 cask [HAN-93300-DEL, page 13].
October 1965	430				To ORNL	Shipped HAPO-IB-1 cask [HAN-92750-DEL, page 14].
September 10, 1965	100				To Quehanna, PA	Shipped HAPO-II-1 cask [HAN-92750-DEL, page 14].
September 1965				14	To PNNL	Shipped 40-gallon cask to PNNL. Pm-147 was from promethium ion exchange column run conducted at 222-S laboratory [HAN-92750-DEL, page 14].
June 18, 1965				120	To PNNL	[HAN-92077-DEL, page 14].
May 14, 1965				45	To PNNL	[HAN-91791-DEL, page 18].
April 1965				125	To PNNL	Loaded out 125kCi of Pm-147 from Strontium Semiworks [HAN-91499-DEL, page 14].
March 19, 1965	340				To ORNL	Shipped HAPO-IB-1 cask [HAN-91198-DEL, page 16].
September 11, 1964	350				To ORNL	Shipped HAPO-IB-1 cask [HW-84354, page A-3 and B-1].
July 6, 1964	420				To ORNL	Shipped HAPO-IB-2 cask [HW-83508, page B-2].
May 18, 1964	120				To ORNL	Shipped HAPO II-1 cask [HW-82526, page B-1].
March 23, 1964	410				To ORNL	Shipped HAPO-IB-2 cask [HW-81620, page A-3].
March 2, 1964			500		To ORNL	Shipped HAPO-IB-2 cask [HW-81620, page A-3].
February 1964			30		To HLO	Shipped 40-gallons cask to HLO [HW-81078, page B-1].
January 1964	110				To Quehanna, PA	Cask shipped [HW-80672, page A-3].
November 29, 1963				49	To ORNL	ORNL Pm cask shipped [HW-79768, page B-1].
November 22, 1963	140				To ORNL	HAPO-II-1 shipped [HW-79768, page B-1].
October 18, 1963	340				To ORNL	HAPO-IB-1 cask shipped [HW-79480, page A-3].
October 7, 1963	170				To ORNL	HAPO-II-2 cask shipped [HW-79480, page A-3].

Table 4. Strontium Semiworks Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
August 12, 1963	470				To ORNL	HAPO-IB-1 cask shipped [HW-78817, page 5 and A-3].
August 5, 1963	140				To Quehanna, PA	HAPO-II-1 cask shipped [HW-78817, page 5 and A-3].
July 19, 1963	170				To Quehanna, PA	HAPO-II-2 cask shipped [HAN-83805-PT7, page 32].
June 14, 1963	160				To ORNL	HAPO-II-1 cask shipped [HAN-85578-DEL, page 11].
May 31, 1963	155				To Quehanna, PA	HAPO-II-2 cask shipped [HW-77795, page 5 and A-3].
April 15, 1963	170					ARH-N-82 page 2 reports 170kCi of Sr-90 shipped to ORNL on April 15, 1963. Monthly report for April 1963 (HAN-85001) does not report this shipment.
March 1963			100		To ORNL	HAPO-I cask shipped [HAN-84757-DEL, page 11].
March 22, 1963	145				To Quehanna, PA	HAPO-II-2 cask shipped [HAN-84757-DEL, page 11].
February 1963	50				To HLO	A HLO cask was loaded in the strontium nitrate form [HW-76848, page B-1].
February 22, 1963	170				To ORNL	Shipped HAPO-II-2 cask [HW-76848, page 5].
December 31, 1962	165				To Quehanna, PA	Shipped HAPO-II-2 cask [HW-76054, page 5].
November 1962	170				To Quehanna, PA	Two HAPO-II casks were loaded with approximately 335kCi of Sr-90 in November 1962. The monthly report does not mention shipment of either cask [HW-75702, page B-1]. Only one of the HAPO-II casks containing 165kCi of Sr-90 is reported as being shipped in December 1962 [HW-76054, page 5]. Therefore, it is assumed that the other cask was shipped in November 1962.
September 29, 1962	94				To Quehanna, PA	Shipped HAPO-II-2 cask [HW-75145, page 5].
November 3, 1962	170				To Quehanna, PA	HAPO-II-1 cask loaded with 170kCi of Sr-90 for shipment on August 3, 1962 [HAN-80582-DEL, page 24].
July 6, 1962	130				To Quehanna, PA	Shipped HAPO-II-2 cask [HW-74505, page 5].
March 26, 1962	140				To ORNL	Shipped HAPO-II-2 cask [HW-73193, page 5].
March 2, 1962	110				To ORNL	Shipped HAPO-II-1 cask [HW-73193, page 5].
July 1961	120				To ORNL	Shipped HAPO-II-1 cask loaded at Hot Semiworks [HW-70588, page B-1].

Table 5. 212-A PUEX Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
January 1961 (See note 1)						Project B-42776, Secondary Containment building at PUREX Fission Product load-out station was completed on January 17, 1971 [HW-68345, page E-2].
April 12, 1961 (See note 1)	20	120			To ORNL	Four shielded transfer tanks (STTs) were loaded with cesium separated from tank 241-A-103 supernatant in PUREX. Shipped HAPO-IA cask that was loaded with strontium that had been purified at Hanford Laboratories (HLO). Cask was loaded at HLO [HW-69443, page 5].
June 1, 1961 (See note 1)	25				To ORNL	HAPO-IA cask loaded at HLO was shipped on June 1, 1961 [HW-69803, page].
July 1961 (See note 1)	13.4				To ORNL	Shipped HAPO-IA cask loaded at HLO [HW-70588, page B-1].
September 30, 1961		66			To ORNL	Two STTs loaded and shipped [HW-71187, page B-2].
January 19, 1962		200			To ORNL	Four STTs were loaded and shipped to ORNL [HW-72551, page B-1].
August 24, 1962		177			To ORNL	Four STTs were loaded and shipped to ORNL [HW-74804, page 5].
September 1962		30			To HLO	Conducted ferrocyanide precipitation test in PUREX head-end. Recovered and shipped to Hanford Laboratories (HLO) 30kCi of Cs-137 for packaging studies [HW-75145, page 5].
December 1962		199				Four SST casks loaded with cesium for shipment [HW-76054, page G-2]. Inventory reported as 199kCi of Cs-137 in ARH-N-82, page 2.
August 1967					From PNNL	Received and unloaded 15 casks of waste [HAN-98529-DEL, page AIII-3].
September 29, 1967					From PNNL	Received and unloaded one 500-gallon bowling ball waste cask [ARH-58-DEL, page 2].
October 1967					From PNNL	Received and unloaded twenty-six 500-gallon and four 300-gallon bowling ball waste casks [ARH-58-DEL, pages 14 to 41].
November 29, 1967			1,340		To PNNL	Shipped cask [ARH-58-DEL, page 94].
April 30, 1968					To PNNL	Shipped one cask of sulfate-free 1WW waste [ARH-458-DEL, page 43].
May 14, 1968					From PNNL	Unloaded one cask. Contamination spread from vent line. Decontamination of cask station conducted [ARH-458-DEL, pages 73 to 79].
June 1968					From PNNL	Unloaded nine 300-gallon cask containing waste [ARH-458-DEL, pages 123 to 127 and 141 to 143].
June 1968					To PNNL	Shipped six casks that contained ~1,400-gallons of sulfate-free 1WW waste to be used by PNNL for B Plant flowsheet studies and rhodium-palladium ratio studies [ARH-458-DEL, pages 131 to 145].
July 1968					From PNNL	Unloaded five cask containing waste [ARH-647-DEL, pages 25 to 43].

Table 5. 212-A PUEX Cask Station Fission Products Shipment Information

Date	Inventory in Shipment (kilocuries)				Destination	Reference
	Sr-90	Cs-137	Ce-144	Pm-147		
July 25, 1968					From PNNL	Received and flushed the 200-gallon Promethium load-out cask. Cask sent to B Plant on July 25, 1968 [ARH-647-DEL, page 35].
August 1968					From PNNL	Unloaded six 300-gallon and two 500-gallon casks containing waste [ARH-647-DEL, pages 54 to 78].
September 16, 1968					From PNNL	Unloaded one cask containing waste [ARH-647-DEL, page 125].
September 25, 1968					From PNNL	Unloaded one 200-gallon cask containing waste [ARH-647-DEL, page 139].
February 10, 1969					From PNNL	Unloaded one cask containing waste [ARH-1023-DEL, page 69].
October 1969					To PNNL	Shipped six bowling ball casks with sulfate-free 1WW waste [ARH-1023-4, pages 10 to 16]

[1] Initial shipments of Sr-90 to HLO. This strontium was made into a 5-watt electric heat source for the Weather Bureau {HW-70998].

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FDNW-RJP-98-028

September 2, 1998

Mr. Jerry W. Cammann
Lockheed Martin Hanford Company
P.O. Box 1500 R2-11
Richland, Washington 99352

Dear Mr. Cammann:

BEST BASIS INVENTORY DKPRO CODE RUN ADDITIONAL SCOPE - RADIONUCLIDES UNCERTAINTY ESTIMATE CALCULATIONS

Reference: Letter, L. N. Cortez to R. T. Steen, "Funding Authorization - Task Order 43-06-01, Best Basis Inventory DKPRO Code Runs, P.O. A42243, Line Item 6," LMHC-9854182, dated May 12, 1998

The attached report documents studies that Lockheed Martin Hanford Company requested of the Specialty Engineering Department within Fluor Daniel Northwest, Inc. to estimate errors in the nuclear data input to theHanford Defined Waste Model. This report completes the deliverables for Task 2 identified in the Reference.

Sincerely,

R. J. Puigh
Manager
Environmental & Nuclear Initiatives

RJP:DWW:gjr

Attachment

c: C. H. Brevick, FDNW
S. H. Finfrock, FDNW
R. W. Harmsen, LMHC
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ATTACHMENT

to

FDNW-RJP-98-028

LETTER REPORT

CONTRIBUTIONS TO UNCERTAINTY IN HANFORD DEFINED WASTE MODEL INVENTORIES FROM RADIONUCLIDE SOURCE FILES

Prepared by

FLUOR DANIEL NORTHWEST, INC

August 1998

Prepared for

LOCKHEED MARTIN HANFORD COMPANY

Task Order LMHC96WO-0006-04061

D. W. Wootan, Technical Author	9/2/98 Date
S. H. Finfrock, Reviewer	9/3/98 Date
R. J. Puigh II, Manager	9/3/98 Date

Contributions to Uncertainty in Hanford Defined Waste Model Inventories from Radionuclide Source Files

Scope

The uncertainty and potential biases introduced in the Hanford Defined Waste Model (HDW) radionuclide inventories by the process of generating the radionuclide source input were evaluated by identifying and quantifying the major contributors to uncertainties and biases in the nuclear data and methods. The intent of this study was to examine major aspects of the nuclear data treament that could bias or introduce substantial uncertainties to the HDW inventories. The parameters examined included actinide and activation product cross sections, variations based on fuel type and the specific reactor in which the fuel was irradiated, fission product yields, and half lives. Additional uncertainties and biases contributed by the HDW model assumptions, such as the practice of applying separations factors after all the radioisotopes had been decayed to a reference date, are described in other reports.

Background

Best Basis tank waste inventories consist of 25 chemicals and 46 radionuclides on a global and tank-specific basis, representing greater than 99.9% of the chemical mass and radionuclide activity. The best-basis inventory was developed by considering actual sampling data, computer model predictions generated by the Hanford Defined Waste Model (HDW), and engineering analyses of historical records such as process flowsheets and material purchase invoices. The HDW model was relied upon heavily to generate the best basis inventory for the radionuclides due to the lack of analytical information. Radionuclide inventory uncertainties are needed to help reconcile global and tank-specific inventories and support tank waste privatization efforts. The current version of the best-basis inventory does not provide information regarding radionuclide uncertainties. Uncertainties are inherent in the process of generating the radionuclide input to the HDW model, arising from both basic nuclear data uncertainties and modeling assumptions.

DKPRO Input to HDW Model

The primary radionuclide input to the HDW model consists of a file of "pre-decayed" isotopic inventories (Fuel Activity Records) generated using the ORIGEN2 (Croff 1980, Wittekind 1994) and DKPRO (Schmittroth 1997) codes. The ORIGEN2 code is used to calculate initial radionuclide inventories as a function of fuel type, fuel burnup, and reactor type, with subsequent decay and processing computed by the DKPRO code. Input to the DKPRO code includes an archive file of separations processing records by fuel batch, a file of processing directives, a file of summary directives, and a set of ORIGEN2 inventory files representing unprocessed radionuclide inventories. The DKPRO code solves the general problem of modeling complex nuclear waste streams using ORIGEN2 radionuclide production files. The processing directives input to DKPRO are used to control the removal or splitting of waste streams. Each fuel batch record contains data on fuel type, fuel tonnage, exposure, separations, date, and cooling time. For each

separations processing record, DKPRO calculates the radionuclide activities in that batch of fuel by interpolating on the ORIGEN2 generated inventory files as a function of fuel type and fuel exposure (MWd/MTU), and then performing decay calculations and whatever processing instructions are provided in the process directives file or the fuel records file. Output from the DKPRO code is approximately 1300 Fuel Activity Records of pre-decayed radionuclide values, each record representing the curies associated with a batch of fuel processed by month (or shorter period) through individual separations plants, but modeled as though the fuel was held (unseparated) until the reference decay date of January 1, 1994 (Watrous 1997). For generating the input needed for the HDW model, no processing of the fuel or removal of constituents is done with DKPRO. Since the DKPRO code (as currently used in generating HDW input) primarily performs the functions of interpolation and decay on the ORIGEN2 inventory files, the major sources of the HDW input radionuclide inventory uncertainty arise from the ORIGEN2 source files. The major sources of uncertainty explored in this study include single pass reactor actinide and activation product cross sections, fission product yields, and half lives.

Reference ORIGEN2 Actinide Cross Sections For Generating Radionuclide Inventories

The ORIGEN2 code is used to generate initial radionuclide inventories as a function of fuel type, fuel burnup, and reactor type for input to the DKPRO code. A base set of cross sections was used for both N reactor and single pass reactor ORIGEN2 calculations, with various adjustments to the cross sections included as part of the ORIGEN2 input for each case. The reference ORIGEN2 cross section library includes cross section sets generated specifically for N reactor fuel. Separate ORIGEN2 cross section sets did not exist for single pass reactor fuel. The N reactor cross sections for ORIGEN2 were initially created by modifying selected actinide capture and fission cross sections in an existing base set of cross sections. The actinide (n,2n) cross sections and all activation product and fission product cross sections were not changed from the original set. Table 1 lists the four cross section sets available in the standard ORIGEN2 library for MK-IV inner and outer fuel elements and MK-1A inner and outer fuel elements. Burnup dependent cross sections were not used.

Table 1. ORIGEN2 N Reactor Cross Section Identifiers.

Fuel Type	Activation	Fission Product	Actinide
MK-IV inner	411	413	412
MK-IV outer	421	423	422
MK-1A inner	431	433	432
MK-1A outer	441	443	442

The following adjustments in generating the ORIGEN2 input to DKPRO (Watrous 1997) were made for N Reactor fuel:

- The ^{238}U cross section was adjusted to correct the (n,2n) reaction that leads to ^{237}Np.
- The ^{243}Am capture cross section was adjusted to correct a problem in the original N Reactor cross sections.

The following adjustments in generating the ORIGEN2 input to DKPROwere made for Single Pass Reactor fuel:

- The N reactor MKIV inner element cross section set was used, with the ^{235}U fission cross section adjusted to match the plutonium conversion rates for the single pass reactor fuel.

The following adjustments in generating the ORIGEN2 input to DKPRO were made for the thorium fuel:

- The ^{232}Th capture cross section was adjusted to match the known ^{233}U production based on an average flux level from the driver fuel.

Evaluation of ORIGEN2 Single Pass Reactor Actinide Cross Sections

In order to assess the adequacy of these cross sections for representing single pass reactor fuel conditions, the MCNP code (Briesmeister 1993) (Carter 1996) was used to model a representative single pass reactor fuel element. Details of the MCNP model are provided in the Appendix. Cross sections derived from this model are compared with those used in the reference ORIGEN2 calculations (Watrous 1997) in Table 2.

Comparison With Plutonium Conversion Equations

Little information is available on single pass reactor fuel isotopic inventories as a function of burnup. Plutonium conversion equations for both natural and enriched single pass reactor fuel for different reactors (Roblyer 1994) were used to evaluate the accuracy of the ORIGEN2 cross sections that were used to generate the initial inventory files for DKPRO analysis. The single pass reactors were treated as three groups. The first group contained B, D, DR, F, and H reactors, the second group contained C reactor, and the third group contained KE and KW reactors. Separate conversion equations were available for these three groups. The conversion equations also distinguished between cored and slug fuel. ORIGEN2 calculations were made using the reference single pass reactor cross sections (Watrous 1997) and the MCNP generated cross sections. Table 3 shows the comparison of plutonium production and ^{240}Pu content for the conversion equations and direct ORIGEN2 calculations for 800 MWd/MT single pass reactor fuel.

Table 2. Comparison of ORIGEN2 and MCNP Cross Sections for Single Pass Reactor Fuel.

Isotope	Reaction	ORIGEN2 cross section, barns		MCNP cross section, barns		MCNP/ ORIGEN2
		ground	excited	ground	excited	
^{235}U	nγ	1.32e+01		2.20e+01		1.670
	n2n	2.70e-03		1.25e-03		0.463
	nf	9.00e+01		1.14e+02		1.269
^{236}U	nγ	7.91e+00		7.76e+00		0.981
	n2n	2.64e-03		1.25e-03		0.471
	nf	1.40e-01		2.20e-01		1.575
^{237}U	nγ	4.42e+01		9.69e+01		2.193
	n2n	0.00e+00		3.68e-03		-
	nf	2.32e-01		7.25e-01		3.126
^{238}U	nγ	6.76e-01		8.92e-01		1.320
	n2n	2.50e-03		2.38e-03		0.952
	nf	6.86e-02		5.97e-02		0.870
^{237}Np	nγ	4.13e+01		6.23e+01		1.509
	n2n	2.75e-04		2.25e-04		0.820
	nf	5.24e-01		3.34e-01		0.637
^{238}Np	nγ	1.79e+01		4.10e+01		2.289
	n2n	0.00e+00		2.30e-03		-
	nf	1.78e+02		4.07e+02		2.289
^{238}Pu	nγ	3.47e+01		9.18e+01		2.645
	n2n	1.67e-04		7.17e-04		4.288
	nf	2.47e+00		3.74e+00		1.513
^{239}Pu	nγ	9.00e+01		1.65e+02		1.837
	n2n	1.12e-03		5.22e-04		0.467
	nf	1.60e+02		2.95e+02		1.845
^{240}Pu	nγ	2.55e+02		2.88e+02		1.130
	n2n	4.48e-04		2.31e-04		0.515
	nf	4.22e-01		4.04e-01		0.957
^{241}Pu	nγ	6.61e+01		1.15e+02		1.746
	n2n	7.52e-03		3.42e-03		0.456
	nf	1.61e+02		3.10e+02		1.928
^{242}Pu	nγ	3.01e+01		3.38e+01		1.123
	n2n	2.31e-03		9.90e-04		0.429
	nf	4.15e-01		2.76e-01		0.665

Isotope	Reaction	ORIGEN2 cross section, barns		MCNP cross section, barns		MCNP/ ORIGEN2
^{241}Am	nγ	1.81e+02	2.24e+01	2.20e+02	2.73e+01	1.219
	n2n	3.28e-04		1.89e-04		0.577
	nf	1.12e+00		1.67e+00		1.495
^{242m}Am	nγ	9.80e+01		3.81e+02		3.883
	n2n	5.67e-03		1.87e-03		0.330
	nf	4.66e+02		1.86e+03		3.999
^{243}Am	nγ	3.02e+00	5.73e+01	3.31e+00	6.28e+01	1.097
	n2n	2.07e-04		1.24e-04		0.599
	nf	3.46e-01		2.68e-01		0.773
^{242}Cm	nγ	5.80e+00		7.03e+00		1.212
	n2n	5.30e-05		2.84e-05		0.536
	nf	5.59e-01		8.00e-01		1.431
^{243}Cm	nγ	8.39e+00		1.80e+01		2.149
	n2n	3.69e-03		1.82e-03		0.493
	nf	7.17e+01		1.91e+02		2.669
^{244}Cm	nγ	1.38e+01		1.40e+01		1.014
	n2n	1.05e-03		5.90e-04		0.563
	nf	8.75e-01		7.28e-01		0.832

Table 3. Comparison of Pu Production and ^{240}Pu Content With Conversion Equations for 800 MWd/MT SPR Fuel

	SPR Natural U		SPR Enriched U	
Reactor	gPu/MT	%^{240}Pu	gPu/MT	%^{240}Pu
Conversion Equations Solid Slug Fuel				
B,D,DR,F,H	675	7.11		
C	688	6.65		
KE,KW	735	6.73		
Conversion Equations Cored Slug Fuel				
B,D,DR,F,H	662	7.11	559	5.23
C	674	6.65	564	5.16
KE,KW	720	6.73	606	5.02
ORIGEN2 Calculations SPR Fuel				
Reference SPR Cross Sections	710	4.51	566	3.63
MCNP SPR Cross Sections	714	6.53	574	5.25

The plutonium production from the conversion equations reveal a 10% range of values among the different fuel and reactor types. A similar range of 10% or less is found for the ^{240}Pu content. Both the reference SPR ORIGEN2 cross sections and the MCNP based SPR cross sections predict the plutonium production within the range of the variation by reactor type. However, the reference ORIGEN2 cross sections underpredict the ^{240}Pu content by about 30-35%, while the MCNP cross sections are within 10% of the conversion equation values.

Activation Product Cross Sections

The same single pass reactor fuel MCNP model was also used to evaluate the adequacy of the ORIGEN2 library cross sections for selected activation products. Table 4 compares the effective one group cross section for the reactions leading to the activation products ^{14}C, ^{59}Ni, ^{60}Co, and ^{63}Ni, and the cross sections for burnout of ^{59}Ni and ^{63}Ni. This table shows that the reactions leading to the production of the important activation products would be biased low by as much as a factor of two using the reference SPR cross sections. The reference N Reactor cross section sets also do not contain activation cross sections generated specifically for N Reactor. Therefore, the same methods were used to compare N Reactor activation product cross sections. Table 5 shows this comparison for MK-IV fuel. The MCNP generated cross sections ranged from approximately 10 to 40 percent higher than the reference values. The larger differences for Single Pass Reactor fuel compared to N reactor fuel is consistent with the actinide cross section comparisons.

Table 4. Comparison of Activation Product Single Pass Reactor Cross Sections

Reaction	MCNP Cross Section, barns	ORIGEN2 Cross Section, barns	MCNP/ ORIGEN2
$^{14}N(n,p)^{14}C$	0.394	0.192	2.058
$^{58}Ni(n,g)^{59}Ni$	0.983	0.567	1.733
$^{59}Ni(n,g)^{60}Ni$	19.099	10.870	1.757
$^{59}Co(n,g)^{60}Co$	9.456	5.556	1.702
$^{62}Ni(n,g)^{63}Ni$	3.035	1.529	1.985

Table 5. Comparison of Activation Product Cross Sections for N Reactor MK-IV Fuel

Reaction	MCNP Cross Section, barns			ORIGEN2 Cross Section, barns		MCNP/ ORIGEN2	
	inner	outer	total	inner	outer	inner	outer
$^{14}N(n,p)^{14}C$	0.257	0.301	0.288	0.192	0.230	1.342	1.308
$^{58}Ni(n,\gamma)^{59}Ni$	0.630	0.745	0.709	0.567	0.692	1.110	1.075
$^{59}Ni(n,\gamma)^{60}Ni$	13.007	15.245	14.555	10.870	12.740	1.197	1.197
$^{59}Co(n,\gamma)^{60}Co$	6.716	7.640	7.355	5.556	6.503	1.209	1.175
$^{62}Ni(n,\gamma)^{63}Ni$	1.930	2.291	2.179	1.529	1.866	1.263	1.227

Impact on Radionuclide Inventory of Single Pass Reactor Cross Section Adjustments

The DKPRO code was used to assess the impact on radionuclide inventories from changing the single pass reactor cross sections in ORIGEN2 to reflect the MCNP generated values. New ORIGEN2 initial inventories for single pass reactor fuel were generated and input to the DKPRO code. Table 6 shows the ratio of the total radionuclide inventory using the new single pass reactor cross sections with the reference calculation.

The amount of change in radionuclide inventory varies with the processing plant due to the amount of single pass reactor fuel processed in each plant. The amount of ^{14}C, ^{59}Ni, and ^{63}Ni increased by up to 50% due to the higher capture cross sections. Smaller differences in other fission products are likely due to changes in the relative proportion of fissions from ^{235}U, ^{238}U, and ^{239}Pu, with corresponding changes in the fission product yields for sensitive isotopes. For the actinides, the main changes were an increase in the inventories of ^{240}Pu, ^{241}Pu, ^{242}Pu, and ^{241}Am due to higher neutron capture cross sections.

Fuel and Cladding Impurities

A previous study (Wootan 1998) investigated the effects of time dependent impurities on the inventory of key radionuclides. The concentration of nickel, nitrogen, and ^{236}U impurities in fuel and cladding varied significantly from the 1940's to the 1980's. This time variation was approximated by making additional ORIGEN2 inventory files with modified material compositions. Each fuel type was categorized by year of reactor discharge as shown in Table 7.

Table 8 shows the ratio of the radionuclide curie inventories in the revised analysis to the inventories in the reference DKPRO calculations (Watrous 1997) for the principal radionuclides affected by the half-life and impurity concentration changes. The net effect of the time dependant nickel impurity concentration change was a reduction in the ^{59}Ni and ^{63}Ni inventories in the fuel processed through B, T, and Redox, but an increase in the inventories in the fuel processed through Purex. Conversely, the net effect of the time dependent nitrogen impurity was an increase in the inventory of ^{14}C in fuel processed through B and T plants, but a reduction in ^{14}C in fuel processed through Redox and Purex. The time dependant ^{236}U impurity concentration resulted in a reduction in the ^{237}Np inventory in fuel processed through Redox and Purex. The 1.0 ppm of cobalt added to all of the fuel increased the inventory of ^{60}Co by a factor of 2.6. The 1.0 ppm of chlorine added to the fuel resulted in the production of approximately 10 Curies of ^{36}Cl, which did not appear in the previous analysis.

Table 6. Radionuclide Inventory Comparison For Single Pass Reactor Cross Section Changes

Radioisotope	Radioisotope Inventory with Modified Single Pass Reactor Cross Sections / Radioisotope Inventory with Original Single Pass Reactor Cross Sections				
	T-plant	B-plant	Redox	Purex	Total
^{3}H	0.980	0.980	0.989	0.992	0.991
^{14}C	1.634	1.634	1.581	1.477	1.500
^{60}Co	1.198	1.197	1.163	1.052	1.058
^{59}Ni	1.269	1.269	1.253	1.238	1.242
^{63}Ni	1.448	1.448	1.427	1.401	1.408
^{79}Se	0.980	0.980	0.983	0.983	0.983
^{90}Sr	0.998	0.998	0.994	0.992	0.992
^{90}Y	0.998	0.998	0.993	0.992	0.993
^{93}Zr	0.997	0.998	0.995	0.995	0.995
^{93m}Nb	0.998	0.998	0.995	0.995	0.995
^{99}Tc	1.001	1.001	1.002	1.002	1.002
^{106}Ru	1.004	1.039	1.061	1.000	1.000
^{113m}Cd	0.821	0.821	0.846	0.877	0.871
^{126}Sn	0.896	0.896	0.917	0.925	0.923
^{125}Sb	0.854	0.857	0.892	0.990	0.989
^{129}I	0.985	0.984	0.996	0.998	0.997
^{134}Cs	0.796	0.789	0.845	0.997	0.997
^{137}Cs	1.002	1.002	1.004	1.003	1.003
^{137m}Ba	1.002	1.002	1.004	1.003	1.004
^{151}Sm	1.024	1.024	1.059	1.062	1.060
^{152}Eu	0.824	0.826	0.866	0.913	0.907
^{154}Eu	0.779	0.779	0.814	0.896	0.888
^{155}Eu	1.077	1.086	1.164	1.086	1.091
^{226}Ra	1.002	1.002	1.003	1.003	1.003
^{228}Ra	1.330	1.331	1.123	1.000	1.000
^{227}Ac	0.997	0.997	0.996	1.000	1.000
^{229}Th	0.792	0.792	0.798	1.000	1.000
^{232}Th	1.330	1.330	1.120	1.000	1.000
^{232}U	0.761	0.761	0.748	1.000	1.000
^{233}U	0.789	0.789	0.798	1.000	1.000
^{234}U	1.002	1.002	1.004	1.004	1.003
^{235}U	0.998	0.998	0.996	0.996	0.997
^{236}U	1.331	1.330	1.113	1.156	1.147

Radioisotope	Radioisotope Inventory with Modified Single Pass Reactor Cross Sections / Radioisotope Inventory with Original Single Pass Reactor Cross Sections				
^{238}U	0.999	1.000	1.000	1.000	1.000
^{237}Np	0.783	0.783	0.800	0.843	0.833
^{238}Pu	0.912	0.912	0.922	0.949	0.945
^{239}Pu	1.022	1.022	0.992	0.985	0.988
^{240}Pu	1.494	1.495	1.424	1.346	1.361
^{241}Pu	1.287	1.283	1.207	1.121	1.129
^{242}Pu	1.744	1.752	1.414	1.248	1.267
^{241}Am	1.287	1.285	1.221	1.170	1.179
^{243}Am	1.541	1.547	1.132	1.065	1.071
^{242}Cm	1.019	1.027	1.009	1.002	1.002
^{243}Cm	1.152	1.153	1.012	1.005	1.005
^{244}Cm	1.328	1.332	1.020	1.007	1.008

Note: The TOTAL column is the ratio for the total inventory, and corresponds to the weighted average of the plant columns.

Table 7. Time Dependant Impurities

Fuel Type	Reactor discharge year	Ni ppm (clad)	N ppm (fuel)	^{236}U ppm (fuel)
AL-0.71UA	1944-1958	100	65	0
AL-0.71UB	1959-1989	11000	17.5	0
AL-0.94U	1944-1989	11000	17.5	60
ZR-0.94UA	1944-1971	550	17.5	100
ZR-0.94UB	1972-1980	550	8.0	300
ZR-0.94UC	1981-1989	550	9.3	500
ZR-1.1UA*	1944-1971	550	17.5	200
ZR-1.1UB*	1972-1980	550	8.0	400
ZR-1.1UC*	1981-1989	550	9.3	650
ZR-2.1U	1944-1989	550	17.5	170

* ORIGEN2 creates 1.1 fuel as a combination of 0.94 and 1.25. The listed impurities are for the 1.25 portion. The 0.94 portion uses the 0.94 impurities.

Table 8. Principal Changes in Radionuclide Inventories - Ratio of Curie Inventory Using Time Dependent Impurities to Previous Inventory (from Table 5.1 in Wootan 98)

Nuclide	T-Plant	B-Plant	Redox	Purex	Total
^{14}C	1.283	1.284	0.801	0.445	0.534
^{60}Co	3.178	3.163	3.064	2.566	2.593
^{59}Ni	0.243	0.243	0.719	1.048	0.954
^{63}Ni	0.249	0.249	0.734	1.051	0.964
^{237}Np	1.000	1.000	0.729	0.905	0.872

Fission Product Half Lives

Table 9 compares the half lives of the 46 radionuclides in the ORIGEN2 library with more recent reference values and uncertainties (Chu 1998, Zhang 1996, Yu 1993, and Chunseng 1997). With a few exceptions (^{63}Ni, ^{79}Se, ^{93m}Nb, ^{126}Sn, and ^{228}Ra) the half life uncertainties or differences are 5% or less.

A previous study (Wootan 1998) investigated the effects of using updated values of selected fission product half lives on the inventory of key radionuclides. The half lives of the radioisotopes ^{79}Se, ^{93m}Nb, and ^{126}Sn in the ORIGEN2 and DKPRO decay libraries were modified to reflect recent evaluations. The old and new half life values are shown in Table 10.

New measurements in China of the ^{79}Se half-life (Yu 1993 and Chunseng 1997) indicate a much longer half-life (4.8 E5 years and 11.3 E5 years, respectively) than previously used (0.65 E5 years). The new half-life value was taken as the average of these two measurements, with an uncertainty of 40% that bounds the two values. A new Chinese measurement (Zhang 1996) of the ^{126}Sn half-life increases that value from 1.0 E5 years to 2.5 E5 years, with an uncertainty of 9.4 %. The ^{93m}Nb half life was also updated to reflect more recent evaluations (Chu 1998).

As shown in Table 11, the net effect of the half-life changes was a reduction by a factor of 0.40 in the Curie inventory of ^{126}Sn, a reduction by a factor of 0.08 in the inventory of ^{79}Se, and a reduction by a factor of 0.93 in the inventory of ^{93m}Nb. The actual amount of ^{126}Sn and ^{79}Se in terms of grams of material hardly changed, but the number of Curies represented by these amounts changed by the inverse ratio of the new to old half-lives. The uncertainties in the half lives translates directly into uncertainties in Curie inventories for these radioisotopes.

Table 9. Comparison of Radionuclide Half Lives

Radioisotope	ORIGEN2	Reference		Reference/ ORIGEN2
	Half-life, years	Half-life, years	Uncertainty, %	
^{3}H	1.23e+01	1.23e+01	0.49%	0.998
^{14}C	5.73e+03	5.73e+03	0.70%	1.000
^{60}Co	5.27e+00	5.27e+00	0.01%	1.000
^{59}Ni	8.00e+04	7.60e+04	6.58%	0.950
^{63}Ni	9.20e+01	1.00e+02	2.00%	1.088
^{79}Se	6.50e+04	8.05e+05	40.00%	12.385
^{90}Sr	2.91e+01	2.88e+01	0.14%	0.988
^{90}Y	7.30e-03	7.31e-03	0.12%	1.001
^{93}Zr	1.53e+06	1.53e+06	6.54%	1.000
^{93m}Nb	1.36e+01	1.61e+01	0.87%	1.186
^{99}Tc	2.13e+05	2.11e+05	0.57%	0.991
^{106}Ru	1.01e+00	1.02e+00	0.04%	1.015
^{113m}Cd	1.46e+01	1.41e+01	3.55%	0.966
^{126}Sn	1.00e+05	2.50e+05	9.40%	2.500
^{125}Sb	2.77e+00	2.76e+00	0.04%	0.996
^{129}I	1.57e+07	1.57e+07	2.55%	1.000
^{134}Cs	2.06e+00	2.06e+00	0.05%	1.001
^{137}Cs	3.00e+01	3.01e+01	0.10%	1.002
^{137m}Ba	4.85e-06	4.85e-06	0.04%	1.000
^{151}Sm	9.00e+01	9.00e+01	8.89%	1.000
^{152}Eu	1.36e+01	1.35e+01	0.04%	0.995
^{154}Eu	8.60e+00	8.59e+00	0.05%	0.999
^{155}Eu	4.96e+00	4.76e+00	0.03%	0.960
^{226}Ra	1.60e+03	1.60e+03	0.44%	1.000
^{228}Ra	6.70e+00	5.75e+00	0.52%	0.858
^{227}Ac	2.18e+01	2.18e+01	0.01%	1.000
^{229}Th	7.34e+03	7.34e+03	2.18%	1.000
^{232}Th	1.41e+10	1.41e+10	0.43%	1.000
^{232}U	7.20e+01	6.89e+01	0.58%	0.957
^{233}U	1.59e+05	1.59e+05	0.00%	1.004
^{234}U	2.45e+05	2.46e+05	0.24%	1.004
^{235}U	7.04e+08	7.04e+08	0.07%	1.000
^{236}U	2.34e+07	2.34e+07	0.00%	1.000
^{238}U	4.47e+09	4.47e+09	0.07%	1.000

Radioisotope	ORIGEN2	Reference		Reference/ ORIGEN2
	Half-life, years	Half-life, years	Uncertainty, %	
^{237}Np	2.14e+06	2.14e+06	0.33%	1.002
^{238}Pu	8.77e+01	8.77e+01	0.34%	1.000
^{239}Pu	2.41e+04	2.41e+04	0.12%	1.002
^{240}Pu	6.54e+03	6.56e+03	0.11%	1.004
^{241}Pu	1.44e+01	1.44e+01	0.70%	0.997
^{242}Pu	3.87e+05	3.73e+05	0.32%	0.965
^{241}Am	4.32e+02	4.32e+02	0.16%	1.000
^{243}Am	7.38e+03	7.37e+03	0.54%	0.999
^{242}Cm	4.47e-01	4.46e-01	0.00%	0.998
^{243}Cm	2.85e+01	2.91e+01	0.34%	1.021
^{244}Cm	1.81e+01	1.81e+01	0.11%	0.999

Table 10. Half-life Changes

Isotope	Old Half Life (Seconds)	New Half Life (Seconds)
^{79}Se	2.050E12	2.540E13
^{93m}Nb	4.292E08	5.081E08
^{126}Sn	3.156E12	7.890E12

Table 11. Principal Changes in Radionuclide Inventories - Ratio of Curie Inventory Using Revised Half-Lives to Previous Inventory (from Table 5.1 in Wootan 1998)

Nuclide	T-Plant	B-Plant	Redox	Purex	Total
^{79}Se	0.081	0.081	0.081	0.081	0.081
^{93m}Nb	0.948	0.952	0.936	0.927	0.930
^{126}Sn	0.400	0.400	0.400	0.399	0.399

Note: These values only reflect changes in the inventory expressed in Curies. Different factors would apply for inventories expressed in grams.

Fission Product Yields

The fission product yields used in generating the HDW input radionuclide inventories are contained in the ORIGEN2 library. The fission product yield data in the ORIGEN2 library dates to prior to 1980 (Croff 1980). No uncertainty information is included in the library. The cumulative fission product yields from ^{235}U fission (obtained by summing the individual chain yields in the ORIGEN2 library) are compared with reference values (England 1994) and their stated uncertainties in Table 12. Except for ^{79}Se and ^{126}Sn, the reference value uncertainties are 4% or less. These results show that ORIGEN2 overpredicts the production of ^{79}Se, ^{113m}Cd, ^{125}Sb, ^{126}Sn, ^{129}I, and ^{155}Eu by 10-30%. Yields for the other fission products agree within 5%.

Table 12. Comparison of Fission Product Yields

Fission Product	ORIGEN2	ENDF/B-VI		ENDF/B-VI / ORIGEN2
	yield, %	yield, %	% unc.	
^{79}Se	5.29e-02	4.47e-02	8.0	0.85
^{90}Sr	5.85e+00	5.78e+00	1.0	0.99
^{93}Zr	6.33e+00	6.35e+00	0.7	1.00
^{99}Tc	6.07e+00	6.11e+00	1.0	1.01
^{106}Ru	4.17e-01	4.02e-01	1.4	0.96
^{113m}Cd	1.85e-02	1.40e-02	4.0	0.76
^{125}Sb	3.97e-02	3.40e-02	2.8	0.86
^{126}Sn	7.21e-02	5.61e-02	8.0	0.78
^{129}I	7.14e-01	5.43e-01	1.0	0.76
^{133}Cs (^{134}Cs*)	6.75e+00	6.70e+00	0.35	0.99
^{137}Cs	6.26e+00	6.19e+00	0.5	0.99
^{151}Sm	4.21e-01	4.19e-01	1.0	0.99
^{151}Eu (^{152}Eu*)	4.21e-01	4.19e-01	1.0	0.99
^{153}Eu (^{154}Eu*)	1.67e-01	1.58e-01	2.8	0.95
^{155}Eu	3.62e-02	3.21e-02	4.0	0.89

*Note: ^{134}Cs, ^{152}Eu, and ^{154}Eu are shielded fission products and have very low direct yields because these mass chains include a stable nuclide. Primary production will be by neutron capture on the fission products ^{133}Cs, ^{151}Eu, and ^{153}Eu.

Conclusions

The contribution of uncertainty or biases to the current HDW radionuclide inventory input generated using ORIGEN2 and DKPRO from actinide and activation product cross sections, variation among reactor types, fission product half lives, time dependent fuel and cladding impurities, and fission product yields have been quantified. The range of biases for each of these parameters is summarized in Table 12. This information can be used to increase the accuracy of the next iteration of HDW inventory analysis by incorporating the improved cross sections, yields, half lives, etc. Alternatively, the biases and uncertainties identified in this report can be included as part of the overall inventory uncertainties.

Table 13. Range of Biases/Uncertainties for Selected Parameters

Parameter	Bias/Uncertainty Range
Single Pass Reactor Cross Sections (actinides and activation products)	0.8 - 1.8
Single Pass Reactor Type (Pu and actinides in B, C, D, DR, F, H, KE, KW reactors)	0.7 - 0.99
Time Dependent Impurities (^{14}C, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{237}Np)	0.25 - 3.2
Half Life (^{79}Se, ^{126}Sn, ^{93m}Nb)*	0.08, 0.40, 0.93
Fission Product Yields (differences >10% were found for ^{79}Se, ^{113m}Cd, ^{125}Sb, ^{126}Sn, ^{129}I, and ^{155}Eu)	0.76 - 1.01

*Note: These bias factors apply only to the inventory in Curies.

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C2.0 E-MAILS

E-mail dated November 17, 1997, "Preliminary Findings on U/Pu Model Inconsistencies," R. A. Corbin to D. E. Place and S. F. Agnew, Los Alamos National Laboratory, Los Alamos, New Mexico.

E-mail dated December 13, 2002, "Volume of 224 Building Waste 10/46 to 2/56," D. E. Place to R. A. Corbin, Numatec Hanford Corporation, Richland, Washington.

E-mail dated January 13, 2003, "Bismuth Concentration of MW, TBP, and PFeCN," B. A. Higley to R. A. Corbin, M. Mandis and D. E. Place, Numatec Hanford Corporation, Richland, Washington.

E-mail dated January 16, 2003, "HDW Modeling P2 (prime) Waste Stream Volume," B. A. Higley to R. A. Corbin, M. Mandis and D. E. Place, Numatec Hanford Corporation, Richland, Washington.

E-mail dated April 3, 2003, "Flowsheet Info for HDW 5," D. E. Place to R. A. Corbin, Numatec Hanford Corporation, Richland, Washington.

E-mail dated August 22, 2003, "RE: Review of HDW5 Rev 232a Spreadsheet," D. E. Place to B. S. Simpson, R. A. Corbin and B. A. Higley, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated September 8, 2003, "HDW5_03_246aDEP Review for P3 Waste Type," D. E. Place to B. S. Simpson and R. A. Corbin, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated September 11, 2003, "Review Comments September 4-11," 2003, B. A. Higley to B. S. Simpson and R. A. Corbin, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated September 18, 2003, "RE: Review of HDW5 Rev 232a Spreadsheet," D. E. Place to B. S. Simpson, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated September 18, 2003, untitled, B. A. Higley to R. A. Corbin and B. S. Simpson, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated September 18, 2003, "Spreadsheet Checks," D. E. Place to R. A. Corbin and B. S. Simpson, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated October 9, 2003, "Material Balance Problem - 1C2 and 1CFeCN Wastes," D. E. Place to B. S. Simpson and R. A. Corbin, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated October 17, 2003, "Review Comments HDW5_3_287b," D. E. Place to R. A. Corbin and B. S. Simpson, CH2M HILL Hanford Group, Inc., Richland, Washington.

E-mail dated January 28, 2004, "HDW5 Error for Z Plant Waste," D. E. Place to R. A. Corbin and B. S. Simpson, CH2M HILL Hanford Group, Inc., Richland, Washington.

Place, David E

From: Rob Corbin <rcorbin@lanl.gov>
Sent: Monday, November 17, 1997 2:31 PM
To: David_E_Place@RL.gov; sfagnew@lanl.gov
Cc: Jerry_W_Cammann@ccmail.rl.gov
Subject: Preliminary Findings on Ur/Pu Model Inconsistencies

Dave,

Thanks again for finding the inconsistencies between the uranium/plutonium istopes (Ci) and the total Ur/Pu (kg). We appreciate your checking of the HDW model. Your input has been very beneficial.

The problem for uranium was traced back to the U-238 isotope calculation in TFeCN waste. This was a spreadsheet error. This affected only the U-238 isotope predictions. The other Ur isotopes as well as the total Ur predictions should be correct. The change in a particular tank depends on the amount of the TFeCN waste type present in its composition. C-109 estimates varied considerably more than normal because 3/4 of the tank is TFeCN waste. Again this error causes an underprediction of U-238 isotope estimates in affected tanks, and leaves the total Ur predictions for the site unchanged.

The problem for plutonium was traced back to total plutonium calculations in AR waste. In this case, the isotope predictions are correct and the total plutonium estimates are off. Preliminary estimates show a sitewide underprediction of about 5-6%. Likewise, the amount an individual tank is affected is relative to the amount of AR waste in that tank. The correct Pu total for a tank can be calculated from the isotopic constituents.

These two preliminary corrections seem to take care of the problems addressed. We will be re-running the complete estimates worksheets to validate these changes.

If you have any questions/comments, please feel free to call or email me.

rob...

****
Robert A. Corbin
CST-4 MS J586 phone: (505) 667-0838
Los Alamos National Laboratory fax : (505) 667-0851
Los Alamos, NM 87545 email: rcorbin@lanl.gov
****

Place, David E

From: Place, David E
Sent: Friday, December 13, 2002 12:29 PM
To: Rob Corbin (E-mail)
Cc: Higley, Bruce A
Subject: FW: Volume of 224 Building Waste 10/46 to 2/56

I could not find anything wrong with the volume calculations that I made for the TI-740 document. The Schneider flowsheet (HW-23043) shows 2200 gallons of 224 Bldg. waste generated per 1240 lb. uranium processed (i.e. 3912 gallons/MTU). The waste volume includes four process effluents from within the 224 Bldg. and the sodium hydroxide added for neutralization. It does not include any 221 Bldg. wastes.

G. L. Borsheim calculated 3912 gallons/MTU based on this same flowsheet. Using the technical manual information and the density /% water from HW-23043, George estimated the 224 Bldg. waste discharge as 3760 gallon/MTU in November 1944.

David E. Place
376-0176

-----Original Message-----
From: Place, David E
Sent: Monday, December 09, 2002 7:06 PM
To: Rob Corbin (E-mail)
Cc: Higley, Bruce A
Subject: Volume of 224 Building Waste 10/46 to 2/56

The total volume of 224 Bldg. waste was 3.02E+07 gallons based on the flowsheet (HNF-SD-WM-TI-740). The transfer of 224 Bldg. waste to the 241-B-361 and 241-T-361 tanks ended in October 1946. Per the latest ORIGEN2 output, 1173 MTU of the total 7798 MTU had been processed by that time (15%). The total volume of 224 Bldg. waste discharged to Tank Farms should be 2.566E+07 gallons for the period of 10/46 to 2/56 assuming a constant waste volume per MTU processed.

< 224 Bldg Wastes>

David E. Place
376-0176

Tracking:	**Recipient**	**Read**
	Rob Corbin (E-mail)	
	Higley, Bruce A	Read: 12/13/2002 12:54 PM

Higley, Bruce A

From: Higley, Bruce A
Sent: Monday, January 13, 2003 10:45 AM
To: Robert A. Corbin (E-mail); Michelle Mandis (E-mail); Place, David E
Subject: Bismuth concentration of MW, TBP and PFeCN

All,

As discussed in the review meeting on January 9th, the bismuth concentration shown for metal waste (0.013 *M* Bi) is suspect based on process knowledge.

A 1948 letter (HW-8697) includes in Table VI an experimentally measured bismuth concentration of 0.06 g/L.

Thus

For MW1 and MW2, insert the following formula in cells B44 and C44,

= (0.06 g/L) / (209.98 g/mole)

This should yield a result of 0.000286 *M* Bi

Include in cells B44 and C44 the following comment "From HW-8697 Table VI"

The TBP process increased the metal waste volume by the addition of nitric acid and subsequent re-neutralization and reduced volume by in-plant evaporation. I don't have the flowsheets available to me determine the net volume change but from the HDW model Rev 4 the total volume of MW was 35,876 kgal and the total volume of TBP, PFeCN1 and PFeCN2 was 56,806 kgal.

Since the MW feed is the only source of Bi in the TBP effluent, conservation of mass requires that the concentration of Bi in the MW be reduced by the dilution effects of the TBP/PFeCN processes.

This should yield a result of about 0.00018 *M* Bi in the TBP, PFeCN1 and PFeCN2 streams (cells I44, J44, and K44). Insertion of the "From HW-8697 Table VI" in these cells would be appropriate.

Also, the concentrations of Fe(NO3)3 and NaCrO4 appear to be direct 'copy and paste' of formulas from the MW composition into the TBP and PFeCN composition. Please review the basis for these entries and determine if the dilution that occurred between MW and TBP/PFeCN should be accounted for.

B. A. Higley, 376-5694
Numatec Hanford Corporation

Higley, Bruce A

From:	Higley, Bruce A
Sent:	Thursday, January 16, 2003 1:59 PM
To:	Robert A. Corbin (E-mail); Michelle Mandis (E-mail); Place, David E
Cc:	Higley, Bruce A
Subject:	HDW Modeling P2 (prime) waste stream volume

Rev 4 of the HDW model indicates that the volume of the P2 (prime) stream was 397 kgal. [1968-1972]. See cell T9.

Review of B Plant strontium recovery records compiled in logbook ARH-N-23 indicates that B Plant received 1,366,593 gallons of CAW. The time period was from April 1968 through November 1972.

This volume of CAW is equal to ~ 83 gal/ton U.

Please update Rev 5 of the HDW model accordingly. Also please include a comment in cell T9, "CAW shipped to B Plant per ARH-N-23".

Thank you.

B. A. Higley, 376-5694
Numatec Hanford Corporation

Place, David E

From: Place, David E
Sent: Thursday, April 03, 2003 3:55 PM
To: 'Rob Corbin (E-mail)'
Cc: Higley, Bruce A
Subject: Flowsheet Info for HDW 5

Attached is an edited copy of the information provided in late January 2003. I have added comments from Mike Johnson and moved the treated PAW/ZAW solids to the BL waste type.

The key change needed in the HDW model is that the complexants belong in the BL waste stream, not the SRR. Also, the waste descriptions should be modified for AR, B, BL and SRR waste types.

Thanks,

David E. Place
376-0176

Higley, Bruce A

From: Place, David E
Sent: Friday, August 22, 2003 3:36 PM
To: 'Brett Simpson'; Place, David E; Rob Corbin; Higley, Bruce A
Subject: RE: Review of HDW5 Rev. 232a Spreadsheets

Suggest the following solubility limits:

PFeCN1: 90Sr 2.48 uCi/mL (non-complexed)
137Cs 0.0198 uCi/mL (HW-38955 for TFeCN which were under pH control)
PFeCN2: 90Sr 0.36 uCi/mL (HW-36293)
137Cs 0.0198 uCi/mL (HW-38955 for TFeCN which were under pH control)
TFeCN: 90Sr 0.328 uCi/mL
137Cs 0.0198 uCi/mL (both based on HW-38955 which were under pH control)
1CFeCN 90Sr 0.0528 uCi/mL (HW-33184)
137Cs 0.000528 uCi/mL (HW-33184)

Correcting to the 1/1/01 basis for the HDW model radionuclide inventories:

PFeCN1: 90Sr 2.48 uCi/mL
137Cs 9.37E-03 uCi/mL
PFeCN2: 90Sr 0.199 uCi/mL
137Cs 9.37E-03 uCi/mL
TFeCN: 90Sr 0.182 uCi/mL
137Cs 9.37E-03 uCi/mL
1CFeCN 90Sr 2.91E-02 uCi/mL
137Cs 2.47E-04 uCi/mL

All fractions precipitated for Sr should be linked to 90Sr rather than using a separate solubility for the chemical.

David E. Place
376-0176

Preceeding messages removed by ediitor.

SPREADSHEET FOR DATA ENTRY AND DECAY CALCULATION

Instructions:

Enter Dates in Cells F7 an F8.
Enter Data in Column F
Decayed values are in Col. H.

Decay from	4/19/1955
Decay to	1/1/2001
Days of Decay	16694

Radionuclide	Alt Radionuclide Name	Half Life (years)	Lambda (1/day)	Decay Factor	Enter Curies Below		Decayed Curies at January 1, 2001
H-3	3H	12.32	1.540E-04	0.0764			
C-14	14C	5715	3.321E-07	0.9945			
Co-60	60Co	5.271	3.600E-04	0.0025			
Ni-59	59Ni	7.6E+04	2.497E-08	0.9996			
Ni-63	63Ni	100	1.898E-05	0.7285			
Se-79	79Se	6.5E+05	2.920E-09	1.0000			
Sr-90	90Sr	28.78	6.594E-05	0.3326	1.000E+00		3.3261E-01
Y-90	90Y	7.31E-03	2.596E-01	0.3326			
Zr-93	93Zr	1.5E+06	1.265E-09	1.0000			
Nb-93m (2nd Order)	93mNb	16.1	1.179E-04	0.1398		(a)	
Tc-99	99Tc	2.13E+05	8.910E-09	0.9999			
Ru-106	106Ru	1.020	1.861E-03	0.0000			
Cd-113m	113mCd	14.1	1.346E-04	0.1057			
Sb-125	125Sb	2.758	6.881E-04	0.0000			
Sn-126	126Sn	2.5E+05	7.591E-09	0.9999			
I-129	129I	1.57E+07	1.209E-10	1.0000			
Cs-134	134Cs	2.065	9.190E-04	0.0000			
Cs-137	137Cs	30.07	6.311E-05	0.3487	1.000E+00		3.4869E-01
Ba-137m	137mBa	4.852E-06	3.911E+02	0.3292			
Sm-151	151Sm	90	2.109E-05	0.7033			
Eu-152	152Eu	13.54	1.402E-04	0.0963			
Eu-154	154Eu	8.593	2.208E-04	0.0251			
Eu-155	155Eu	4.75	3.995E-04	0.0013			
Ra-226	226Ra	1599	1.187E-06	0.9804			
Ra-228 (2nd Order)	228Ra	5.76	3.295E-04	0.0041		(b)	
Ac-227 (2nd Order)	227Ac	21.774	8.716E-05	0.2334		(c)	
Th-229	229Th	7.3E+03	2.600E-07	0.9957			
Th-232	232Th	1.40E+10	1.356E-13	1.0000			
Pa-231	231Pa	3.28E+04	5.786E-08	0.9990			
U-232	232U	69.8	2.719E-05	0.6352			
U-233	233U	1.592E+05	1.192E-08	0.9998			
U-234	234U	2.46E+05	7.714E-09	0.9999			
U-235	235U	7.04E+08	2.696E-12	1.0000			
U-236	236U	2.342E+07	8.103E-11	1.0000			
U-238	238U	4.47E+09	4.245E-13	1.0000			
Np-237	237Np	2.14E+06	8.868E-10	1.0000			
Pu-238	238Pu	87.7	2.164E-05	0.6968			
Pu-239	239Pu	2.410E+04	7.874E-08	0.9987			
Pu-240	240Pu	6.56E+03	2.893E-07	0.9952			
Pu-241	241Pu	14.4	1.318E-04	0.1108			
Pu-242	242Pu	3.75E+05	5.061E-09	0.9999			
Am-241 (2nd Order)	241Am	432.7	4.386E-06	0.9294		(d)	
Am-243	243Am	7.37E+03	2.575E-07	0.9957			
Cm-242	242Cm	4.46E-01	See note (e)	0.7988		(e)	
Cm-243	243Cm	29.1	6.521E-05	0.3367			
Cm-244	244Cm	18.1	1.048E-04	0.1737			

Second Order Decay factors for Parent nuclides have been moved to below:
These factors are used in four cells of column H.

	Lambda (d^-1) of Parent	
Nb-93* (Zr-93 Factor)	1.2652E-09	8.602E-01
Ra-228 (Th-232 Factor)	1.3555E-13	9.959E-01
Ac-227 (Pa-231 Factor)	5.7858E-08	7.661E-01
Am-241 (Pu-241 Factor)	1.3179E-04	2.818E-02

Notes:
(a) Second Order Decay. Curies of parent (Zr-93) must also be entered.
(b) Second Order Decay. Curies of parent (Th-232) must also be entered.
(c) Second Order Decay. Curies of parent (Pa-231) must also be entered.
(d) Second Order Decay. Curies of parent (Pu-241) must also be entered.
(e) Cm-242 assumed to be in secular equilibrium with 141 yr Am-242m parent.

All half-lives taken from the Fifteenth Edition of the Chart of the Nuclides.

90Sr

HDW Model Basis	1/1/2001	1/1/2001	1/1/2001	1/1/2001
90Sr mass	1.6360E+04	1.6360E+04	1.6360E+04	1.6360E+04
Other isotopes	3.3001E+04	3.3001E+04	3.3001E+04	3.3001E+04
Total Sr grams	4.9361E+04	4.9361E+04	4.9361E+04	4.9361E+04
Wt% 90Sr	33%	33%	33%	33%
Document	HW-38955	HW-30399	HW-33184	HW-36293
Doc Date	9/1/1955	1/8/1954	9/30/1954	4/19/1955
90Sr Decay Factors	3.3558E-01	0.322543043	0.328228664	0.332607899
90Sr mass	4.8751E+04	5.0722E+04	4.9843E+04	4.9187E+04
Total Sr grams	8.1752E+04	8.3723E+04	8.2844E+04	8.2188E+04
Wt% Sr	60%	61%	60%	60%
Correction factor	0.556	0.547	0.551	0.554

ORIGEN2 as of 1/1/01

	T Plant	B Plant	Units
SR86	4.89E-01	2.72E-01	grams
SR87	1.71E-02	9.54E-03	grams
SR88	2.12E+04	1.18E+04	grams
SR89	0.00E+00	0.00E+00	grams
SR90	1.07E+04	5.66E+03	grams

137Cs

HDW Model Basis	1/1/2001	1/1/2001	1/1/2001	1/1/2001
137Cs mass	3.0300E+04	3.0300E+04	3.0300E+04	3.0300E+04
Other isotopes	1.3110E+05	1.3110E+05	1.3110E+05	1.3110E+05
Total Cs grams	1.6140E+05	1.6140E+05	1.6140E+05	1.6140E+05
Wt% 137Cs	19%	19%	19%	19%
Document	HW-38955	HW-30399	HW-33184	HW-36293
Doc Date	9/1/1955	1/8/1954	9/30/1954	4/19/1955
37Cs Decay Factors	3.517E-01	3.386E-01	3.443E-01	3.487E-01
137Cs mass	8.6159E+04	8.9490E+04	8.8006E+04	8.6896E+04
Total Cs grams	2.1726E+05	2.2059E+05	2.1911E+05	2.1800E+05
Wt% 137Cs	40%	41%	40%	40%
Correction factor	0.473	0.463	0.467	0.471

ORIGEN2 as of 1/1/01

	T Plant	B Plant	Units
CS133	6.51E+04	3.64E+04	grams
CS134	1.38E-05	4.22E-06	grams
CS135	1.90E+04	1.06E+04	grams
CS137	1.98E+04	1.05E+04	grams

Solubility Limits for Radionuclides Decayed to 1/1/01

	90Sr	137Cs	Units
PFeCN1	2.48	9.37E-03	uCi/mL
PFeCN2	1.99E-01	9.37E-03	uCi/mL
TFeCN	1.82E-01	9.37E-03	uCi/mL
1CFeCN	2.91E-02	2.47E-04	uCi/mL

Higley, Bruce A

From: Place, David E
Sent: Monday, September 08, 2003 5:21 PM
To: Brett Simpson (bsimpson@tri-inc.com); Rob Corbin (rcorbin@tri-inc.com)
Cc: Higley, Bruce A
Subject: HDW5_03_246a DEP Review for P3 Waste Type

Attached are the recommended changes for P3AZ1 and P3AZ2 waste types. Call me if you have any questions.

I tried the new numbers in the model and got reasonable results, but we may be precipitating too much sulfate.

I also noted that the fraction precipitated for carbon-14 does not match Na2CO3 and Sr does not match 90Sr. We should link these in the spreadsheet.

Non-relevent text removed from message by editor.

Thanks,

David E. Place
376-0176

P3 Volume and Composition Corrections

Volume Comparison	AZ-101	AZ-102		
HDW model total volume	727	409	kgal	
HDW model sludge volume	26.9	49.1	kgal	
SBI	1001	991	kgal	
SBI Sludge	52	105	kgal	
SBI Supernate	949	886	kgal	
Metric Tons Uranium	2488	1402	MTU	ORIGEN2
Actual volume transferred	1026	609	kgal	includes flushes and cold uranium recycle
gal/MTU	413	435		

Species Inventory	AZ-101	AZ-102	Units	Source
Al	43100	24300	kg	Based on Essential Material usage and PUREX flowsheet
Cd	2650	1520	kg	Based on PUREX flowsheet
Cr (corrosion)	2200	3630	kg	Sample based minus initial heel
Fe (chemicals added)	11800	11500	kg	Based on Essential Material usage and PUREX flowsheet
Fe (corrosion)	5290	13600	kg	Corrosion estimated from Cr
Na	347200	194400	kg	AZ-101 based on PUREX flowsheet. AZ-102 based on caustic usage plus NaNO2 from flowsheet.
Ni (corrosion)	1170	1910	kg	Corrosion estimated from Cr
NO_2 (nitrite)	27473	15070	kg	Based on PUREX flowsheet
SO_4 (sulfate)	74700	59600	kg	Based on Essential Material usage and PUREX flowsheet
Sr	78.6	44.9	kg	Based on updated ORIGEN2

Species Molecular Weight	MW
Al	26.98
Cd	112.4
Cr	51.996
Fe	55.847
Fe Corrosion	55.847
Na	22.99
Ni	58.71
NO_2	46.01
SO_4	96.06
Sr	87.62

References:

RPP-13489, Rev. 0, *Activity of Fuel Batches Processed though Hanford Separations Plants, 1944 through 1989*, R. A. Watrous, D. W. Weetan and S. F. Finfrock, November 2002, CH2M Hill Hanford Group, Inc., Richland, Washington 99352.

WHC-SD-WM-ER-410, Rev. 0B, *Tank Characterization Report For Double-Shell Tank 241-AZ-101*, S. L. Lambert, August 31, 1998, Lockheed Martin Hanford Corporation, Richland, Washington.

WHC-SD-WM-ER-411, Rev. 0C, *Tank Characterization Report For Double-Shell Tank 241-AZ-102*, S. L. Lambert, July 28, 1998, Lockheed Martin Hanford Corporation, Richland, Washington.

PFD-P-020-00001, Rev. A-8, *PUREX Flowsheet Reprocessing N Reactor Fuels*, September 16, 1985, G. K. Allen, D. C. Hedengren, L. L. Jacobs, R. D. Fox and D. W. Reberger, Rockwell Hanford Operations, Richland, Washington.

Revsion in Volumes and Chemicals in

	Was P3AZ1	Was P3AZ2	Is P3AZ1	Is P3AZ2	
st date	1982	1986	1982	1986	
en date	1986	1990	1986	1990	
short tons fuel	2717	1562	2743	1545	
kgal waste input					
volume factor					
kgal waste out	727	409	993	959	
gal/ton	267.5745307	261.84379	362	621	
avg. MWD/T	1163	1163	1163	1163	Comments below from Bruce Higely.
g Pu-239*/MWD	0.74	0.74	0.74	0.74	[redacted]
kg Pu-239*	2338.30454	1344.28844	2338.30454	1344.28844	
Pu* ex. %	99.6	99.6	99.6	99.6	
res. kg Pu-239*	9.35321816	5.37715376	9.35321816	5.37715376	
Pu-239* µCi/L	207.3435856	211.8815291	207.3435856	211.8815291	
(* Pu-239 is U-233 for TH waste)			0	0	Comments below from Bruce Higely.
then			0	0	[redacted]
MCi Cs-137	8.929063875	5.133307977	8.929063875	5.133307977	
MCi Sr-90	7.711540775	4.433355425	7.711540775	4.433355425	
kCi Tc-99	1.078259759	0.620465125	1.078259759	0.620465125	
Ci I-129	2.198511489	1.263921565	2.198511489	1.263921565	
1994			0	0	
MCi Cs-137	7.097855003	4.472908735	7.097855003	4.472908735	
MCi Sr-90	6.025776863	3.823452358	6.025776863	3.823452358	
kgal solids	26.899	49.08	44	73	
vol% solids	3.7	12	4.43	7.61	
uncertainty	1	1			
kgal solids left	26.899	49.08	44	73	

chemicals in mol/L	Was P3AZ1	Was P3AZ2	Is P3AZ1	Is P3AZ2	
HNO3	0.41	0.41	2.28E+00	1.28E+00	PFD-P-020-00001 corrected volume and for other NO2 and NO3 compounds listed
NaNO2	0.34	0.34	4.29E-01	2.46E-01	WHC-SD-WM-ER-410 and 411. Essential Material Usage and PFD-P-020-00001.
Al(NO3)3					
Fe(HSO4)2	0.067394	0.067394	5.62E-02	5.67E-02	WHC-SD-WM-ER-410 and 411. Essential Material Usage and PFD-P-020-00001.
Fe(NO3)3	0.05	0.05	3.95E-02	6.71E-02	WHC-SD-WM-ER-410 and 411 corrosion estimates.
NaCrO4			1.13E-02	1.92E-02	WHC-SD-WM-ER-410 and 411 corrosion estimates.
BiPO4					
ZrO(OH)2					
NaSO4			5.30E-03	6.85E-03	WHC-SD-WM-ER-410 and 411 corrosion estimates.
NaOH	2.2	2.2	3.13E+00	1.81E+00	
NaNO2	0.01	0.01	1.16E-01	6.01E-02	WHC-SD-WM-ER-410 and 411. Based on PFD-P-020-00001.
Na2CO3	0.018264	0.018264	1.34E-02	7.78E-03	Adjusted Rev. 4 concentrations.
Na3PO4					
Na2SO4			8.92E-02	4.85E-02	WHC-SD-WM-ER-410 and 411. Essential Material Usage and PFD-P-020-00001. Reduced by other compounds listed.
Na2SiO3	0.092132	0.092132	0.00E+00	0.00E+00	Silicon is associated with the bonding layer of Al-clad fuels, not Zr-clad fules.
Na2SiF6					
NaF	0.03	0.03	5.18E-02	3.18E-02	PFD-P-020-00001 adjusted for volume.
NaCl	0.0508	0.0508	3.70E-02	2.16E-02	Rev. 4 concentrations adjusted for volume.
Na2S					
La(NO3)3					
Hg(NO3)2					
KNO3	0.011	0.011	8.05E-03	4.69E-03	Rev. 4 concentrations adjusted for volume.
Ca(NO3)2	0.018264	0.018264	1.34E-02	7.78E-03	Rev. 4 concentrations adjusted for volume.
KMnO4					
Sr(NO3)2	0.000331499	0.000342415	2.39E-04	1.41E-04	RPP-13489, ORIGEN2.
PbSO4					
H3C6H5O7					
H4EDTA					
H3HEDTA					
Hglycolate					
Hacetate					
H2oxalate					
Na4Fe(CN)6					
NH3					

Place, David E

From:	Higley, Bruce A
Sent:	Thursday, September 11, 2003 10:46 AM
To:	Bret Simpson (bsimpson@tri-inc.com); Robert A. Corbin (rcorbin@tri-inc.com)
Cc:	Place, David E
Subject:	Review comments September 4-11, 2003

Rob and Bret,

The attached file summarizes all the text files and emails that we have sent you during this review cycle.

<Review Comments_September 4-9, 2003 Amended 9-11.doc>

B. A. Higley, 376-5694
Flowsheet and Process Models
CH2M Hill Hanford Group, Inc.

Review Comments – September 4-9, 2003, Amended 9-11-03

SOLUBILITYWORKUP245A.XLS

Cell H75 still needs to be corrected to 9.18E-03 uCi/mL.

The HDW model Rev. 4 radionuclide solubilities for 106Ru, 113mCd, and 125Sb were used for complexed wastes in the absence of other data. However, the Rev. 4 radionuclide decay date is 1/1/94 rather than 1/1/01 used for Rev. 5. The HDW model Rev. 4 concentrations need to be corrected to 1/1/01.

Also, a 154Eu solubility limit of 8.54 E-04 Ci/L was recommended for complexed wastes based on TCD data. The use of the HDW model Rev. 4 limit for 154Eu is unnecessary.

Revised complexed waste solubility limits for the HDW5 "solubilities" worksheet are:

106Ru: 4.06E-11 Ci/L
113mCd: 4.30E-05 Ci/L **(value should also be applied to all PUREX wastes)**
125Sb: 3.30E-03 Ci/L
154Eu: 8.54E-04 Ci/L

HDWorigenInputFY03_245a.xls

PUREX Iodine distribution. Delete the distribution of the silver reactor flushes between CWP2 and CWZr1. Since REDOX did not flush their silver reactors, we don't the CWZr1 to include this inventory. (remove the 0.9563 and 0.0437 terms from cells W180 and X180 respectively.) Also, because CWP1 changes to CWP2 before P1 changes to P2, part of the iodine recovered from silver reactors during P1 belongs in CWP2. Iodine from P1 61-62 belongs in CWP2. So the silver reactor iodine from P1 is further split 0.6372 to CWP1 and 0.3628 to CWP2.

Cell X180: It would probably be best to delete the second term that includes a fraction of the P2, P2', TH1 and TH2 iodine-129 due to the impact on the Redox production. The revised CWZr1 iodine-129 inventory would be equal to Cell S126.

Cell V180: The time period for CWP1 includes only a portion of P1 (to 1960). Therefore the second term of the CWP1 inventory should be factored downward based on the iodine-129 in the P1 fuels through 1960 (9.47743 Ci/14.87329 Ci = 0.6372). New equation =Q126+F126*0.778*(9.47743/14.87329).

Cell W180: The CWP2 inventory should be revised to include the iodine-129 that was removed from CWZr1 and CWP1 above. The revised equation would be R126+U126+V126+(0.778*(G126+K126)+0.5555*(H126+L126))+F126*0.778*(1-9.47743/14.87329).

The extraneous Soil Inventory Model Comparison Estimates in the upper right hand portion of the spreadsheet should be deleted.

HDW5_03_246a.xls

The engineering estimates for several AZ-101 and AZ-102 chemical concentrations have not yet been incorporated in the spreadsheet. Recommended changes were sent in a separate E-mail message.

I looked into the sulfate precipitation a little further and I believe that we should fix the fraction of the sulfate precipitated for AZ-101 and AZ-102. These tanks may not fit the normal solubility limit because: (1) the temperature is higher, (2) the sodium concentration is relatively low (< 5 molar), and (3) the nitrate ion concentration is low which precludes precipitation of a NO3/SO4 double salt.

Based on the current BBI, the fraction sulfate precipitated should be 11.3% for AZ-101 and 2.68% for AZ-102. The calculation of the fraction sulfate precipitated is sensitive to the assumed void fraction. I therefore iterated results with the HDW model until the void fraction stopped changing (0.682 and 0.833 were the final void fraction values for AZ-101 and AZ-102 respectively).

See D. E. Place EMAIL HDWf_03246a DEP Review for P3 Waste Type dated September 8, 2003 for recommended changes to the P3AZ1 and P3AZ2 waste types.

There is no Na2SO4 listed for any of the PUREX HLW streams. Sodium sulfate is needed to account for the sulfamic acid (a major source of sulfate that can not be adequately addressed with ferrous sulfamate alone).

The P2' chemical composition is deficient. Chemical input does not include Fe(HSO4)2, Na2SO4, Na2SiO3 (Al-clad fuels) or NaF/NaAlO2 (Zr-clad fuels). The AR, B, BL and SRR waste stream chemical compositions (with the exception of Hg) are established independently, so this does not affect the model results. However it is unsettling to see this misleading information in the spreadsheet. Suggest deleting all chemical compositions except Hg.

<u>CWZr1</u> The time period for CWZr1 is 1965-1972.

<u>Mercury</u> Need to incorporate the 80/20 split between MW2 and 1C2. The fraction that goes to TBP etc is then 0.8*0.94. MW2 would be 5.13E-05 and 1C2 is 1.59E-05. The 80/20 split is discussed in the BiPO4 letter # 7G300-02-NWK-024.

<u>CSR Model Material Balance</u>

We need to verify the accuracy of the CSR model.

The total of all streams to cesium IX per the model is 59,259 kgal (cells B754 to AI754 and AL754 to AW754). HOWEVER this number, 59,259 kgal, is not consistent with the volume in cited in cell AJ7 (25,638 kgal). A large number of these input streams are unlikely because of there inherently low cesium concentration.

CSR feed streams

Stream	Volume (kgal)	Comment
MW1 & MW2	0.52	
1C1 & 1C2	0.39	
2C1 & 2C2	80.5	
TBP	95.1	
PFeCN, TFeCN	4.67	
R1 & R2	5,602	RSN
CWR1 &CWR2	11.1	
P1 & P2	26,230	PSN
PL1	625.1	
CWP1 & CWP2	1,414	
OWW [stored with P1 & P2]	11,590	PSN
AR	4,092	PSS
B	5,357	Double accounting?
BL	577	Double accounting?
SRR	54	Double accounting?
DW [decon waste]	576	
BT-SltCk	143	
RSltCk	1,807	RSN

According to logbook ARH-N-23 and the monthly reports, Cs-IX processed 10,548 kgal PSN, 7,915 kgal of RSN, and 2,166 kgal of PSS. This totals to 20,629 kgal processed by Cs-IX, not 59,259. The value used by the CSR model 25,638 may be an accurate representation if product rework is included.

RSN [Redox alkaline supernatant] should be equivalent to the sum of the R1+R2+RSltCk supernatants (7,409 kgal). This value is similar to B Plant records.

PSN [Purex alkaline supernatant] should be equivalent to the sum of the P1+P2+OWW supernatants (34,820 kgal). This value is over three times the B Plant records.

PSS [Purex sludge supernatant] (sludge washings) should be equivalent to AR supernatant (4,091 kgal). This value is nearly twice the B Plant records.

The balance of the CSR feed streams total to 8,918 kgal. That's a lot of incidental low grade feed.

One explanation is that the HDW Model does not account for the self-concentration of the waste (primarily the boiling waste tanks) and the small waste concentration processes

like the AX-101 stream coil, and the REDOX D-12 concentrator. If this is the reason for the volume discrepancy then the CSR model needs to also account for the tritium cribbed from self-concentration of the waste.

AR Sludge Rad. Partition Fractions The AR sludge calculations model the sluicing of PUREX sludge with various supernatants (P1, P2, OWW & B). This does not truly reflect washing with water or acidification of the solids. (The ratios of C-14, Tc-99, and Cs-137 to Sr-90 are roughly the same for AR, P1, and P2). C-14, I-129, Tc-99, Cs-134. Cs-137, and Ba-137m should be depleted relative to Sr-90. Per the table this is has not occurred. One would suspect that there would be a relative depletion of the soluble species, say 90%. However the current measured Cs/Sr ratio for AR sludge in C-103 and C-106 is 2.8E-02 and 4.0E-02 respectively. Recommendation: Leave all AR Rad. Fractions at 1.

Current relative sludge compositions from HDW Model.

Isotope	AR (Ci)	AR (frac)	P1 (Ci)	P1 (frac)	P2 (Ci)	P2 (frac)
Sr-90	8,010	1.0E+00	7,790	1.1E+00	10,185	1.1E+00
C-14	0.0246	3.1E-06	0.064	8.2E-06	0.0397	3.9E-06
Tc-99	0.0443	5.6E-06	0.0414	5.3E-06	0.0613	6.0E-06
I-129	2.25E-05	2.8E-09	2.5E-06	3.2E-10	3.68E-06	3.6E-10
Cs-137	178.6	2.2E-02	156.7	2.0E-02	262.4	2.6E-02

Organic Saltcake Are you going to be able to provide an organic saltcake? We need to have the correct dates for the organic saltcake included.

Saltcake Rad. Partition Fractions

The preferred means to calculate the tritium split is as follows and is based on the knowledge that tritium follows water through the evaporator is indirect proportion to the mass of water. Recommend that these formulas be placed in a scratch calculation in a clear area of the spreadsheet.

Mass Feed (g/L) = AR142*1000

Mass Feed Dry Basis (g/L) = SUMPRODUCT(moles, molecular weight) = SUMPRODUCT(AR127:AR140, mol. Wt.)+SUMPRODUCT(AR146:AR154, mol. Wt.)

Mass feed water = Mass feed – Mass feed dry basis

Mass evaporator condensate = 1000*(1-volume factor) = 1000*(1-AR8)

Tritium split [to tanks], AS782 = (Mass feed water-mass condensate) / mass feed water

Cesium and Strontium Material Balance.

The HS Sr-90 balance matches plant records.

Using current partition factors and source terms the Sr-90 recovery is 33.9 MCi. This is 16% higher than the 28.36 MCi indicated by plant records. This is close enough.

Using current partition factors and source terms the Cs-137 recovery is 63.3 MCi. This is 4% higher than the 60.6 MCi indicated by plant records. This is close enough.

BiPO4 Cesium and Strontium DF's The current cesium and strontium DFs are analogies of ^{131}I. Previously you had mentioned that "line sample data" implied much higher DFs for cesium and strontium. Have you documented this data yet?

Radionuclide Inventory Balance (rows 16 thru 26) These values do not seem to be current with the latest ORIGEN2 results. I am not sure of the value of these calculations. They should be updated, removed or zeroed.

Purex Iodine Distribution Checks (For checking purposes only - use the new equations provided on page 1)

	1956-1962	1963-1967	1968-1972	83-88 (AZ1)	83-88 (AZ2)
ORIGEN Core (Ci)	14.87 (P1)	11.93 (P2)	8.16 (P2')	2.099	1.14
ORIGEN Clad (Ci)	0.0095 (CWP1)	0.023 (CWP2)		0.174 (CWZ2)	
Stack/SW Loss (frac)	0.099	0.0.099	0.55	0.54184	0.54184
Stack/SW Loss formula	14.87*(1-0.901)	11.93*(1-0.901)	8.16*(1-0.45)	2.099*(1-0.45816)	1.14*(1-0.45816)
Stack/SW Loss (Ci)	1.472	1.18	4.49	2.641	0.617
HLW formula	14.87*0.901*0.0333	11.93*0.901*0.0333	8.16*0.45*0.0667	2.099*0.45816*0.0911	1.14*0.45816*0.0911
HLW (Ci)	0.446	0.3579	0.2449	0.0876	0.0476
OWW formula	14.87*0.901*0.1887	11.93*0.901*0.1887	8.16*0.45*0.3778	(2.099+1.14)*0.45816*0.5165	
	2.528 (OWW1)	2.028 (OWW2)	1.38 (OWW3)	0.7666 (PL2)	
CW formula	0.0095+14.87*0.901*0.7	0.023+11.93*0.901*0.7778+8.16*0.		0.174+(2.099+1.14)*0.458	

	778*0.6372 (CWP1)	45*0.5555+14.87 *0.901*0.7778*0. 3628 (CWP2)		16*0.3924 (CWZr2)	
CW (Ci)	6.640	14.20		0.756	

Salt Cake Checks

	HDW Model Prediction			2003 Templates		
Saltcake	Vol (kgal)	Density	Wt% H_2O	Vol (kgal)	Density	Wt% H_2O
BT	1,403	1.718	42.48	1,199	1.72	31.6
BY	4,126	1.721	26.84	3,685	1.72	28.3
RSlt	880	1.718	34.65	724	1.72	21.1
T2	5,467	1.635	36.42	5,201	1.64	28.3
S1	5,715	1.684	34.14	5,272	1.68	30.2
S2	2,259	1.626	38.53	2,300	1.63	35.0
A1	1,303	1.66	35.36	1,073	1.66	37.9
A2	2,182	1.586	40.07	2,513	1.59	NA

Impact of addition of an Organic Saltcake on Tank Layer Volumes

Saltcake	Without OrgSltCk	With OrgSltCk
OrSltCk	0	712
A2SltCk	2,513	2,146
S1SltCk	5,272	5,146
S2SltCk	2,300	2,082
Total	10,085	10,086

Higley, Bruce A

From: Place, David E
Sent: Thursday, September 18, 2003 8:52 AM
To: 'Brett Simpson'
Cc: Rob Corbin; Higley, Bruce A
Subject: RE: Review of HDW5 Rev. 232a Spreadsheets

The PFeCN1 solubility limit back-calculated from the crib data would imply 95% 90Sr precipitation, which is suspect since the HDW model prediction for the 90Sr fraction precipitated in PFeCN2 (with the addition of chemical strontium) is only slightly higher (98%). There would have been no incentive for development of the 90Sr scavenging processes if the 90Sr solubility limit for PFeCN1 was actually that low.

The development work for Ca(NO3)2 scavenging (HW-36293) indicates that 3 to 6 fold improvements in the 90Sr decontamination were expected in plant operation. Assuming a DF of 5 and that the Ca scavenging was as effective as Sr scavenging, the HDW model 90Sr fraction precipitated for PFeCN1 should be ~90%. This corresponds to a 90Sr solubility limit of 1E-03 Ci/L (about twice what you had proposed).

David E. Place
376-0176

-----Original Message-----
From: Brett Simpson [mailto:bsimpson@tri-inc.com]
Sent: Wednesday, September 17, 2003 3:33 PM
To: 'Place, David E'; Brett Simpson; Rob Corbin; 'Higley, Bruce A'
Subject: RE: Review of HDW5 Rev. 232a Spreadsheets

<< Message: Untitled Attachment >> << File: PFeCN1 Solubility derivation.xls >>

Higley, Bruce A

From: Higley, Bruce A
Sent: Thursday, September 18, 2003 12:28 PM
To: Robert A. Corbin (rcorbin@tri-inc.com); Bret Simpson (bsimpson@tri-inc.com)
Cc: Place, David E

Since we are using the CSR model to account for the Cs recovered by the 241-C-801 cask station as well as the Cs recovered by B-Plant I have changed the CSR definition as follows.

"CSR Supernatants from which the cesium has been removed by ion-exchange. 241-C-801 cask station (1962-1967). B Plant Waste Fractionization (1967-1976)."

The C-801 process was fed from tank C-105 as was B Plant ion-exchange. Supernatant was pumped from tank C-105 to C-801 through a cask filled with ion-exchange media, then back to another tank. The C-801 casks were not eluted in the 200 Areas so there is no waste stream from this operation.

Please change cells AJ3 from 1967 to 1962.

Thanks

B. A. Higley, 376-5694
Flowsheet and Process Models
CH2M Hill Hanford Group, Inc.

Higley, Bruce A

From: Place, David E
Sent: Thursday, September 18, 2003 3:16 PM
To: Rob Corbin (rcorbin@tri-inc.com); Brett Simpson (bsimpson@tri-inc.com)
Cc: Higley, Bruce A
Subject: Spreadsheet Checks

Solubility

- The Sr fraction precipitated should be linked to 90Sr (comment previously made).
- The fraction precipitated for 59Ni and 63Ni is different than for Ni in the FeCN wastes only. The problem arises because there are two Ni compounds listed and NiFe(CN)6-- is precipitated fully and independently of the Ni(OH)2.

Pu Balance

- TFeCN Pu balance is very bad. The formula in Cell L114 must changed to convert grams to kgs (divide by 1000). This should also fix a Pu balance problem in the BY saltcake.
- The Z waste Pu balance is slightly off. The 239Pu specific activity in Cells AB110 and AB114 should be revised from the old 0.061 Ci/g to 0.0621 Ci/g. Rows 17 and 22 also contain the incorrect specific activity for 239Pu (these do no enter into the HDW model calculations). The 240Pu specific activity in Cell AB114 should be revised from 0.229 to 0.227 Ci/g.
- We should fill out the plutonium distribution for the Z Plant waste. Suggest using the following:

  238Pu = 0.256 times the 240Pu input inventory (Cell AB109).
  241Pu = 16.1 times the 240Pu input inventory (Cell AB112)
  242Pu = 9.94E-05 times the 240Pu input inventory (Cell AB113).

These ratios are based on the global ORIGEN2 inventories (Table H-1 in RPP-13489).

Non-relevant text removed from message by editor.

David E. Place
376-0176

Higley, Bruce A

From: Place, David E
Sent: Thursday, October 09, 2003 11:12 AM
To: Brett Simpson (bsimpson@tri-inc.com); Rob Corbin (rcorbin@tri-inc.com)
Cc: Higley, Bruce A
Subject: Material Balance Problem - 1C2 and 1CFeCN Wastes

There is a radionuclide material balance problem between the 1C2 and 1CFeCN waste types.

- The 1CFeCN contains a portion of the cladding waste inventory that is already fully accounted for in the 1C2.
- The 1C2 inventory includes all of the separations waste associated with the 1CFeCN.

Proposed solution:

1. Cells M72 through M119 - Bring the 1CFeCN radionuclide inventory directly in from ORIGEN2 (T Plant separations waste processed in 1955 and 1956). Alternately, the same 1CFeCN data could be brought in through the HDW ORIGEN2 Input spreadsheet.

2. Revise the calculation of the 1C2 concentration (species mol/L) to exclude the 1CFeCN inventory. For example:
H-3 (Ci/L) Cell E167 was: =((E782-1)*C72+E72)/E$9/3785
Revise to: =((E782-1)*C72-M72*E782+E72)/E$9/3785

Editors Note: The above formula was subsequently corrected to the following form.

=((E782-1)*C72-M72*E782+E72)/E$9/3786

3. Cells M167 through M214 - Set the 1CFeCN Rad. Partition Factors equal to 1C2 (or change the 1CFeCN concentration cell references [species mol/L] to refer to the 1C2 Rad. Partition Factors.

1CFeCN
entory.xls (22

David E. Place
376-0176

1CFeCN Input Inventories		Curies
H-3 (Ci)	H03	356.302
C-14 (Ci)	C14	39.668
Ni-59 (Ci)	NI59	1.86608
Ni-63 (Ci)	NI63	167.746
Co-60 (Ci)	CO60	9.1224
Se-79 (Ci)	SE79	0.318784
Sr-90 (Ci)	SR90	297520
Y-90 (Ci)	Y90	297608
Zr-93 (Ci)	ZR93	19.4704
Nb-93m (Ci)	NB93*	16.7729
Tc-99 (Ci)	TC99	139.498
Ru-106 (Ci)	RU106	9.26E-08
Cd-113m (Ci)	CD113*	10.9092
Sb-125 (Ci)	SB125	0.63482
Sn-126 (Ci)	SN126	1.15114
I-129 (Ci)	I129	0.183741
Cs-134 (Ci)	CS134	0.004185
Cs-137 (Ci)	CS137	338917
Ba-137m (Ci)	BA137*	320041
Sm-151 (Ci)	SM151	15139.3
Eu-152 (Ci)	EU152	0.25215
Eu-154 (Ci)	EU154	31.5439
Eu-155 (Ci)	EU155	41.7244
Ra-226 (Ci)	RA226	0.001628
Ra-228 (Ci)	RA228	6.52E-09
Ac-227 (Ci)	AC227	0.008092
Pa-231 (Ci)	PA231	0.017039
Th-229 (Ci)	TH229	8.9E-07
Th-232 (Ci)	TH232	7.96E-09
U-232 (Ci)	U232	0.003881
U-233 (Ci)	U233	0.000289
U-234 (Ci)	U234	389.328
U-235 (Ci)	U235	17.5377
U-236 (Ci)	U236	3.50053
U-238 (Ci)	U238	396.132
U-Total (mols)		
Np-237 (Ci)	NP237	0.85089
Pu-238 (Ci)	PU238	2.29832
Pu-239 (Ci)	PU239	635.62
Pu-240 (Ci)	PU240	43.1734
Pu-241 (Ci)	PU241	55.7375
Pu-242 (Ci)	PU242	0.000159
Pu-Total (kg)		
Am-241 (Ci)	AM241	22.1749
Am-243 (Ci)	AM243	0.000543
Cm-242 (Ci)	CM242	0.000995
Cm-243 (Ci)	CM243	4.52E-06
Cm-244 (Ci)	CM244	0.000127

From RPP-13489 ORIGEN2 data (ORIGEN2-DKPRO-Ver 9.16.02-forRC.xls)
T Plant Fuel Processed 1955 and 1956 (1CFeCN processing began 12/31/54).

Higley, Bruce A

From: Place, David E
Sent: Friday, October 17, 2003 12:08 PM
To: Rob Corbin (rcorbin@tri-inc.com); Brett Simpson (bsimpson@tri-inc.com)
Cc: Higley, Bruce A
Subject: Review Comments HDW5_3_287b

1. There are several inconsistencies in molecular weights:

Cell BP308 Al(OH)4- lists a value of 58.98 versus a value of 95.02 calculated from the chemical formula.
Cell BP309 Fe should be revised to 55.847 to agree with two other locations.
Cell BP328 OH lists a value of 6 versus a known MW of 17.
Cell BP336 Cl lists a value of 35.43 (should be 35.453).
Cell BP384 uranium should be revised to 238.03 to agree with two other locations.
Cell BP413 Cr(OH)3 lists a value of 151.99 versus a value of 103.02 calculated from the chemical formula.
Cell BP422 Na3HEDTA lists a value of 341 versus a known MW of 344.
Cell BP423 Na4EDTA lists a value of 378 versus a known MW of 380.

2. Cell M209 Pu-Total equation should add "*1000" since input was kg Pu. Note that this will correct downstream imbalances in BT, T2 and S2 saltcakes).

3. The PFeCN1 shows a Ni concentration of > 0 even though the input Ni and FeCN concentrations are equal and NiFeCN is assumed to be fully precipitated. This indicates an error in the equations. Also, none of the ferrocyanide wastes have a corrosion contribution for Ni (perhaps should add 0.0016 molar NiSO4 to each).

4. Cell U30 kgal of PL1 has nothing to do with 90Sr, replace with "=U9*U31/100".

5. Row 58 mercury has some entries in moles rather than mol/L.

6. Row 349 some tritium cell equations include a factor of Na/12. This factor should be deleted (remnant of HDW model Rev. 4 tritium reduction which has been completely replaced).

7. A few negative concentrations were found: DE wt% water in Cells 234 and 569; NIT OH in Cells AL146, 236, 237, 328, 571, 572 and 663. The DE wt% water was entered as -6, which could be set to zero. The NIT waste type is not used by the BBI.

8. Rows 760 through 763: I was unable to re-derive these formulas, although they seem to be reducing the NO3 and NO2 properly. Please check validity. Also, the sum of the 90Sr and 137Cs needs to be multiplied by 1.1811 to reflect a 1/1/94 decay date needed for the equation (ORIGEN2 data was decayed to 1/1/01).

Thanks,

David E. Place
376-0176

Higley, Bruce A

From: Place, David E
Sent: Wednesday, January 28, 2004 9:46 AM
To: Rob Corbin (rcorbin@tri-inc.com); Brett Simpson (bsimpson@tri-inc.com)
Cc: Higley, Bruce A
Subject: HDW5 Error for Z Plant Waste

The Pu isotopes and 241Am disappeared from the Z Plant waste stream. The error occurred when the kg 239Pu in cell AB16 was deleted. All of the Pu isotopes and 241Am were built off of this value. The fix seems straight-forward: type 133 in Cell AB110 in place of the AB16 reference, add a comment to this cell and add a change record. Do you concur? Would this have any significant downstream impacts?

Thanks,

David E. Place
376-0176

APPENDIX D

SUPPORTING INFORMATION

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D.0 SUPPORTING INFORMATION

This appendix consists of supporting calculations and data used by Revision 5.0 of the Hanford Defined Waste Model.

D1.0 FUEL ACTIVITY DATA LOADING WORKSHEET

This section documents the contents of the Input to HDW worksheet. The function of this worksheet is to interface ORIGEN2 predicted fuel activity records with the HDW Model. This worksheet is also used to account for tritium losses to the soil from in-plant waste concentration, atmospheric losses of ^{14}C and ^{129}I during fuel dissolution, and ^{99}Tc losses with the uranium product. See Section 5.2. Table D-1 is a printout of the Input to HDW worksheet. This table includes editorial changes made for the purpose of publication.

Table D-1. Input to HDW Worksheet. (Sheet 1)

input from ORIGEN	BT1	BT2	R1	R2	P1	P2	P2Prime	P3AZ1	P3AZ2	TH1	TH2
H-3 (Ci)	6.15E+02	1.82E+03	7.60E+03	1.49E+04	3.57E+04	3.82E+04	3.22E+04	1.72E+04	1.04E+04	4.10E+01	1.04E+02
C-14 (Ci)	1.05E+02	2.29E+02	7.84E+02	2.17E+02	1.40E+03	6.00E+02	3.20E+02	3.87E+01	2.07E+01	1.05E-03	2.22E-03
Ni-59 (Ci)	4.95E+00	1.08E+01	3.70E+01	3.80E+01	1.35E+02	1.05E+02	6.53E+01	2.11E+01	1.14E+01	8.09E-03	1.72E-02
Ni-63 (Ci)	4.22E+02	9.51E+02	3.34E+03	3.60E+03	1.25E+04	1.01E+04	6.29E+03	2.04E+03	1.11E+03	6.89E-01	1.50E+00
Co-60 (Ci)	8.97E+00	3.78E+01	1.91E+02	5.40E+02	1.23E+03	1.89E+03	2.09E+03	4.38E+03	3.07E+03	1.38E-02	4.42E-02
Se-79 (Ci)	8.45E-01	1.87E+00	6.53E+00	8.42E+00	2.39E+01	1.91E+01	1.30E+01	3.34E+00	1.85E+00	3.21E-02	6.82E-02
Sr-90 (Ci)	6.56E+05	1.61E+06	5.93E+06	9.19E+06	2.39E+07	2.16E+07	1.60E+07	5.52E+06	3.21E+06	2.01E+04	4.61E+04
Y-90 (Ci)	6.56E+05	1.61E+06	5.93E+06	9.19E+06	2.39E+07	2.16E+07	1.60E+07	5.52E+06	3.21E+06	2.01E+04	4.61E+04
Zr-93 (Ci)	5.16E+01	1.13E+02	3.91E+02	5.04E+02	1.42E+03	1.14E+03	7.73E+02	2.02E+02	1.12E+02	8.54E-01	1.82E+00
Nb-93m (Ci)	4.65E+01	9.90E+01	3.36E+02	4.06E+02	1.18E+03	8.96E+02	5.80E+02	1.14E+02	5.93E+01	6.69E-01	1.37E+00
Tc-99 (Ci)	3.69E+02	8.18E+02	2.85E+03	3.63E+03	1.04E+04	8.29E+03	5.53E+03	1.37E+03	7.59E+02	3.62E+00	7.70E+00
Ru-106 (Ci)	2.02E-09	1.79E-07	5.21E-06	1.50E-03	3.75E-04	8.74E-03	8.55E-02	3.45E+02	7.06E+02	9.54E-07	1.98E-05
Cd-113m (Ci)	1.99E+01	6.16E+01	2.69E+02	5.02E+02	1.26E+03	1.31E+03	1.14E+03	6.03E+02	3.46E+02	1.69E+00	4.17E+00
Sb-125 (Ci)	2.60E-01	2.16E+00	1.66E+01	1.53E+02	1.86E+02	5.38E+02	1.01E+03	8.91E+03	7.99E+03	7.57E-01	3.58E+00
Sn-126 (Ci)	3.05E+00	7.20E+00	2.64E+01	3.41E+01	9.87E+01	7.96E+01	5.60E+01	1.49E+01	8.09E+00	1.05E-01	2.24E-01
I-129 (Ci)	4.87E-01	1.12E+00	4.02E+00	5.13E+00	1.49E+01	1.19E+01	8.16E+00	2.10E+00	1.14E+00	1.14E-02	2.42E-02
Cs-134 (Ci)	1.01E-03	2.23E-02	3.70E-01	1.12E+01	7.05E+00	3.53E+01	1.44E+02	4.09E+03	3.85E+03	2.30E-02	1.44E-01
Cs-137 (Ci)	7.53E+05	1.87E+06	7.01E+06	1.07E+07	2.84E+07	2.56E+07	1.88E+07	6.31E+06	3.62E+06	1.73E+04	3.94E+04
Ba-137m (Ci)	7.11E+05	1.77E+06	6.62E+06	1.02E+07	2.68E+07	2.41E+07	1.78E+07	5.96E+06	3.42E+06	1.63E+04	3.72E+04
Sm-151 (Ci)	3.79E+04	8.14E+04	2.74E+05	3.47E+05	1.01E+06	8.23E+05	5.08E+05	1.33E+05	7.58E+04	3.64E+02	7.93E+02
Eu-152 (Ci)	4.69E-01	3.89E+00	2.78E+01	9.46E+01	1.51E+02	1.90E+02	3.26E+02	1.83E+02	9.32E+01	1.03E-01	2.57E-01
Eu-154 (Ci)	4.54E+01	2.86E+02	1.88E+03	6.28E+03	1.12E+04	1.52E+04	2.34E+04	2.15E+04	1.18E+04	4.11E+00	1.12E+01
Eu-155 (Ci)	3.69E+01	1.57E+02	7.72E+02	2.63E+03	5.13E+03	8.42E+03	8.60E+03	1.46E+04	1.09E+04	1.47E+00	4.93E+00
Ra-226 (Ci)	6.21E-03	6.74E-03	3.75E-04	5.16E-04	9.41E-04	8.43E-04	7.52E-04	2.99E-04	1.51E-04	1.03E-04	3.73E-04
Ra-228 (Ci)	2.08E-08	3.98E-08	2.11E-09	4.46E-09	5.79E-09	6.89E-09	1.04E-08	1.70E-08	1.00E-08	4.53E-01	1.14E+00
Ac-227 (Ci)	2.90E-02	3.23E-02	1.61E-03	2.14E-03	4.19E-03	3.90E-03	3.63E-03	1.48E-03	7.79E-04	1.49E+00	3.00E+00
Pa-231 (Ci)	5.57E-02	6.60E-02	2.39E-03	3.13E-03	5.97E-03	5.96E-03	5.92E-03	3.29E-03	1.91E-03	2.19E+00	4.66E+00
Th-229 (Ci)	2.94E-06	5.63E-06	7.91E-06	2.80E-06	1.57E-05	5.11E-06	3.55E-06	1.97E-06	1.00E-06	3.85E-01	7.03E-01
Th-232 (Ci)	2.46E-08	4.79E-08	2.27E-09	4.57E-09	5.97E-09	7.17E-09	1.09E-08	1.93E-08	1.17E-08	4.24E-01	9.01E-01
U-232 (Ci)	9.50E-03	2.23E-02	7.25E-04	4.53E-04	1.06E-03	1.38E-03	4.40E-03	4.26E-03	2.07E-03	1.82E+00	3.99E+00
U-233 (Ci)	8.41E-04	1.75E-03	3.57E-03	1.29E-03	7.47E-03	2.51E-03	1.60E-03	1.37E-03	6.40E-04	1.16E+02	2.37E+02
U-234 (Ci)	1.09E+03	1.47E+03	1.78E+01	5.94E+00	1.55E+01	1.77E+01	1.54E+01	1.23E+01	6.90E+00	8.79E-01	1.87E+00
U-235 (Ci)	4.90E+01	6.49E+01	7.67E-01	2.25E-01	6.63E-01	7.39E-01	6.63E-01	4.59E-01	2.75E-01	3.12E-06	6.63E-06
U-236 (Ci)	9.28E+00	1.99E+01	3.69E-01	1.72E-01	3.42E-01	4.54E-01	7.55E-01	1.17E+00	6.81E-01	5.44E-07	1.16E-06
U-238 (Ci)	1.11E+03	1.50E+03	1.83E+01	4.15E+00	1.59E+01	1.73E+01	1.16E+01	8.45E+00	4.75E+00	4.87E-14	1.03E-13
U-Total (mols)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Np-237 (Ci)	2.25E+00	5.08E+00	1.81E+01	7.76E+00	4.09E+01	1.61E+01	1.17E+01	1.95E+01	1.06E+01	4.02E-07	8.55E-07
Pu-238 (Ci)	4.85E+00	2.65E+01	4.86E+01	7.66E+01	1.28E+02	1.50E+02	5.57E+02	4.99E+02	2.51E+02	6.85E-05	1.49E-04
Pu-239 (Ci)	1.40E+03	2.99E+03	2.56E+03	1.12E+03	5.18E+03	3.12E+03	4.94E+03	4.72E+03	2.53E+03	3.47E-09	7.38E-09
Pu-240 (Ci)	9.46E+01	3.78E+02	4.97E+02	2.62E+02	1.04E+03	7.66E+02	1.73E+03	1.35E+03	6.91E+02	2.39E-10	5.08E-10
Pu-241 (Ci)	9.16E+01	8.31E+02	1.73E+03	1.99E+03	4.57E+03	6.82E+03	3.27E+04	4.04E+04	2.01E+04	9.20E-10	2.27E-09
Pu-242 (Ci)	4.28E-04	6.04E-03	1.51E-02	1.51E-02	3.25E-02	5.54E-02	2.95E-01	1.75E-01	8.31E-02	1.95E-15	4.15E-15
Pu-Total (kg)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Am-241 (Ci)	4.89E+01	3.56E+02	1.67E+03	3.80E+03	6.04E+03	8.39E+03	2.07E+04	2.42E+04	1.57E+04	1.33E-10	2.74E-10
Am-243 (Ci)	2.11E-03	5.52E-02	6.10E-01	3.29E+00	2.78E+00	4.47E+00	1.98E+01	7.57E+00	3.50E+00	4.73E-16	1.01E-15
Cm-242 (Ci)	3.70E-03	9.50E-02	1.02E+00	5.95E+00	4.73E+00	7.78E+00	3.31E+01	1.40E+01	6.38E+00	8.94E-16	5.54E-16
Cm-243 (Ci)	2.19E-05	1.15E-03	1.82E-02	4.61E-01	9.26E-02	4.67E-01	3.57E+00	2.17E+00	9.15E-01	1.80E-17	4.11E-17
Cm-244 (Ci)	5.13E-04	2.70E-02	4.50E-01	1.02E+01	2.45E+00	1.09E+01	8.74E+01	5.63E+01	2.27E+01	3.91E-16	9.35E-16

Table D-1. Input to HDW Worksheet. (Sheet 2)

Input from ORIGEN	CWBT1	CWBT2	CWR1	CWR2	CWP1	CWP2	CWZr1	CWZr2	CWTH1	CWTH2	Totals
H-3 (Ci)	5.25E+03	1.50E+04	7.37E+04	8.01E+04	1.70E+05	5.70E+05	1.39E+03	3.28E+03	6.97E+03	1.76E+04	1.10E+06
C-14 (Ci)	2.11E+00	4.62E+00	1.86E+01	1.25E+01	3.68E+01	8.41E+01	3.00E+01	3.97E+01	1.00E+00	2.13E+00	3.94E+03
Ni-59 (Ci)	3.11E-01	6.80E-01	2.24E+01	9.13E+01	1.45E+02	6.13E+02	1.50E+00	8.17E-01	8.08E+00	1.72E+01	1.33E+03
Ni-63 (Ci)	7.58E+01	1.39E+02	2.18E+03	8.74E+03	1.36E+04	5.94E+04	1.30E+02	7.84E+01	6.88E+02	1.49E+03	1.27E+05
Co-60 (Ci)	3.76E+00	1.59E+01	1.03E+02	1.92E+02	2.88E+02	1.63E+03	5.89E+01	2.65E+02	1.38E+01	4.41E+01	1.61E+04
Se-79 (Ci)	8.46E-04	1.87E-03	7.85E-03	6.66E-03	1.53E-02	3.72E-02	3.90E-02	2.10E-02	6.87E-04	1.46E-03	7.90E+01
Sr-90 (Ci)	6.57E+02	1.61E+03	7.25E+03	7.38E+03	1.49E+04	4.24E+04	4.41E+04	3.53E+04	4.31E+02	9.87E+02	8.79E+07
Y-90 (Ci)	6.57E+02	1.61E+03	7.25E+03	7.39E+03	1.49E+04	4.24E+04	4.41E+04	3.53E+04	4.31E+02	9.87E+02	8.79E+07
Zr-93 (Ci)	5.17E-02	1.13E-01	4.70E-01	3.99E-01	9.10E-01	2.21E+00	3.68E+00	1.99E+00	1.83E-02	3.89E-02	4.72E+03
Nb-93m (Ci)	4.65E-02	9.91E-02	4.02E-01	3.20E-01	7.64E-01	1.74E+00	2.84E+00	1.10E+00	1.43E-02	2.93E-02	3.73E+03
Tc-99 (Ci)	3.70E-01	8.19E-01	3.42E+00	2.86E+00	6.65E+00	1.61E+01	8.83E+01	1.14E+02	7.76E-02	1.65E-01	3.43E+04
Ru-106 (Ci)	2.02E-12	1.79E-10	1.40E-08	1.19E-06	9.04E-08	5.72E-05	1.67E-04	4.25E+00	2.04E-08	4.25E-07	1.06E+03
Cd-113m (Ci)	1.59E+00	4.45E+00	2.16E+01	2.25E+01	4.91E+01	1.58E+02	3.80E+00	3.96E+00	1.75E+00	4.33E+00	5.79E+03
Sb-125 (Ci)	3.08E-02	1.21E-01	2.13E-01	1.53E-01	1.07E-01	1.60E+00	5.23E+00	1.66E+02	2.01E-02	9.49E-02	1.90E+04
Sn-126 (Ci)	3.05E-03	7.20E-03	3.17E-02	2.67E-02	6.28E-02	1.55E-01	1.85E-01	9.30E-02	2.25E-03	4.79E-03	3.29E+02
I-129 (Ci)	4.87E-04	1.12E-03	4.82E-03	4.03E-03	9.49E-03	2.33E-02	1.37E-01	1.74E-01	2.44E-04	5.19E-04	4.94E+01
Cs-134 (Ci)	1.01E-06	2.23E-05	6.69E-04	7.90E-03	2.88E-03	1.07E-01	4.28E+00	4.26E+02	4.94E-04	3.10E-03	8.56E+03
Cs-137 (Ci)	7.54E+02	1.87E+03	8.55E+03	8.59E+03	1.77E+04	5.02E+04	3.02E+05	5.33E+05	3.70E+02	8.45E+02	1.04E+08
Ba-137m (Ci)	7.12E+02	1.77E+03	8.08E+03	8.11E+03	1.67E+04	4.74E+04	2.85E+05	5.04E+05	3.50E+02	7.98E+02	9.83E+07
Sm-151 (Ci)	3.79E+01	8.15E+01	3.29E+02	2.79E+02	6.45E+02	1.59E+03	1.15E+03	8.45E+02	7.81E+00	1.70E+01	3.30E+06
Eu-152 (Ci)	4.70E-04	3.89E-03	3.68E-02	6.72E-02	8.82E-02	4.11E-01	1.67E+00	1.12E+00	2.21E-03	5.50E-03	1.07E+03
Eu-154 (Ci)	4.55E-02	2.86E-01	2.46E+00	4.48E+00	6.40E+00	3.18E+01	1.13E+02	1.35E+02	8.81E-02	2.40E-01	9.19E+04
Eu-155 (Ci)	3.69E-02	1.57E-01	1.02E+00	2.24E+00	2.78E+00	1.76E+01	1.47E+01	1.03E+02	3.15E-02	1.06E-01	5.14E+04
Ra-226 (Ci)	5.03E-06	5.47E-06	1.37E-05	7.85E-06	2.01E-05	3.27E-05	1.20E-05	8.41E-06	5.29E-05	1.02E-04	1.76E-02
Ra-228 (Ci)	1.69E-11	3.23E-11	1.27E-10	1.14E-10	2.15E-10	4.50E-10	4.76E-10	6.55E-10	4.66E-01	9.84E-01	3.04E+00
Ac-227 (Ci)	2.36E-05	2.63E-05	6.52E-05	3.55E-05	9.78E-05	1.64E-04	7.22E-05	4.04E-05	3.18E-02	6.43E-02	4.66E+00
Pa-231 (Ci)	4.52E-05	5.36E-05	1.39E-04	8.45E-05	2.15E-04	4.01E-04	1.85E-04	1.72E-04	4.70E-02	9.98E-02	7.15E+00
Th-229 (Ci)	2.66E-09	5.09E-09	1.89E-08	1.18E-08	3.37E-08	6.41E-08	5.36E-08	4.53E-08	1.07E-01	2.17E-01	1.41E+00
Th-232 (Ci)	2.00E-11	3.89E-11	1.55E-10	1.45E-10	2.67E-10	5.84E-10	6.34E-10	1.09E-09	4.73E-01	1.00E+00	2.80E+00
U-232 (Ci)	8.97E-06	2.49E-05	1.29E-04	1.41E-04	2.62E-04	7.57E-04	1.38E-03	2.34E-03	5.07E-01	1.11E+00	7.48E+00
U-233 (Ci)	7.93E-07	1.65E-06	6.58E-06	4.78E-06	1.24E-05	2.69E-05	2.09E-05	2.86E-05	3.10E+01	6.58E+01	4.49E+02
U-234 (Ci)	8.81E-01	1.19E+00	3.41E+00	2.77E+00	5.57E+00	1.27E+01	5.60E+00	1.24E+01	2.45E-01	5.20E-01	2.69E+03
U-235 (Ci)	3.98E-02	5.26E-02	1.45E-01	1.05E-01	2.38E-01	5.23E-01	2.59E-01	4.75E-01	8.69E-07	1.85E-06	1.20E+02
U-236 (Ci)	7.53E-03	1.62E-02	6.99E-02	7.78E-02	1.27E-01	3.30E-01	3.94E-01	1.20E+00	1.51E-07	3.22E-07	3.53E+01
U-238 (Ci)	8.96E-01	1.21E+00	3.33E+00	1.93E+00	5.72E+00	1.21E+01	3.92E+00	8.54E+00	1.35E-14	2.88E-14	2.72E+03
U-Total (mols)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Np-237 (Ci)	2.32E-03	5.29E-03	2.27E-02	1.86E-02	4.46E-02	1.09E-01	6.45E-02	1.22E-01	8.62E-09	1.83E-08	1.32E+02
Pu-238 (Ci)	1.77E-01	9.48E-01	6.56E+00	7.25E+00	1.43E+01	4.45E+01	6.64E+01	1.01E+02	1.47E-06	3.20E-06	1.98E+03
Pu-239 (Ci)	5.15E+01	1.07E+02	4.12E+02	2.84E+02	8.09E+02	1.84E+03	6.53E+02	1.00E+03	7.44E-11	1.58E-10	3.37E+04
Pu-240 (Ci)	3.47E+00	1.40E+01	7.83E+01	6.25E+01	1.69E+02	4.34E+02	2.52E+02	2.82E+02	5.12E-12	1.09E-11	8.11E+03
Pu-241 (Ci)	3.36E+00	3.12E+01	2.88E+02	4.03E+02	7.31E+02	3.14E+03	5.15E+03	8.35E+03	1.97E-11	4.86E-11	1.27E+05
Pu-242 (Ci)	1.57E-05	2.29E-04	2.32E-03	2.65E-03	5.24E-03	2.20E-02	4.87E-02	3.55E-02	4.19E-17	8.90E-17	7.94E-01
Pu-Total (kg)	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
Am-241 (Ci)	1.26E+00	9.42E+00	7.05E+01	6.45E+01	1.54E+02	4.53E+02	6.22E+02	4.44E+02	2.85E-12	5.86E-12	8.27E+04
Am-243 (Ci)	2.16E-06	5.63E-05	7.66E-04	1.20E-03	1.71E-03	1.21E-02	6.49E-02	4.45E-02	1.01E-17	2.16E-17	4.22E+01
Cm-242 (Ci)	3.78E-06	9.70E-05	1.31E-03	2.20E-03	2.91E-03	1.88E-02	1.16E-01	8.20E-02	0.00E+00	0.00E+00	7.33E+01
Cm-243 (Ci)	2.19E-08	1.15E-06	2.41E-05	7.94E-05	5.44E-05	9.84E-04	3.27E-02	1.25E-02	3.85E-19	8.81E-19	7.74E+00
Cm-244 (Ci)	5.13E-07	2.70E-05	5.89E-04	2.16E-03	1.42E-03	3.05E-02	7.01E-01	3.19E-01	8.38E-18	2.00E-17	1.92E+02

Table D-1. Input to HDW Worksheet. (Sheet 3)

loss factors (fraction lost)	BT1	BT2	R1	R2	P1	P2	P2Prime	P3AZ1	P3AZ2	TH1	TH2
H-3 (Ci)	0.00E+00	0.00E+00	6.60E-01	5.80E-01	9.89E-01	9.89E-01	9.72E-01	8.72E-01	8.72E-01	9.89E-01	9.72E-01
C-14 (Ci)	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01	8.20E-01
Ni-59 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Se-79 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-93 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-93m (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99 (Ci)	0.00E+00	0.00E+00	1.30E-01	1.30E-01	2.80E-01	2.80E-01	2.80E-01	2.80E-01	2.80E-01	0.00E+00	0.00E+00
Ru-106 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-113m (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-125 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-126 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129 (Ci)	6.64E-01	6.70E-02	1.25E-02	5.00E-02	9.90E-02	9.90E-02	5.50E-01	5.42E-01	5.42E-01	9.90E-02	5.50E-01
Cs-134 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-137m (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-154 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-155 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-226 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-228 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ac-227 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pa-231 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-229 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-232 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-233 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-234 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-235 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-238 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-Total (mols)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-237 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-238 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-239 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-240 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-241 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-Total (kg)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-242 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-243 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-244 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D-1. Input to HDW Worksheet. (Sheet 4)

loss factors (fraction lost)	CWBT1	CWBT2	CWR1	CWR2	CWP1	CWP2	CWZr1	CWZr2	CWTH1	CWTH2
H-3 (Ci)	9.77E-01	9.77E-01	9.77E-01	9.77E-01	9.77E-01	9.77E-01	0.00E+00	0.00E+00	9.77E-01	9.77E-01
C-14 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-59 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ni-63 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-60 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Se-79 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-93 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-93m (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tc-99 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cd-113m (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sb-125 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-126 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-137 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ba-137m (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sm-151 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-154 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-155 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-226 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-228 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ac-227 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pa-231 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-229 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-232 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-233 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-234 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-235 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-236 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-238 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
U-Total (mols)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Np-237 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-238 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-239 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-240 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-241 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-242 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pu-Total (kg)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-243 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-242 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-243 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-244 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D-1. Input to HDW Worksheet. (Sheet 5)

Inventory Retained	BT1	BT2	R1	R2	P1	P2	P2Prime	P3AZ1	P3AZ2	TH1	TH2
H-3 (Ci)	6.15E+02	1.82E+03	2.58E+03	6.26E+03	3.93E+02	4.21E+02	9.03E+02	2.20E+03	1.33E+03	4.51E-01	2.90E+00
C-14 (Ci)	1.89E+01	4.12E+01	1.41E+02	3.90E+01	2.51E+02	1.08E+02	5.76E+01	6.97E+00	3.73E+00	1.88E-04	4.00E-04
Ni-59 (Ci)	4.95E+00	1.08E+01	3.70E+01	3.80E+01	1.35E+02	1.05E+02	6.53E+01	2.11E+01	1.14E+01	8.09E-03	1.72E-02
Ni-63 (Ci)	4.22E+02	9.51E+02	3.34E+03	3.60E+03	1.25E+04	1.01E+04	6.29E+03	2.04E+03	1.11E+03	6.89E-01	1.50E+00
Co-60 (Ci)	8.97E+00	3.78E+01	1.91E+02	5.40E+02	1.23E+03	1.89E+03	2.09E+03	4.38E+03	3.07E+03	1.38E-02	4.42E-02
Se-79 (Ci)	8.45E-01	1.87E+00	6.53E+00	8.42E+00	2.39E+01	1.91E+01	1.30E+01	3.34E+00	1.85E+00	3.21E-02	6.82E-02
Sr-90 (Ci)	6.56E+05	1.61E+06	5.93E+06	9.19E+06	2.39E+07	2.16E+07	1.60E+07	5.52E+06	3.21E+06	2.01E+04	4.61E+04
Y-90 (Ci)	6.56E+05	1.61E+06	5.93E+06	9.19E+06	2.39E+07	2.16E+07	1.60E+07	5.52E+06	3.21E+06	2.01E+04	4.61E+04
Zr-93 (Ci)	5.16E+01	1.13E+02	3.91E+02	5.04E+02	1.42E+03	1.14E+03	7.73E+02	2.02E+02	1.12E+02	8.54E-01	1.82E+00
Nb-93m (Ci)	4.65E+01	9.90E+01	3.36E+02	4.06E+02	1.18E+03	8.96E+02	5.80E+02	1.14E+02	5.93E+01	6.69E-01	1.37E+00
Tc-99 (Ci)	3.69E+02	8.18E+02	2.48E+03	3.15E+03	7.49E+03	5.97E+03	3.98E+03	9.86E+02	5.46E+02	3.62E+00	7.70E+00
Ru-106 (Ci)	2.02E-09	1.79E-07	5.21E-06	1.50E-03	3.75E-04	8.74E-03	8.55E-02	3.45E+02	7.06E+02	9.54E-07	1.98E-05
Cd-113m (Ci)	1.99E+01	6.16E+01	2.69E+02	5.02E+02	1.26E+03	1.31E+03	1.14E+03	6.03E+02	3.46E+02	1.69E+00	4.17E+00
Sb-125 (Ci)	2.60E-01	2.16E+00	1.66E+01	1.53E+02	1.86E+02	5.38E+02	1.01E+03	8.91E+03	7.99E+03	7.57E-01	3.58E+00
Sn-126 (Ci)	3.05E+00	7.20E+00	2.64E+01	3.41E+01	9.87E+01	7.96E+01	5.60E+01	1.49E+01	8.09E+00	1.05E-01	2.24E-01
I-129 (Ci)	1.64E-01	1.04E+00	3.97E+00	4.88E+00	1.34E+01	1.08E+01	3.67E+00	9.62E-01	5.24E-01	1.03E-02	1.09E-02
Cs-134 (Ci)	1.01E-03	2.23E-02	3.70E-01	1.12E+01	7.05E+00	3.53E+01	1.44E+02	4.09E+03	3.85E+03	2.30E-02	1.44E-01
Cs-137 (Ci)	7.53E+05	1.87E+06	7.01E+06	1.07E+07	2.84E+07	2.56E+07	1.88E+07	6.31E+06	3.62E+06	1.73E+04	3.94E+04
Ba-137m (Ci)	7.11E+05	1.77E+06	6.62E+06	1.02E+07	2.68E+07	2.41E+07	1.78E+07	5.96E+06	3.42E+06	1.63E+04	3.72E+04
Sm-151 (Ci)	3.79E+04	8.14E+04	2.74E+05	3.47E+05	1.01E+06	8.23E+05	5.08E+05	1.33E+05	7.58E+04	3.64E+02	7.93E+02
Eu-152 (Ci)	4.69E-01	3.89E+00	2.78E+01	9.46E+01	1.51E+02	1.90E+02	3.26E+02	1.83E+02	9.32E+01	1.03E-01	2.57E-01
Eu-154 (Ci)	4.54E+01	2.86E+02	1.88E+03	6.28E+03	1.12E+04	1.52E+04	2.34E+04	2.15E+04	1.18E+04	4.11E+00	1.12E+01
Eu-155 (Ci)	3.69E+01	1.57E+02	7.72E+02	2.63E+03	5.13E+03	8.42E+03	8.60E+03	1.46E+04	1.09E+04	1.47E+00	4.93E+00
Ra-226 (Ci)	6.21E-03	6.74E-03	3.75E-04	5.16E-04	9.41E-04	8.43E-04	7.52E-04	2.99E-04	1.51E-04	1.03E-04	3.73E-04
Ra-228 (Ci)	2.08E-08	3.98E-08	2.11E-09	4.46E-09	5.79E-09	6.89E-09	1.04E-08	1.70E-08	1.00E-08	4.53E-01	1.14E+00
Ac-227 (Ci)	2.90E-02	3.23E-02	1.61E-03	2.14E-03	4.19E-03	3.90E-03	3.63E-03	1.48E-03	7.79E-04	1.49E+00	3.00E+00
Pa-231 (Ci)	5.57E-02	6.60E-02	2.39E-03	3.13E-03	5.97E-03	5.96E-03	5.92E-03	3.29E-03	1.91E-03	2.19E+00	4.66E+00
Th-229 (Ci)	2.94E-06	5.63E-06	7.91E-06	2.80E-06	1.57E-05	5.11E-06	3.55E-06	1.97E-06	1.00E-06	3.85E-01	7.03E-01
Th-232 (Ci)	2.46E-08	4.79E-08	2.27E-09	4.57E-09	5.97E-09	7.17E-09	1.09E-08	1.93E-08	1.17E-08	4.24E-01	9.01E-01
U-232 (Ci)	9.50E-03	2.23E-02	7.25E-04	4.53E-04	1.06E-03	1.38E-03	4.40E-03	4.26E-03	2.07E-03	1.82E+00	3.99E+00
U-233 (Ci)	8.41E-04	1.75E-03	3.57E-03	1.29E-03	7.47E-03	2.51E-03	1.60E-03	1.37E-03	6.40E-04	1.16E+02	2.37E+02
U-234 (Ci)	1.09E+03	1.47E+03	1.78E+01	5.94E+00	1.55E+01	1.77E+01	1.54E+01	1.23E+01	6.90E+00	8.79E-01	1.87E+00
U-235 (Ci)	4.90E+01	6.49E+01	7.67E-01	2.25E-01	6.63E-01	7.39E-01	6.63E-01	4.59E-01	2.75E-01	3.12E-06	6.63E-06
U-236 (Ci)	9.28E+00	1.99E+01	3.69E-01	1.72E-01	3.42E-01	4.54E-01	7.55E-01	1.17E+00	6.81E-01	5.44E-07	1.16E-06
U-238 (Ci)	1.11E+03	1.50E+03	1.83E+01	4.15E+00	1.59E+01	1.73E+01	1.16E+01	8.45E+00	4.75E+00	4.87E-14	1.03E-13
U-Total (mols)	1.39E+07	1.88E+07	2.30E+05	5.23E+04	2.00E+05	2.18E+05	1.46E+05	1.07E+05	6.00E+04	5.23E+01	1.07E+02
Np-237 (Ci)	2.25E+00	5.08E+00	1.81E+01	7.76E+00	4.09E+01	1.61E+01	1.17E+01	1.95E+01	1.06E+01	4.02E-07	8.55E-07
Pu-238 (Ci)	4.85E+00	2.65E+01	4.86E+01	7.66E+01	1.28E+02	1.50E+02	5.57E+02	4.99E+02	2.51E+02	6.85E-05	1.49E-04
Pu-239 (Ci)	1.40E+03	2.99E+03	2.56E+03	1.12E+03	5.18E+03	3.12E+03	4.94E+03	4.72E+03	2.53E+03	3.47E-09	7.38E-09
Pu-240 (Ci)	9.46E+01	3.78E+02	4.97E+02	2.62E+02	1.04E+03	7.66E+02	1.73E+03	1.35E+03	6.91E+02	2.39E-10	5.08E-10
Pu-241 (Ci)	9.16E+01	8.31E+02	1.73E+03	1.99E+03	4.57E+03	6.82E+03	3.27E+04	4.04E+04	2.01E+04	9.20E-10	2.27E-09
Pu-242 (Ci)	4.28E-04	6.04E-03	1.51E-02	1.51E-02	3.25E-02	5.54E-02	2.95E-01	1.75E-01	8.31E-02	1.95E-15	4.15E-15
Pu-Total (kg)	2.30E+01	4.98E+01	4.34E+01	1.92E+01	8.81E+01	5.38E+01	8.76E+01	8.24E+01	4.40E+01	4.06E-09	8.83E-09
Am-241 (Ci)	4.89E+01	3.56E+02	1.67E+03	3.80E+03	6.04E+03	8.39E+03	2.07E+04	2.42E+04	1.57E+04	1.33E-10	2.74E-10
Am-243 (Ci)	2.11E-03	5.52E-02	6.10E-01	3.29E+00	2.78E+00	4.47E+00	1.98E+01	7.57E+00	3.50E+00	4.73E-16	1.01E-15
Cm-242 (Ci)	3.70E-03	9.50E-02	1.02E+00	5.95E+00	4.73E+00	7.78E+00	3.31E+01	1.40E+01	6.38E+00	8.94E-16	5.54E-16
Cm-243 (Ci)	2.19E-05	1.15E-03	1.82E-02	4.61E-01	9.26E-02	4.67E-01	3.57E+00	2.17E+00	9.15E-01	1.80E-17	4.11E-17
Cm-244 (Ci)	5.13E-04	2.70E-02	4.50E-01	1.02E+01	2.45E+00	1.09E+01	8.74E+01	5.63E+01	2.27E+01	3.91E-16	9.35E-16

Table D-1. Input to HDW Worksheet. (Sheet 6)

Inventory Retained	CWBT1	CWBT2	CWR1	CWR2	CWP1	CWP2	CWZr1	CWZr2	CWTH1	CWTH2
H-3 (Ci)	1.21E+02	3.45E+02	1.70E+03	1.84E+03	3.91E+03	1.31E+04	1.39E+03	3.28E+03	1.60E+02	4.05E+02
C-14 (Ci)	2.11E+00	4.62E+00	1.86E+01	1.25E+01	3.68E+01	8.41E+01	3.00E+01	3.97E+01	1.00E+00	2.13E+00
Ni-59 (Ci)	3.11E-01	6.80E-01	2.24E+01	9.13E+01	1.45E+02	6.13E+02	1.50E+00	8.17E-01	8.08E+00	1.72E+01
Ni-63 (Ci)	7.58E+01	1.39E+02	2.18E+03	8.74E+03	1.36E+04	5.94E+04	1.30E+02	7.84E+01	6.88E+02	1.49E+03
Co-60 (Ci)	3.76E+00	1.59E+01	1.03E+02	1.92E+02	2.88E+02	1.63E+03	5.89E+01	2.65E+02	1.38E+01	4.41E+01
Se-79 (Ci)	8.46E-04	1.87E-03	7.85E-03	6.66E-03	1.53E-02	3.72E-02	3.90E-02	2.10E-02	6.87E-04	1.46E-03
Sr-90 (Ci)	6.57E+02	1.61E+03	7.25E+03	7.38E+03	1.49E+04	4.24E+04	4.41E+04	3.53E+04	4.31E+02	9.87E+02
Y-90 (Ci)	6.57E+02	1.61E+03	7.25E+03	7.39E+03	1.49E+04	4.24E+04	4.41E+04	3.53E+04	4.31E+02	9.87E+02
Zr-93 (Ci)	5.17E-02	1.13E-01	4.70E-01	3.99E-01	9.10E-01	2.21E+00	3.68E+00	1.99E+00	1.83E-02	3.89E-02
Nb-93m (Ci)	4.65E-02	9.91E-02	4.02E-01	3.20E-01	7.64E-01	1.74E+00	2.84E+00	1.10E+00	1.43E-02	2.93E-02
Tc-99 (Ci)	3.70E-01	8.19E-01	3.42E+00	2.86E+00	6.65E+00	1.61E+01	8.83E+01	1.14E+02	7.76E-02	1.65E-01
Ru-106 (Ci)	2.02E-12	1.79E-10	1.40E-08	1.19E-06	9.04E-08	5.72E-05	1.67E-04	4.25E+00	2.04E-08	4.25E-07
Cd-113m (Ci)	1.59E+00	4.45E+00	2.16E+01	2.25E+01	4.91E+01	1.58E+02	3.80E+00	3.96E+00	1.75E+00	4.33E+00
Sb-125 (Ci)	3.08E-02	1.21E-01	2.13E-01	1.53E-01	1.07E-01	1.60E+00	5.23E+00	1.66E+02	2.01E-02	9.49E-02
Sn-126 (Ci)	3.05E-03	7.20E-03	3.17E-02	2.67E-02	6.28E-02	1.55E-01	1.85E-01	9.30E-02	2.25E-03	4.79E-03
I-129 (Ci)	4.87E-04	1.12E-03	4.82E-03	4.03E-03	9.49E-03	2.33E-02	1.37E-01	1.74E-01	2.44E-04	5.19E-04
Cs-134 (Ci)	1.01E-06	2.23E-05	6.69E-04	7.90E-03	2.88E-03	1.07E-01	4.28E+00	4.26E+02	4.94E-04	3.10E-03
Cs-137 (Ci)	7.54E+02	1.87E+03	8.55E+03	8.59E+03	1.77E+04	5.02E+04	3.02E+05	5.33E+05	3.70E+02	8.45E+02
Ba-137m (Ci)	7.12E+02	1.77E+03	8.08E+03	8.11E+03	1.67E+04	4.74E+04	2.85E+05	5.04E+05	3.50E+02	7.98E+02
Sm-151 (Ci)	3.79E+01	8.15E+01	3.29E+02	2.79E+02	6.45E+02	1.59E+03	1.15E+03	8.45E+02	7.81E+00	1.70E+01
Eu-152 (Ci)	4.70E-04	3.89E-03	3.68E-02	6.72E-02	8.82E-02	4.11E-01	1.67E+00	1.12E+00	2.21E-03	5.50E-03
Eu-154 (Ci)	4.55E-02	2.86E-01	2.46E+00	4.48E+00	6.40E+00	3.18E+01	1.13E+02	1.35E+02	8.81E-02	2.40E-01
Eu-155 (Ci)	3.69E-02	1.57E-01	1.02E+00	2.24E+00	2.78E+00	1.76E+01	1.47E+01	1.03E+02	3.15E-02	1.06E-01
Ra-226 (Ci)	5.03E-06	5.47E-06	1.37E-05	7.85E-06	2.01E-05	3.27E-05	1.20E-05	8.41E-06	5.29E-05	1.02E-04
Ra-228 (Ci)	1.69E-11	3.23E-11	1.27E-10	1.14E-10	2.15E-10	4.50E-10	4.76E-10	6.55E-10	4.66E-01	9.84E-01
Ac-227 (Ci)	2.36E-05	2.63E-05	6.52E-05	3.55E-05	9.78E-05	1.64E-04	7.22E-05	4.04E-05	3.18E-02	6.43E-02
Pa-231 (Ci)	4.52E-05	5.36E-05	1.39E-04	8.45E-05	2.15E-04	4.01E-04	1.85E-04	1.72E-04	4.70E-02	9.98E-02
Th-229 (Ci)	2.66E-09	5.09E-09	1.89E-08	1.18E-08	3.37E-08	6.41E-08	5.36E-08	4.53E-08	1.07E-01	2.17E-01
Th-232 (Ci)	2.00E-11	3.89E-11	1.55E-10	1.45E-10	2.67E-10	5.84E-10	6.34E-10	1.09E-09	4.73E-01	1.00E+00
U-232 (Ci)	8.97E-06	2.49E-05	1.29E-04	1.41E-04	2.62E-04	7.57E-04	1.38E-03	2.34E-03	5.07E-01	1.11E+00
U-233 (Ci)	7.93E-07	1.65E-06	6.58E-06	4.78E-06	1.24E-05	2.69E-05	2.09E-05	2.86E-05	3.10E+01	6.58E+01
U-234 (Ci)	8.81E-01	1.19E+00	3.41E+00	2.77E+00	5.57E+00	1.27E+01	5.60E+00	1.24E+01	2.45E-01	5.20E-01
U-235 (Ci)	3.98E-02	5.26E-02	1.45E-01	1.05E-01	2.38E-01	5.23E-01	2.59E-01	4.75E-01	8.69E-07	1.85E-06
U-236 (Ci)	7.53E-03	1.62E-02	6.99E-02	7.78E-02	1.27E-01	3.30E-01	3.94E-01	1.20E+00	1.51E-07	3.22E-07
U-238 (Ci)	8.96E-01	1.21E+00	3.33E+00	1.93E+00	5.72E+00	1.21E+01	3.92E+00	8.54E+00	1.35E-14	2.88E-14
U-Total (mols)	1.13E+04	1.53E+04	4.19E+04	2.43E+04	7.20E+04	1.52E+05	4.96E+04	1.08E+05	1.40E+01	2.97E+01
Np-237 (Ci)	2.32E-03	5.29E-03	2.27E-02	1.86E-02	4.46E-02	1.09E-01	6.45E-02	1.22E-01	8.62E-09	1.83E-08
Pu-238 (Ci)	1.77E-01	9.48E-01	6.56E+00	7.25E+00	1.43E+01	4.45E+01	6.64E+01	1.01E+02	1.47E-06	3.20E-06
Pu-239 (Ci)	5.15E+01	1.07E+02	4.12E+02	2.84E+02	8.09E+02	1.84E+03	6.53E+02	1.00E+03	7.44E-11	1.58E-10
Pu-240 (Ci)	3.47E+00	1.40E+01	7.83E+01	6.25E+01	1.69E+02	4.34E+02	2.52E+02	2.82E+02	5.12E-12	1.09E-11
Pu-241 (Ci)	3.36E+00	3.12E+01	2.88E+02	4.03E+02	7.31E+02	3.14E+03	5.15E+03	8.35E+03	1.97E-11	4.86E-11
Pu-242 (Ci)	1.57E-05	2.29E-04	2.32E-03	2.65E-03	5.24E-03	2.20E-02	4.87E-02	3.55E-02	4.19E-17	8.90E-17
Pu-Total (kg)	8.45E-01	1.78E+00	6.99E+00	4.86E+00	1.38E+01	3.16E+01	1.17E+01	1.74E+01	8.69E-11	1.89E-10
Am-241 (Ci)	1.26E+00	9.42E+00	7.05E+01	6.45E+01	1.54E+02	4.53E+02	6.22E+02	4.44E+02	2.85E-12	5.86E-12
Am-243 (Ci)	2.16E-06	5.63E-05	7.66E-04	1.20E-03	1.71E-03	1.21E-02	6.49E-02	4.45E-02	1.01E-17	2.16E-17
Cm-242 (Ci)	3.78E-06	9.70E-05	1.31E-03	2.20E-03	2.91E-03	1.88E-02	1.16E-01	8.20E-02	0.00E+00	0.00E+00
Cm-243 (Ci)	2.19E-08	1.15E-06	2.41E-05	7.94E-05	5.44E-05	9.84E-04	3.27E-02	1.25E-02	3.85E-19	8.81E-19
Cm-244 (Ci)	5.13E-07	2.70E-05	5.89E-04	2.16E-03	1.42E-03	3.05E-02	7.01E-01	3.19E-01	8.38E-18	2.00E-17

Table D-1. Input to HDW Worksheet. (Sheet 7)

input to HDW	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	1CFeCN	R1	R2
H-3 (Ci)	6.15E+02	1.82E+03	7.36E+02	2.17E+03	6.15E+02	1.82E+03	6.15E+02	1.82E+03	3.56E+02	2.58E+03	6.26E+03
C-14 (Ci)	1.89E+01	4.12E+01	2.10E+01	4.59E+01	1.89E+01	4.12E+01	1.89E+01	4.12E+01	3.97E+01	1.41E+02	3.90E+01
Ni-59 (Ci)	4.95E+00	1.08E+01	5.26E+00	1.14E+01	4.95E+00	1.08E+01	4.95E+00	1.08E+01	1.87E+00	3.70E+01	3.80E+01
Ni-63 (Ci)	4.22E+02	9.51E+02	4.98E+02	1.09E+03	4.22E+02	9.51E+02	4.22E+02	9.51E+02	1.68E+02	3.34E+03	3.60E+03
Co-60 (Ci)	8.97E+00	3.78E+01	1.27E+01	5.37E+01	8.97E+00	3.78E+01	8.97E+00	3.78E+01	9.12E+00	1.91E+02	5.40E+02
Se-79 (Ci)	8.45E-01	1.87E+00	8.46E-01	1.87E+00	8.45E-01	1.87E+00	8.45E-01	1.87E+00	3.19E-01	6.53E+00	8.42E+00
Sr-90 (Ci)	6.56E+05	1.61E+06	6.57E+05	1.61E+06	6.56E+05	1.61E+06	6.56E+05	1.61E+06	2.98E+05	5.93E+06	9.19E+06
Y-90 (Ci)	6.56E+05	1.61E+06	6.57E+05	1.61E+06	6.56E+05	1.61E+06	6.56E+05	1.61E+06	2.98E+05	5.93E+06	9.19E+06
Zr-93 (Ci)	5.16E+01	1.13E+02	5.17E+01	1.13E+02	5.16E+01	1.13E+02	5.16E+01	1.13E+02	1.95E+01	3.91E+02	5.04E+02
Nb-93m (Ci)	4.65E+01	9.90E+01	4.65E+01	9.91E+01	4.65E+01	9.90E+01	4.65E+01	9.90E+01	1.68E+01	3.36E+02	4.06E+02
Tc-99 (Ci)	3.69E+02	8.18E+02	3.70E+02	8.19E+02	3.69E+02	8.18E+02	3.69E+02	8.18E+02	1.39E+02	2.48E+03	3.15E+03
Ru-106 (Ci)	2.02E-09	1.79E-07	2.02E-09	1.79E-07	2.02E-09	1.79E-07	2.02E-09	1.79E-07	9.26E-08	5.21E-06	1.50E-03
Cd-113m (Ci)	1.99E+01	6.16E+01	2.15E+01	6.61E+01	1.99E+01	6.16E+01	1.99E+01	6.16E+01	1.09E+01	2.69E+02	5.02E+02
Sb-125 (Ci)	2.60E-01	2.16E+00	2.91E-01	2.28E+00	2.60E-01	2.16E+00	2.60E-01	2.16E+00	6.35E-01	1.66E+01	1.53E+02
Sn-126 (Ci)	3.05E+00	7.20E+00	3.05E+00	7.20E+00	3.05E+00	7.20E+00	3.05E+00	7.20E+00	1.15E+00	2.64E+01	3.41E+01
I-129 (Ci)	1.64E-01	1.04E+00	1.64E-01	1.04E+00	1.64E-01	1.04E+00	1.64E-01	1.04E+00	1.84E-01	3.97E+00	4.88E+00
Cs-134 (Ci)	1.01E-03	2.23E-02	1.01E-03	2.23E-02	1.01E-03	2.23E-02	1.01E-03	2.23E-02	4.18E-03	3.70E-01	1.12E+01
Cs-137 (Ci)	7.53E+05	1.87E+06	7.54E+05	1.87E+06	7.53E+05	1.87E+06	7.53E+05	1.87E+06	3.39E+05	7.01E+06	1.07E+07
Ba-137m (Ci)	7.11E+05	1.77E+06	7.12E+05	1.77E+06	7.11E+05	1.77E+06	7.11E+05	1.77E+06	3.20E+05	6.62E+06	1.02E+07
Sm-151 (Ci)	3.79E+04	8.14E+04	3.79E+04	8.15E+04	3.79E+04	8.14E+04	3.79E+04	8.14E+04	1.51E+04	2.74E+05	3.47E+05
Eu-152 (Ci)	4.69E-01	3.89E+00	4.70E-01	3.89E+00	4.69E-01	3.89E+00	4.69E-01	3.89E+00	2.52E-01	2.78E+01	9.46E+01
Eu-154 (Ci)	4.54E+01	2.86E+02	4.55E+01	2.86E+02	4.54E+01	2.86E+02	4.54E+01	2.86E+02	3.15E+01	1.88E+03	6.28E+03
Eu-155 (Ci)	3.69E+01	1.57E+02	3.69E+01	1.57E+02	3.69E+01	1.57E+02	3.69E+01	1.57E+02	4.17E+01	7.72E+02	2.63E+03
Ra-226 (Ci)	6.21E-03	6.74E-03	6.21E-03	6.75E-03	6.21E-03	6.74E-03	6.21E-03	6.74E-03	1.63E-03	3.75E-04	5.16E-04
Ra-228 (Ci)	2.08E-08	3.98E-08	2.08E-08	3.98E-08	2.08E-08	3.98E-08	2.08E-08	3.98E-08	6.52E-09	2.11E-09	4.46E-09
Ac-227 (Ci)	2.90E-02	3.23E-02	2.91E-02	3.23E-02	2.90E-02	3.23E-02	2.90E-02	3.23E-02	8.09E-03	1.61E-03	2.14E-03
Pa-231 (Ci)	5.57E-02	6.60E-02	5.58E-02	6.61E-02	5.57E-02	6.60E-02	5.57E-02	6.60E-02	1.70E-02	2.39E-03	3.13E-03
Th-229 (Ci)	2.94E-06	5.63E-06	2.94E-06	5.63E-06	2.94E-06	5.63E-06	2.94E-06	5.63E-06	8.90E-07	7.91E-06	2.80E-06
Th-232 (Ci)	2.46E-08	4.79E-08	2.46E-08	4.80E-08	2.46E-08	4.79E-08	2.46E-08	4.79E-08	7.96E-09	2.27E-09	4.57E-09
U-232 (Ci)	9.50E-03	2.23E-02	9.51E-03	2.24E-02	9.50E-03	2.23E-02	9.50E-03	2.23E-02	3.88E-03	7.25E-04	4.53E-04
U-233 (Ci)	8.41E-04	1.75E-03	8.42E-04	1.76E-03	8.41E-04	1.75E-03	8.41E-04	1.75E-03	2.89E-04	3.57E-03	1.29E-03
U-234 (Ci)	1.09E+03	1.47E+03	1.09E+03	1.47E+03	1.09E+03	1.47E+03	1.09E+03	1.47E+03	3.89E+02	1.78E+01	5.94E+00
U-235 (Ci)	4.90E+01	6.49E+01	4.91E+01	6.49E+01	4.90E+01	6.49E+01	4.90E+01	6.49E+01	1.75E+01	7.67E-01	2.25E-01
U-236 (Ci)	9.28E+00	1.99E+01	9.29E+00	1.99E+01	9.28E+00	1.99E+01	9.28E+00	1.99E+01	3.50E+00	3.69E-01	1.72E-01
U-238 (Ci)	1.11E+03	1.50E+03	1.11E+03	1.50E+03	1.11E+03	1.50E+03	1.11E+03	1.50E+03	3.96E+02	1.83E+01	4.15E+00
U-Total (mols)	1.39E+07	1.88E+07	1.39E+07	1.88E+07	1.39E+07	1.88E+07	1.39E+07	1.88E+07	4.99E+06	2.30E+05	5.23E+04
Np-237 (Ci)	2.25E+00	5.08E+00	2.26E+00	5.09E+00	2.25E+00	5.08E+00	2.25E+00	5.08E+00	8.51E-01	1.81E+01	7.76E+00
Pu-238 (Ci)	4.85E+00	2.65E+01	5.03E+00	2.74E+01	4.85E+00	2.65E+01	4.85E+00	2.65E+01	2.30E+00	4.86E+01	7.66E+01
Pu-239 (Ci)	1.40E+03	2.99E+03	1.45E+03	3.09E+03	1.40E+03	2.99E+03	1.40E+03	2.99E+03	6.36E+02	2.56E+03	1.12E+03
Pu-240 (Ci)	9.46E+01	3.78E+02	9.81E+01	3.92E+02	9.46E+01	3.78E+02	9.46E+01	3.78E+02	4.32E+01	4.97E+02	2.62E+02
Pu-241 (Ci)	9.16E+01	8.31E+02	9.49E+01	8.62E+02	9.16E+01	8.31E+02	9.16E+01	8.31E+02	5.57E+01	1.73E+03	1.99E+03
Pu-242 (Ci)	4.28E-04	6.04E-03	4.44E-04	6.27E-03	4.28E-04	6.04E-03	4.28E-04	6.04E-03	1.59E-04	1.51E-02	1.51E-02
Pu-Total (kg)	2.30E+01	4.98E+01	2.39E+01	5.16E+01	2.30E+01	4.98E+01	2.30E+01	4.98E+01	1.04E+01	4.34E+01	1.92E+01
Am-241 (Ci)	4.89E+01	3.56E+02	5.01E+01	3.66E+02	4.89E+01	3.56E+02	4.89E+01	3.56E+02	2.22E+01	1.67E+03	3.80E+03
Am-243 (Ci)	2.11E-03	5.52E-02	2.11E-03	5.52E-02	2.11E-03	5.52E-02	2.11E-03	5.52E-02	5.43E-04	6.10E-01	3.29E+00
Cm-242 (Ci)	3.70E-03	9.50E-02	3.70E-03	9.51E-02	3.70E-03	9.50E-02	3.70E-03	9.50E-02	9.95E-04	1.02E+00	5.95E+00
Cm-243 (Ci)	2.19E-05	1.15E-03	2.19E-05	1.15E-03	2.19E-05	1.15E-03	2.19E-05	1.15E-03	4.52E-06	1.82E-02	4.61E-01
Cm-244 (Ci)	5.13E-04	2.70E-02	5.13E-04	2.70E-02	5.13E-04	2.70E-02	5.13E-04	2.70E-02	1.27E-04	4.50E-01	1.02E+01

Table D-1. Input to HDW Worksheet. (Sheet 8)

Input to HDW	CWR1	CWR2	P1	P2	P2'	PL1	CWP1	CWP2	CWZr1	OWW1	OWW2
H-3 (Ci)	1.70E+03	1.84E+03	3.93E+02	4.21E+02	9.03E+02	9.06E+02	3.91E+03	1.37E+04	1.39E+03	3.93E+02	4.21E+02
C-14 (Ci)	1.86E+01	1.25E+01	2.51E+02	1.08E+02	5.76E+01	5.76E+01	3.68E+01	8.72E+01	3.00E+01	2.51E+02	1.08E+02
Ni-59 (Ci)	2.24E+01	9.13E+01	1.35E+02	1.05E+02	6.53E+01	6.53E+01	1.45E+02	6.38E+02	1.50E+00	1.35E+02	1.05E+02
Ni-63 (Ci)	2.18E+03	8.74E+03	1.25E+04	1.01E+04	6.29E+03	6.30E+03	1.36E+04	6.16E+04	1.30E+02	1.25E+04	1.01E+04
Co-60 (Ci)	1.03E+02	1.92E+02	1.23E+03	1.89E+03	2.09E+03	2.09E+03	2.88E+02	1.69E+03	5.89E+01	1.23E+03	1.89E+03
Se-79 (Ci)	7.85E-03	6.66E-03	2.39E+01	1.91E+01	1.30E+01	1.31E+01	1.53E-02	3.94E-02	3.90E-02	2.39E+01	1.91E+01
Sr-90 (Ci)	7.25E+03	7.38E+03	2.39E+07	2.16E+07	1.60E+07	1.60E+07	1.49E+04	4.38E+04	4.41E+04	2.39E+07	2.16E+07
Y-90 (Ci)	7.25E+03	7.39E+03	2.39E+07	2.16E+07	1.60E+07	1.61E+07	1.49E+04	4.38E+04	4.41E+04	2.39E+07	2.16E+07
Zr-93 (Ci)	4.70E-01	3.99E-01	1.42E+03	1.14E+03	7.73E+02	7.75E+02	9.10E-01	2.27E+00	3.68E+00	1.42E+03	1.14E+03
Nb-93m (Ci)	4.02E-01	3.20E-01	1.18E+03	8.96E+02	5.80E+02	5.81E+02	7.64E-01	1.78E+00	2.84E+00	1.18E+03	8.97E+02
Tc-99 (Ci)	3.42E+00	2.86E+00	7.49E+03	5.97E+03	3.98E+03	3.99E+03	6.65E+00	1.64E+01	8.83E+01	7.49E+03	5.97E+03
Ru-106 (Ci)	1.40E-08	1.19E-06	3.75E-04	8.74E-03	8.55E-02	8.55E-02	9.04E-08	5.77E-05	1.67E-04	3.75E-04	8.74E-03
Cd-113m (Ci)	2.16E+01	2.25E+01	1.26E+03	1.31E+03	1.14E+03	1.15E+03	4.91E+01	1.64E+02	3.80E+00	1.26E+03	1.31E+03
Sb-125 (Ci)	2.13E-01	1.53E-01	1.86E+02	5.38E+02	1.01E+03	1.02E+03	1.07E-01	1.72E+00	5.23E+00	1.86E+02	5.39E+02
Sn-126 (Ci)	3.17E-02	2.67E-02	9.87E+01	7.96E+01	5.60E+01	5.62E+01	6.28E-02	1.62E-01	1.85E-01	9.87E+01	7.97E+01
I-129 (Ci)	4.82E-03	4.03E-03	4.46E-01	3.58E-01	2.45E-01	0.00E+00	6.65E+00	1.42E+01	1.37E-01	2.53E+00	2.03E+00
Cs-134 (Ci)	6.69E-04	7.90E-03	7.05E+00	3.53E+01	1.44E+02	1.44E+02	2.88E-03	1.11E-01	4.28E+00	7.05E+00	3.54E+01
Cs-137 (Ci)	8.55E+03	8.59E+03	2.84E+07	2.56E+07	1.88E+07	1.89E+07	1.77E+04	5.14E+04	3.02E+05	2.84E+07	2.56E+07
Ba-137m (Ci)	8.08E+03	8.11E+03	2.68E+07	2.41E+07	1.78E+07	1.78E+07	1.67E+04	4.85E+04	2.85E+05	2.68E+07	2.42E+07
Sm-151 (Ci)	3.29E+02	2.79E+02	1.01E+06	8.23E+05	5.08E+05	5.09E+05	6.45E+02	1.62E+03	1.15E+03	1.01E+06	8.24E+05
Eu-152 (Ci)	3.68E-02	6.72E-02	1.51E+02	1.90E+02	3.26E+02	3.26E+02	8.82E-02	4.19E-01	1.67E+00	1.51E+02	1.90E+02
Eu-154 (Ci)	2.46E+00	4.48E+00	1.12E+04	1.52E+04	2.34E+04	2.34E+04	6.40E+00	3.21E+01	1.13E+02	1.12E+04	1.52E+04
Eu-155 (Ci)	1.02E+00	2.24E+00	5.13E+03	8.42E+03	8.60E+03	8.61E+03	2.78E+00	1.78E+01	1.47E+01	5.13E+03	8.42E+03
Ra-226 (Ci)	1.37E-05	7.85E-06	9.41E-04	8.43E-04	7.52E-04	1.12E-03	2.01E-05	1.88E-04	1.20E-05	9.41E-04	9.46E-04
Ra-228 (Ci)	1.27E-10	1.14E-10	5.79E-09	6.89E-09	1.04E-08	1.14E+00	2.15E-10	1.45E+00	4.76E-10	5.79E-09	4.53E-01
Ac-227 (Ci)	6.52E-05	3.55E-05	4.19E-03	3.90E-03	3.63E-03	3.01E+00	9.78E-05	9.63E-02	7.22E-05	4.19E-03	1.49E+00
Pa-231 (Ci)	1.39E-04	8.45E-05	5.97E-03	5.96E-03	5.92E-03	4.67E+00	2.15E-04	1.47E-01	1.85E-04	5.97E-03	2.20E+00
Th-229 (Ci)	1.89E-08	1.18E-08	1.57E-05	5.11E-06	3.55E-06	7.03E-01	3.37E-08	3.24E-01	5.36E-08	1.57E-05	3.85E-01
Th-232 (Ci)	1.55E-10	1.45E-10	5.97E-09	7.17E-09	1.09E-08	9.01E-01	2.67E-10	1.48E+00	6.34E-10	5.97E-09	4.24E-01
U-232 (Ci)	1.29E-04	1.41E-04	1.06E-03	1.38E-03	4.40E-03	3.99E+00	2.62E-04	1.62E+00	1.38E-03	1.06E-03	1.82E+00
U-233 (Ci)	6.58E-06	4.78E-06	7.47E-03	2.51E-03	1.60E-03	2.37E+02	1.24E-05	9.68E+01	2.09E-05	7.47E-03	1.16E+02
U-234 (Ci)	3.41E+00	2.77E+00	1.55E+01	1.77E+01	1.54E+01	1.72E+01	5.57E+00	1.34E+01	5.60E+00	1.55E+01	1.86E+01
U-235 (Ci)	1.45E-01	1.05E-01	6.63E-01	7.39E-01	6.63E-01	6.63E-01	2.38E-01	5.23E-01	2.59E-01	6.63E-01	7.39E-01
U-236 (Ci)	6.99E-02	7.78E-02	3.42E-01	4.54E-01	7.55E-01	7.55E-01	1.27E-01	3.30E-01	3.94E-01	3.42E-01	4.54E-01
U-238 (Ci)	3.33E+00	1.93E+00	1.59E+01	1.73E+01	1.16E+01	1.16E+01	5.72E+00	1.21E+01	3.92E+00	1.59E+01	1.73E+01
U-Total (mols)	4.19E+04	2.43E+04	2.00E+05	2.18E+05	1.46E+05	1.46E+05	7.20E+04	1.52E+05	4.96E+04	2.00E+05	2.18E+05
Np-237 (Ci)	2.27E-02	1.86E-02	4.09E+01	1.61E+01	1.17E+01	1.17E+01	4.46E-02	1.09E-01	6.45E-02	4.09E+01	1.61E+01
Pu-238 (Ci)	6.56E+00	7.25E+00	1.28E+02	1.50E+02	5.57E+02	5.57E+02	1.43E+01	4.45E+01	6.64E+01	1.28E+02	1.50E+02
Pu-239 (Ci)	4.12E+02	2.84E+02	5.18E+03	3.12E+03	4.94E+03	4.94E+03	8.09E+02	1.84E+03	6.53E+02	5.18E+03	3.12E+03
Pu-240 (Ci)	7.83E+01	6.25E+01	1.04E+03	7.66E+02	1.73E+03	1.73E+03	1.69E+02	4.34E+02	2.52E+02	1.04E+03	7.66E+02
Pu-241 (Ci)	2.88E+02	4.03E+02	4.57E+03	6.82E+03	3.27E+04	3.27E+04	7.31E+02	3.14E+03	5.15E+03	4.57E+03	6.82E+03
Pu-242 (Ci)	2.32E-03	2.65E-03	3.25E-02	5.54E-02	2.95E-01	2.95E-01	5.24E-03	2.20E-02	4.87E-02	3.25E-02	5.54E-02
Pu-Total (kg)	6.99E+00	4.86E+00	8.81E+01	5.38E+01	8.76E+01	8.76E+01	1.38E+01	3.16E+01	1.17E+01	8.81E+01	5.38E+01
Am-241 (Ci)	7.05E+01	6.45E+01	6.04E+03	8.39E+03	2.07E+04	2.07E+04	1.54E+02	4.53E+02	6.22E+02	6.04E+03	8.39E+03
Am-243 (Ci)	7.66E-04	1.20E-03	2.78E+00	4.47E+00	1.98E+01	1.98E+01	1.71E-03	1.21E-02	6.49E-02	2.78E+00	4.47E+00
Cm-242 (Ci)	1.31E-03	2.20E-03	4.73E+00	7.78E+00	3.31E+01	3.31E+01	2.91E-03	1.88E-02	1.16E-01	4.73E+00	7.78E+00
Cm-243 (Ci)	2.41E-05	7.94E-05	9.26E-02	4.67E-01	3.57E+00	3.57E+00	5.44E-05	9.84E-04	3.27E-02	9.26E-02	4.67E-01
Cm-244 (Ci)	5.89E-04	2.16E-03	2.45E+00	1.09E+01	8.74E+01	8.74E+01	1.42E-03	3.05E-02	7.01E-01	2.45E+00	1.09E+01

Table D-1. Input to HDW Worksheet. (Sheet 9)

input to HDW	OWW3	TH1	TH2	P3AZ1	P3AZ2	PL2	CWZr2
H-3 (Ci)	9.06E+02	4.51E-01	2.90E+00	2.20E+03	1.33E+03	3.53E+03	3.28E+03
C-14 (Ci)	5.76E+01	1.88E-04	4.00E-04	6.97E+00	3.73E+00	1.07E+01	3.97E+01
Ni-59 (Ci)	6.53E+01	8.09E-03	1.72E-02	2.11E+01	1.14E+01	3.25E+01	8.17E-01
Ni-63 (Ci)	6.30E+03	6.89E-01	1.50E+00	2.04E+03	1.11E+03	3.15E+03	7.84E+01
Co-60 (Ci)	2.09E+03	1.38E-02	4.42E-02	4.38E+03	3.07E+03	7.45E+03	2.65E+02
Se-79 (Ci)	1.31E+01	3.21E-02	6.82E-02	3.34E+00	1.85E+00	5.18E+00	2.10E-02
Sr-90 (Ci)	1.60E+07	2.01E+04	4.61E+04	5.52E+06	3.21E+06	8.73E+06	3.53E+04
Y-90 (Ci)	1.61E+07	2.01E+04	4.61E+04	5.52E+06	3.21E+06	8.73E+06	3.53E+04
Zr-93 (Ci)	7.75E+02	8.54E-01	1.82E+00	2.02E+02	1.12E+02	3.14E+02	1.99E+00
Nb-93m (Ci)	5.81E+02	6.69E-01	1.37E+00	1.14E+02	5.93E+01	1.73E+02	1.10E+00
Tc-99 (Ci)	3.99E+03	3.62E+00	7.70E+00	9.86E+02	5.46E+02	1.53E+03	1.14E+02
Ru-106 (Ci)	8.55E-02	9.54E-07	1.98E-05	3.45E+02	7.06E+02	1.05E+03	4.25E+00
Cd-113m (Ci)	1.15E+03	1.69E+00	4.17E+00	6.03E+02	3.46E+02	9.49E+02	3.96E+00
Sb-125 (Ci)	1.02E+03	7.57E-01	3.58E+00	8.91E+03	7.99E+03	1.69E+04	1.66E+02
Sn-126 (Ci)	5.62E+01	1.05E-01	2.24E-01	1.49E+01	8.09E+00	2.30E+01	9.30E-02
I-129 (Ci)	1.39E+00	3.42E-04	7.26E-04	8.76E-02	4.77E-02	7.67E-01	7.57E-01
Cs-134 (Ci)	1.44E+02	2.30E-02	1.44E-01	4.09E+03	3.85E+03	7.93E+03	4.26E+02
Cs-137 (Ci)	1.89E+07	1.73E+04	3.94E+04	6.31E+06	3.62E+06	9.94E+06	5.33E+05
Ba-137m (Ci)	1.78E+07	1.63E+04	3.72E+04	5.96E+06	3.42E+06	9.38E+06	5.04E+05
Sm-151 (Ci)	5.09E+05	3.64E+02	7.93E+02	1.33E+05	7.58E+04	2.09E+05	8.45E+02
Eu-152 (Ci)	3.26E+02	1.03E-01	2.57E-01	1.83E+02	9.32E+01	2.76E+02	1.12E+00
Eu-154 (Ci)	2.34E+04	4.11E+00	1.12E+01	2.15E+04	1.18E+04	3.33E+04	1.35E+02
Eu-155 (Ci)	8.61E+03	1.47E+00	4.93E+00	1.46E+04	1.09E+04	2.55E+04	1.03E+02
Ra-226 (Ci)	1.12E-03	1.03E-04	3.73E-04	2.99E-04	1.51E-04	4.50E-04	8.41E-06
Ra-228 (Ci)	1.14E+00	4.53E-01	1.14E+00	1.70E-08	1.00E-08	2.70E-08	6.55E-10
Ac-227 (Ci)	3.01E+00	1.49E+00	3.00E+00	1.48E-03	7.79E-04	2.26E-03	4.04E-05
Pa-231 (Ci)	4.67E+00	2.19E+00	4.66E+00	3.29E-03	1.91E-03	5.20E-03	1.72E-04
Th-229 (Ci)	7.03E-01	3.85E-01	7.03E-01	1.97E-06	1.00E-06	2.97E-06	4.53E-08
Th-232 (Ci)	9.01E-01	4.24E-01	9.01E-01	1.93E-08	1.17E-08	3.10E-08	1.09E-09
U-232 (Ci)	3.99E+00	1.82E+00	3.99E+00	4.26E-03	2.07E-03	6.33E-03	2.34E-03
U-233 (Ci)	2.37E+02	1.16E+02	2.37E+02	1.37E-03	6.40E-04	2.01E-03	2.86E-05
U-234 (Ci)	1.72E+01	8.79E-01	1.87E+00	1.23E+01	6.90E+00	1.92E+01	1.24E+01
U-235 (Ci)	6.63E-01	3.12E-06	6.63E-06	4.59E-01	2.75E-01	7.34E-01	4.75E-01
U-236 (Ci)	7.55E-01	5.44E-07	1.16E-06	1.17E+00	6.81E-01	1.85E+00	1.20E+00
U-238 (Ci)	1.16E+01	4.87E-14	1.03E-13	8.45E+00	4.75E+00	1.32E+01	8.54E+00
U-Total (mols)	1.46E+05	5.23E+01	1.07E+02	1.07E+05	6.00E+04	1.67E+05	1.08E+05
Np-237 (Ci)	1.17E+01	4.02E-07	8.55E-07	1.95E+01	1.06E+01	3.01E+01	1.22E-01
Pu-238 (Ci)	5.57E+02	6.85E-05	1.49E-04	4.99E+02	2.51E+02	7.51E+02	1.01E+02
Pu-239 (Ci)	4.94E+03	3.47E-09	7.38E-09	4.72E+03	2.53E+03	7.25E+03	1.00E+03
Pu-240 (Ci)	1.73E+03	2.39E-10	5.08E-10	1.35E+03	6.91E+02	2.04E+03	2.82E+02
Pu-241 (Ci)	3.27E+04	9.20E-10	2.27E-09	4.04E+04	2.01E+04	6.05E+04	8.35E+03
Pu-242 (Ci)	2.95E-01	1.95E-15	4.15E-15	1.75E-01	8.31E-02	2.58E-01	3.55E-02
Pu-Total (kg)	8.76E+01	4.06E-09	8.83E-09	8.24E+01	4.40E+01	1.26E+02	1.74E+01
Am-241 (Ci)	2.07E+04	1.33E-10	2.74E-10	2.42E+04	1.57E+04	3.98E+04	4.44E+02
Am-243 (Ci)	1.98E+01	4.73E-16	1.01E-15	7.57E+00	3.50E+00	1.11E+01	4.45E-02
Cm-242 (Ci)	3.31E+01	8.94E-16	5.54E-16	1.40E+01	6.38E+00	2.04E+01	8.20E-02
Cm-243 (Ci)	3.57E+00	1.80E-17	4.11E-17	2.17E+00	9.15E-01	3.08E+00	1.25E-02
Cm-244 (Ci)	8.74E+01	3.91E-16	9.35E-16	5.63E+01	2.27E+01	7.90E+01	3.19E-01

D2.0 SOLUBILITIES WORKSHEET

This section documents the contents of the Solubilities worksheet. The function of this worksheet is to implement waste stream solubility limits. See Section 5.3.

For Revision 5.0, the uranium solubility limit applied to metal waste was increased by a factor of 30 to allow for the complexing of uranium with carbonate. Revised solubility definitions in the HDW Rev. 5.0 for ^{90}Sr and ^{137}Cs in ferrocyanide waste streams (PFeCN1, PFeCN2, TFeCN, and 1CFeCN) were based on laboratory results for the ferrocyanide scavenging process (Sloat 1955a, Sloat 1955b, and Michelson 1957), rather than using the general bismuth phosphate process solubility description for those analytes.

The solubility of $CaCO_3$ was increased for the DW, N, and PASF waste streams to reflect the fact that these are very dilute, non-separations waste streams as opposed to the other HDW waste streams, which are of high ionic strength. Thus, the expected solubility behavior for these waste streams would be less affected by common ion effects and complexing agents and follow more straightforward solubility estimates. However, the pH of the solution is critical to the solubility of the $CaCO_3$ (Bialkowski 2004) and even in the narrow range of pH expected for these streams (pH 6-8), the CO_3- solubility varies significantly. The CO_3- anion concentrations in the solids fraction go negative using the new generic solubility limits and variable solubility calculation in these very dilute waste streams, which is physically not realistic. Therefore, for these three waste streams, the previous solubility limit for $CaCO_3$ was used from the HDW model Rev. 4.0, which the variable solubility calculation allows.

The "solids fraction precipitated" for the P3AZ1 and P3AZ2 streams were adjusted to reflect tank farm surveillance information regarding the presence of solids and the unique conditions in tanks 241-AZ-101 and 241-AZ-102. These tanks are significantly warmer in temperature than other double-shell tanks or single-shell tanks, and precipitated sulfate varies (11.3% for AZ-101 and 2.68% for AZ-102), the sodium concentration is relatively low (Na < 5 M), and the nitrate ion concentration is also low which precludes the formation of a nitrate-sulfate double salt. Based on this information and applying the variable solubility computations (the solubility model for sulfate is extremely sensitive in these tanks) until the physical parameters were acceptable, the sulfate solubility for double-shell tank 241-AZ-101 should be 0.11375 M (assuming Na_2SO_4) and the sulfate solubility for double-shell tank 241-AZ-102 should be 0.1254 M (assuming Na_2SO4).

Table D-2 is a printout of the Solubilities worksheet. This table includes editorial changes made for the purpose of publication.

Table D-2. Solubilities Worksheet. (Sheet 1)

	Units	MW1	MW2	1C1	1C2	2C1	2C2	224-1	224-2	UR/TBP	PFeCN1	PFeCN2	TFeCN
NaNO3	M	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00
NaNO2	M	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00
NaF	M	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01
Na2CO3	M	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01
Na3PO4	M	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02
Na2SO4	M	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01
Na2SiO3	M	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02
NaAlO2	M	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00
FeO(OH)	M	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03
Cr(OH)3	M	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02
MnO2	M	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04
BiPO4	M	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04
Pb(OH)2	M	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04
La2O3	M	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
HgO	M	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Na 2 Oxalate	M	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
CaCO3.6H2O	M	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
Ni(OH)2	M	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03
ZrO(OH)2	M	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04
Co-60	Ci/L	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05
Se-79	Ci/L	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06
Sr-90	Ci/L	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	1.00E-03	1.99E-04	1.82E-04
Ru-106	Ci/L	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14	3.37E-14
Cd-113m	Ci/L	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05	5.46E-05
Sb-125	Ci/L	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07	2.82E-07
Sn-126	Ci/L	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06
I-129	Ci/L	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07
Cs-137	Ci/L										9.37E-06	9.37E-06	9.37E-06
Eu-154	Ci/L	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05	1.08E-05
Ra-226	Ci/L	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11
Ac-227	Ci/L	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10
Pa-231	Ci/L	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06
Th-232	Ci/L	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10
U-Total	Ci/L	4.00E-03	4.00E-03	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237	Ci/L	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07
Pu-Total	Ci/L	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05
Am-241	Ci/L	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06
Cm-244	Ci/L	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08

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Table D-2. Solubilities Worksheet. (Sheet 2)

	Units	1CFeCN	R1	R2	CWR1	CWR2	P1	P2	PL1	CWP1	CWP2	CWZr1	OWW1
NaNO3	M	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00
NaNO2	M	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00
NaF	M	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01
Na2CO3	M	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01
Na3PO4	M	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02
Na2SO4	M	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01
Na2SiO3	M	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02
NaAlO2	M	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00
FeO(OH)	M	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03
Cr(OH)3	M	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02
MnO2	M	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04
BiPO4	M	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04
Pb(OH)2	M	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04
La2O3	M	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
HgO	M	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Na 2 Oxalate	M	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
CaCO3.6H2O	M	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03
Ni(OH)2	M	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03
ZrO(OH)2	M	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04
Co-60	Ci/L	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05
Se-79	Ci/L	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06
Sr-90	Ci/L	2.91E-05	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03
Ru-106	Ci/L	3.37E-14	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11
Cd-113m	Ci/L	5.46E-05	1.29E-04	1.29E-04	1.29E-04	1.29E-04	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05
Sb-125	Ci/L	2.82E-07	3.30E-06	3.30E-06	3.30E-06	3.30E-06	8.74E-06	8.74E-06	8.74E-06	8.74E-06	8.74E-06	8.74E-06	8.74E-06
Sn-126	Ci/L	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06
I-129	Ci/L	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07
Cs-137	Ci/L	2.47E-07											
Eu-154	Ci/L	1.08E-05	4.83E-05	4.83E-05	4.83E-05	4.83E-05	8.16E-05	8.16E-05	8.16E-05	8.16E-05	8.16E-05	8.16E-05	8.16E-05
Ra-226	Ci/L	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11
Ac-227	Ci/L	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10
Pa-231	Ci/L	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06
Th-232	Ci/L	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10
U-Total	Ci/L	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237	Ci/L	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07
Pu-Total	Ci/L	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05
Am-241	Ci/L	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06
Cm-244	Ci/L	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08

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Table D-2. Solubilities Worksheet. (Sheet 3)

	Units	OWW2	OWW3	Z	HS	TH1	TH2	AR	B	BL	SRR	CSR	DW
NaNO3	M	3.50E+00	3.50E+00	3.50E+00	4.11E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	4.11E+00	3.50E+00	3.50E+00	3.50E+00
NaNO2	M	3.09E+00	3.09E+00	3.09E+00	2.28E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	2.28E+00	3.09E+00	3.09E+00	3.09E+00
NaF	M	2.74E-01	2.74E-01	2.74E-01	2.75E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.75E-01	2.74E-01	2.74E-01	2.74E-01
Na2CO3	M	6.40E-01	6.40E-01	6.40E-01	1.34E+00	6.40E-01	6.40E-01	6.40E-01	6.40E-01	1.34E+00	6.40E-01	6.40E-01	6.40E-01
Na3PO4	M	7.06E-02	7.06E-02	7.06E-02	6.37E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	6.37E-02	7.06E-02	7.06E-02	7.06E-02
Na2SO4	M	1.24E-01	1.24E-01	1.24E-01	1.82E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.82E-01	1.24E-01	1.24E-01	1.24E-01
Na2SiO3	M	1.05E-02	1.05E-02	1.05E-02	3.00E-03	1.05E-02	1.05E-02	1.05E-02	1.05E-02	3.00E-03	1.05E-02	1.05E-02	1.05E-02
NaAlO2	M	1.75E+00	1.75E+00	1.75E+00	7.37E-01	1.75E+00	1.75E+00	1.75E+00	1.75E+00	7.37E-01	1.75E+00	1.75E+00	1.75E+00
FeO(OH)	M	1.88E-03	1.88E-03	1.88E-03	4.82E-02	1.88E-03	1.88E-03	1.88E-03	1.88E-03	4.82E-02	1.88E-03	1.88E-03	1.88E-03
Cr(OH)3	M	5.54E-02	5.54E-02	5.54E-02	7.65E-03	5.54E-02	5.54E-02	5.54E-02	5.54E-02	7.65E-03	5.54E-02	5.54E-02	5.54E-02
MnO2	M	5.55E-04	5.55E-04	5.55E-04	1.11E-02	5.55E-04	5.55E-04	5.55E-04	5.55E-04	1.11E-02	5.55E-04	5.55E-04	5.55E-04
BiPO4	M	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04
Pb(OH)2	M	7.20E-04	7.20E-04	7.20E-04	2.19E-03	7.20E-04	7.20E-04	7.20E-04	7.20E-04	2.19E-03	7.20E-04	7.20E-04	7.20E-04
La2O3	M	1.00E-06	1.00E-06	1.00E-06	3.11E-04	1.00E-06	1.00E-06	1.00E-06	1.00E-06	3.11E-04	1.00E-06	1.00E-06	1.00E-06
HgO	M	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Na 2 Oxalate	M	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
CaCO3.6H2O	M	3.75E-03	3.75E-03	3.75E-03	1.61E-02	3.75E-03	3.75E-03	3.75E-03	3.75E-03	1.61E-02	3.75E-03	3.75E-03	9.00E-03
Ni(OH)2	M	1.82E-03	1.82E-03	1.82E-03	1.01E-02	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.01E-02	1.82E-03	1.82E-03	1.82E-03
ZrO(OH)2	M	2.95E-04	2.95E-04	2.95E-04	1.01E-03	2.95E-04	2.95E-04	2.95E-04	2.95E-04	1.01E-03	2.95E-04	2.95E-04	2.95E-04
Co-60	Ci/L	2.40E-05	2.40E-05	2.40E-05	1.34E-04	2.40E-05	2.40E-05	2.40E-05	2.40E-05	1.34E-04	2.40E-05	2.40E-05	2.40E-05
Se-79	Ci/L	1.21E-06	1.21E-06	1.21E-06	8.67E-07	1.21E-06	1.21E-06	1.21E-06	1.21E-06	8.67E-07	1.21E-06	1.21E-06	1.21E-06
Sr-90	Ci/L	2.48E-03	2.48E-03	2.48E-03	9.97E-02	2.48E-03	2.48E-03	2.48E-03	2.48E-03	9.97E-02	2.48E-03	2.48E-03	2.48E-03
Ru-106	Ci/L	5.11E-11	5.11E-11	5.11E-11	4.06E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	4.06E-11	5.11E-11	5.11E-11	5.11E-11
Cd-113m	Ci/L	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05
Sb-125	Ci/L	8.74E-06	8.74E-06	8.74E-06	3.30E-03	8.74E-06	8.74E-06	8.74E-06	8.74E-06	3.30E-03	8.74E-06	8.74E-06	8.74E-06
Sn-126	Ci/L	8.83E-06	8.83E-06	8.83E-06	9.85E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	9.85E-06	8.83E-06	8.83E-06	8.83E-06
I-129	Ci/L	2.80E-07	2.80E-07	2.80E-07	1.31E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	1.31E-07	2.80E-07	2.80E-07	2.80E-07
Cs-137	Ci/L												
Eu-154	Ci/L	8.16E-05	8.16E-05	8.16E-05	8.54E-04	8.16E-05	8.16E-05	8.16E-05	8.16E-05	8.54E-04	8.16E-05	8.16E-05	8.16E-05
Ra-226	Ci/L	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11
Ac-227	Ci/L	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10
Pa-231	Ci/L	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06
Th-232	Ci/L	2.23E-10	2.23E-10	2.23E-10	2.28E-09	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.28E-09	2.23E-10	2.23E-10	2.23E-10
U-Total	Ci/L	1.30E-04	1.30E-04	1.30E-04	1.30E-04			1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237	Ci/L	4.69E-07	4.69E-07	4.69E-07	7.19E-08	4.69E-07	4.69E-07	4.69E-07	4.69E-07	7.19E-08	4.69E-07	4.69E-07	4.69E-07
Pu-Total	Ci/L	8.67E-05	8.67E-05	8.67E-05	1.02E-04	8.67E-05	8.67E-05	8.67E-05	8.67E-05	1.02E-04	8.67E-05	8.67E-05	8.67E-05
Am-241	Ci/L	6.73E-06	6.73E-06	6.73E-06	6.96E-04	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.96E-04	6.73E-06	6.73E-06	6.73E-06
Cm-244	Ci/L	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08

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Table D-2. Solubilities Worksheet. (Sheet 4)

	Units	OWW2	OWW3	Z	HS	TH1	TH2	AR	B	BL	SRR	CSR	DW
NaNO3	M	3.50E+00	3.50E+00	3.50E+00	4.11E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	4.11E+00	3.50E+00	3.50E+00	3.50E+00
NaNO2	M	3.09E+00	3.09E+00	3.09E+00	2.28E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	2.28E+00	3.09E+00	3.09E+00	3.09E+00
NaF	M	2.74E-01	2.74E-01	2.74E-01	2.75E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.75E-01	2.74E-01	2.74E-01	2.74E-01
Na2CO3	M	6.40E-01	6.40E-01	6.40E-01	1.34E+00	6.40E-01	6.40E-01	6.40E-01	6.40E-01	1.34E+00	6.40E-01	6.40E-01	6.40E-01
Na3PO4	M	7.06E-02	7.06E-02	7.06E-02	6.37E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	6.37E-02	7.06E-02	7.06E-02	7.06E-02
Na2SO4	M	1.24E-01	1.24E-01	1.24E-01	1.82E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.82E-01	1.24E-01	1.24E-01	1.24E-01
Na2SiO3	M	1.05E-02	1.05E-02	1.05E-02	3.00E-03	1.05E-02	1.05E-02	1.05E-02	1.05E-02	3.00E-03	1.05E-02	1.05E-02	1.05E-02
NaAlO2	M	1.75E+00	1.75E+00	1.75E+00	7.37E-01	1.75E+00	1.75E+00	1.75E+00	1.75E+00	7.37E-01	1.75E+00	1.75E+00	1.75E+00
FeO(OH)	M	1.88E-03	1.88E-03	1.88E-03	4.82E-02	1.88E-03	1.88E-03	1.88E-03	1.88E-03	4.82E-02	1.88E-03	1.88E-03	1.88E-03
Cr(OH)3	M	5.54E-02	5.54E-02	5.54E-02	7.65E-03	5.54E-02	5.54E-02	5.54E-02	5.54E-02	7.65E-03	5.54E-02	5.54E-02	5.54E-02
MnO2	M	5.55E 04	5.55E-04	5.55E-04	1.11E-02	5.55E-04	5.55E-04	5.55E-04	5.55E-04	1.11E-02	5.55E-04	5.55E-04	5.55E-04
BiPO4	M	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04
Pb(OH)2	M	7.20E-04	7.20E-04	7.20E-04	2.19E-03	7.20E-04	7.20E-04	7.20E-04	7.20E-04	2.19E-03	7.20E-04	7.20E-04	7.20E-04
La2O3	M	1.00E-06	1.00E-06	1.00E-06	3.11E-04	1.00E-06	1.00E-06	1.00E-06	1.00E-06	3.11E-04	1.00E-06	1.00E-06	1.00E-06
HgO	M	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Na 2 Oxalate	M	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
CaCO3.6H2O	M	3.75E-03	3.75E-03	3.75E-03	1.61E-02	3.75E-03	3.75E-03	3.75E-03	3.75E-03	1.61E-02	3.75E-03	3.75E-03	9.00E-03
Ni(OH)2	M	1.82E-03	1.82E-03	1.82E-03	1.01E-02	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.01E-02	1.82E-03	1.82E-03	1.82E-03
ZrO(OH)2	M	2.95E-04	2.95E-04	2.95E-04	1.01E-03	2.95E-04	2.95E-04	2.95E-04	2.95E-04	1.01E-03	2.95E-04	2.95E-04	2.95E-04
Co-60	Ci/L	2.40E-05	2.40E-05	2.40E-05	1.34E-04	2.40E-05	2.40E-05	2.40E-05	2.40E-05	1.34E-04	2.40E-05	2.40E-05	2.40E-05
Se-79	Ci/L	1.21E-06	1.21E-06	1.21E-06	8.67E-07	1.21E-06	1.21E-06	1.21E-06	1.21E-06	8.67E-07	1.21E-06	1.21E-06	1.21E-06
Sr-90	Ci/L	2.48E-03	2.48E-03	2.48E-03	9.97E-02	2.48E-03	2.48E-03	2.48E-03	2.48E-03	9.97E-02	2.48E-03	2.48E-03	2.48E-03
Ru-106	Ci/L	5.11E-11	5.11E-11	5.11E-11	4.06E-11	5.11E-11	5.11E-11	5.11E-11	5.11E-11	4.06E-11	5.11E-11	5.11E-11	5.11E-11
Cd-113m	Ci/L	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05	4.30E-05
Sb-125	Ci/L	8.74E-06	8.74E-06	8.74E-06	3.30E-03	8.74E-06	8.74E-06	8.74E-06	8.74E-06	3.30E-03	8.74E-06	8.74E-06	8.74E-06
Sn-126	Ci/L	8.83E-06	8.83E-06	8.83E-06	9.85E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	9.85E-06	8.83E-06	8.83E-06	8.83E-06
I-129	Ci/L	2.80E-07	2.80E-07	2.80E-07	1.31E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	1.31E-07	2.80E-07	2.80E-07	2.80E-07
Cs-137	Ci/L												
Eu-154	Ci/L	8.16E-05	8.16E-05	8.16E-05	8.54E-04	8.16E-05	8.16E-05	8.16E-05	8.16E-05	8.54E-04	8.16E-05	8.16E-05	8.16E-05
Ra-226	Ci/L	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11
Ac-227	Ci/L	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10
Pa-231	Ci/L	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06
Th-232	Ci/L	2.23E-10	2.23E-10	2.23E-10	2.28E-09	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.28E-09	2.23E-10	2.23E-10	2.23E-10
U-Total	Ci/L	1.30E-04	1.30E-04	1.30E-04	1.30E-04			1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237	Ci/L	4.69E-07	4.69E-07	4.69E-07	7.19E-08	4.69E-07	4.69E-07	4.69E-07	4.69E-07	7.19E-08	4.69E-07	4.69E-07	4.69E-07
Pu-Total	Ci/L	8.67E-05	8.67E-05	8.67E-05	1.02E-04	8.67E-05	8.67E-05	8.67E-05	8.67E-05	1.02E-04	8.67E-05	8.67E-05	8.67E-05
Am-241	Ci/L	6.73E-06	6.73E-06	6.73E-06	6.96E-04	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.96E-04	6.73E-06	6.73E-06	6.73E-06
Cm-244	Ci/L	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08

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Table D-2. Solubilities Worksheet. (Sheet 5)

	Units	BiPO4	Redox	Purex	P3AZ1	P3AZ2	Complex
NaNO3	M	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	4.11E+00
NaNO2	M	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	2.28E+00
NaF	M	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.75E-01
Na2CO3	M	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	1.34E+00
Na3PO4	M	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	6.37E-02
Na2SO4	M	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.82E-01
Na2SiO3	M	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	3.00E-03
NaAlO2	M	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	7.37E-01
FeO(OH)	M	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	4.82E-02
Cr(OH)3	M	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	7.65E-03
MnO2	M	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	1.11E-02
BiPO4	M	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04
Pb(OH)2	M	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	2.19E-03
La2O3	M	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	3.11E-04
HgO	M	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Na 2 Oxalate	M	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
CaCO3.6H2O	M	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	1.61E-02
Ni(OH)2	M	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.01E-02
ZrO(OH)2	M	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	1.01E-03
Co-60	Ci/L	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	1.34E-04
Se-79	Ci/L	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	8.67E-07
Sr-90	Ci/L	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	9.97E-02
Ru-106	Ci/L	3.37E-14	5.11E-11	5.11E-11	6.13E-05	2.33E-04	4.06E-11
Cd-113m	Ci/L	5.46E-05	1.29E-04	4.30E-05	4.30E-05	4.30E-05	4.30E-05
Sb-125	Ci/L	2.82E-07	3.30E-06	8.74E-06	6.78E-04	1.11E-03	3.30E-03
Sn-126	Ci/L	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	9.85E-06
I-129	Ci/L	2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	1.31E-07
Cs-137	Ci/L						
Eu-154	Ci/L	1.08E-05	4.83E-05	8.16E-05	5.79E-04	5.88E-04	8.54E-04
Ra-226	Ci/L	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11
Ac-227	Ci/L	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10
Pa-231	Ci/L	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06
Th-232	Ci/L	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.28E-09
U-Total	Ci/L	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237	Ci/L	4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	7.19E-08
Pu-Total	Ci/L	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	1.02E-04
Am-241	Ci/L	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.96E-04
Cm-244	Ci/L	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08

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D3.0 SOLUBILITY WORKUP WORKBOOK

This section documents the contents of the Solubility Workup workbook. The Solubility Workup workbook supports the Solubilities worksheet. See Section 5.3. Table D-3 is a printout of the Solubility Workup workbook. This table includes editorial changes made for purposes of publication.

Table D-3. Solubility Workup Workbook

Species	Units	Original HDW Values	MW	Species	Units	7G300-02-NWK-037			Report Data Converted to HDW Solubility Units Waste Steam Solubilities								
						Non complex	Complex	hdw	Non Complex	Complex	hdw	BiPO4	REDOX	PUREX	P3AZ1	P3AZ2	Complex
NaNO3	M	2.8	62	NO_3	µg/mL	2.17E+05	2.55E+05	1.74E+05	3.50E+00	4.11E+00	2.81E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	4.11E+00
NaNO2	M	3.1	46	NO_2	µg/mL	1.42E+05	1.05E+05	1.43E+05	3.09E+00	2.28E+00	3.11E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	3.09E+00	2.28E+00
NaCl	M	0.17			µg/mL												
NaF	M	0.24	19	F	µg/mL	5.20E+03	5.23E+03	4.56E+03	2.74E-01	2.75E-01	2.40E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.74E-01	2.75E-01
Sr(OH)2	M	0.002	87.63	Sr	µg/mL	5.66E+00	2.27E+02	1.75E+02	6.46E-05	2.59E-03	2.00E-03	6.46E-05	6.46E-05	6.46E-05	6.46E-05	6.46E-05	2.59E-03
Na2CO3	M	0.4	60	CO_3	µg/mL	3.84E+04	8.04E+04	2.45E+04	6.40E-01	1.34E+00	4.08E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	6.40E-01	1.34E+00
Na3PO4	M	0.15	95	PO_4	µg/mL	6.71E+03	6.05E+03	1.46E+04	7.06E-02	6.37E-02	1.54E-01	7.06E-02	7.06E-02	7.06E-02	7.06E-02	7.06E-02	6.37E-02
Na2SO4	M	0.35	96	SO_4	µg/mL	1.19E+04	1.75E+04	3.33E+04	1.24E-01	1.82E-01	3.47E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.82E-01
Na2SiO3	M	0.034	28	Si	µg/mL	2.95E+02	8.41E+01	9.55E+02	1.05E-02	3.00E-03	3.41E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	3.00E-03
NaAlO2	M	1.6	27	Al	µg/mL	4.73E+04	1.99E+04	4.32E+04	1.75E+00	7.37E-01	1.60E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	1.75E+00	7.37E-01
FeO(OH)	M	0.002	56	Fe	µg/mL	1.05E+02	2.70E+03	1.12E+02	1.88E-03	4.82E-02	2.00E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	1.88E-03	4.82E-02
Cr(OH)3	M	0.12	52	Cr	µg/mL	2.88E+03	3.98E+02	6.24E+03	5.54E-02	7.65E-03	1.20E-01	5.54E-02	5.54E-02	5.54E-02	5.54E-02	5.54E-02	7.65E-03
MnO2	M	0.009	56	Mn	µg/mL	3.11E+01	6.23E+02	4.94E+02	5.55E-04	1.11E-02	8.82E-03	5.55E-04	5.55E-04	5.55E-04	5.55E-04	5.55E-04	1.11E-02
BiPO4	M	0.004	209	Bi	µg/mL	9.60E+01	9.60E+01	8.36E+02	4.59E-04	4.59E-04	4.00E-03	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04	4.59E-04
Pb(OH)2	M	0.0016	207	Pb	µg/mL	1.49E+02	4.54E+02	3.32E+02	7.20E-04	2.19E-03	1.60E-03	7.20E-04	7.20E-04	7.20E-04	7.20E-04	7.20E-04	2.19E-03
La2O3	M	0	139	La	µg/mL	1.39E-01	4.32E+01	0.00E+00	1.00E-06	3.11E-04	0.00E+00	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	3.11E-04
HgO	M	0.00001	201	Hg	µg/mL	3.25E-01	3.25E-01	2.01E+00	1.62E-06	1.62E-06	1.00E-05	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06	1.62E-06
Na 2 Oxalate	M	0.005			µg/mL							5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
CaCO3.6H2O	M	0.009	40	Ca	µg/mL	1.50E-02	6.44E+02	3.61E+02	3.75E-03	1.61E-02	9.03E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	3.75E-03	1.61E-02
Ni(OH)2	M	0.0018	58.7	Ni	µg/mL	1.07E+02	5.95E+02	1.06E+02	1.82E-03	1.01E-02	1.81E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.82E-03	1.01E-02
ZrO(OH)2	M	0.003	91	Zr	µg/mL	2.68E+01	9.15E+01	2.74E+02	2.95E-04	1.01E-03	3.01E-03	2.95E-04	2.95E-04	2.95E-04	2.95E-04	2.95E-04	1.01E-03
Co-60	Ci/L	0.0001		Co-60	µCi/mL	2.40E-02	1.34E-01	3.98E-02	2.40E-05	1.34E-04	3.98E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	2.40E-05	1.34E-04
Se-79	Ci/L	0.000002		Se-79		1.21E-03	8.67E-04	2.00E-03	1.21E-06	8.67E-07	2.00E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	1.21E-06	8.67E-07
Sr-90	Ci/L	0.034		Sr-90		2.48E+00	9.97E+01	3.09E+01	2.48E-03	9.97E-02	3.09E-02	2.48E-03	2.48E-03	2.48E-03	2.48E-03	2.48E-03	9.97E-02
Zr-93	Ci/L	0.00001															
Nb-93m	Ci/L	0.000007															
Ru-106	Ci/L	5E-09				See Table D-3a for data				4.06E-11		3.37E-14	5.11E-11	5.11E-11	6.13E-05	2.33E-04	4.06E-11
Cd-113m	Ci/L	0.00006				See Table D-3a for data				4.30E-05		5.46E-05	1.29E-04	4.30E-05	4.30E-05	4.30E-05	4.30E-05
Sb-125	Ci/L	0.019				See Table D-3a for data				3.30E-03		2.82E-07	3.30E-06	8.74E-06	6.78E-04	1.11E-03	3.30E-03
Sn-126	Ci/L	0.000003		Sn-126		8.83E-03	9.85E-03	3.00E-03	8.83E-06	9.85E-06	3.00E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	8.83E-06	9.85E-06
add I-129	Ci/L			I-129		2.80E-04	1.31E-04	NR	2.80E-07	1.31E-07		2.80E-07	2.80E-07	2.80E-07	2.80E-07	2.80E-07	1.31E-07
Sm-151	Ci/L	0.007															
Eu-154	Ci/L	0.0005				See Table D-3a for data				8.54E-04		1.08E-05	4.83E-05	8.16E-05	5.79E-04	5.88E-04	8.54E-04
Ra-226	Ci/L	6.2E-11										6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11	6.20E-11
Ac-227	Ci/L	3.6E-10										3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10	3.60E-10
Pa-231	Ci/L	2E-09		Pa-231		8.51E-03	NR	2.00E-06	8.51E-06		2.00E-09	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06	8.51E-06
Th-232	Ci/L	7E-07		Th-232		2.23E-07	2.28E-06	7.00E-04	2.23E-10	2.28E-09	7.00E-07	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.23E-10	2.28E-09
U-Total	M	0.004		U-Total		3.10E+01	3.10E+01	9.52E+02	1.30E-04	1.30E-04	4.00E-03	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04	1.30E-04
Np-237	Ci/L			Np-237		4.69E-04	7.19E-05	NR	4.69E-07	7.19E-08		4.69E-07	4.69E-07	4.69E-07	4.69E-07	4.69E-07	7.19E-08
Pu-Total	g/L	0.000148		Pu-239/240		6.25E-03	7.35E-03	9.18E-03	8.67E-05	1.02E-04	1.27E-04	8.67E-05	8.67E-05	8.67E-05	8.67E-05	8.67E-05	1.02E-04
Am-241	Ci/L	0.00003		Am-241		6.73E-03	6.96E-01	3.00E-02	6.73E-06	6.96E-04	3.00E-05	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.73E-06	6.96E-04
Cm-244	Ci/L	1E-07		Cm-243/244		2.00E-05	2.00E-05	NR	1.92E-08	1.92E-08		1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08

Table D-3a. Plant Specific Solubility Estimates for Short-Live Nuclides in Non-Complexed Wastes

Process	Europium-154	Ruthenium-106	Antimony-125	Cadmium-113m	µCi/mL
BiPO4	1.08E-02	3.37E-11	2.82E-04	5.46E-02	µCi/mL
Redox	4.83E-02	5.11E-08	3.30E-03	1.29E-01	µCi/mL
Early PUREX	8.16E-02	5.11E-08	8.74E-03	NR	µCi/mL
AZ-101	5.79E-01	6.13E-02	6.78E-01	NR	µCi/mL
AZ-102	5.88E-01	2.33E-01	1.11E+00	NR	µCi/mL

D4.0 B AND T1 SALTCAKE

Based on the nearly identical concentrations of the B and T1 saltcakes predicted by the Revision 4.0 of the HDW Model, these waste types were combined into a single waste type B and TI saltcake (BT-SltCk) for Revision 5.0 of the HDW Model. This change was made to facilitate development of an organic saltcake waste type. The organic saltcake is of special concern in the tank farms because of its propensity to generate and accumulate gas. The organic rich saltcakes exhibit a different solubility behavior from other saltcakes. Development of a separate organic saltcake stream was not completed.

At the completion of Revision 5.0 of the HDW Model, this change was re-evaluated. Table D-4 compares the HDW Model Revision 5.0 prediction of the BT-SltCk saltcake solids with the solids composition predicted for the BSltCk and T1SltCk saltcakes. Table D-5 compares the HDW Model Revision 5.0 prediction of the BT-SltCk saltcake liquid with the compositions predicted for the BSltCk and T1SltCk saltcake liquids. These comparisons indicate that the predicted radionuclide compositions of BSltCk and T1SltCk saltcakes have diverged with this update. The uranium content and plutonium content of the two saltcakes have diverged noticeably. This change is a result of the method used to calculate separation plant losses of uranium and plutonium. Previously, in Revision 4.0 of the model, these losses were based on the average loss for the life of the facility or a campaign. For Revision 5.0, the separation plant losses were calculated from monthly facility production records. See Section 5.1.

Table D-4. Comparison of HDW Model Predicted BT-SltCk Saltcake Solids Composition with Predicted Solids Compositions for BSltCk and T1SltCk. (3 Sheets)

Pred. Sludge ppm	BT-SltCk	BSltCk	T1SltCk	BSltCk vs. BT-SltCk	T1SltCk vs. BT-SltCk
Na	1.70E+05	1.73E+05	1.69E+05	2%	1%
Al	1.08E+02	1.05E+02	9.35E+01	2%	14%
Fe	4.81E+03	4.31E+03	4.51E+03	11%	7%
Cr	1.40E+02	1.38E+02	1.43E+02	2%	2%
Bi	4.02E+03	3.56E+03	3.72E+03	12%	8%
La	0.00E+00	0.00E+00	0.00E+00		
Hg	3.83E+00	3.19E+00	3.60E+00	18%	6%
$ZrO(OH)_2$	7.70E+00	7.16E+00	1.24E+01	7%	47%
Pb	0.00E+00	0.00E+00	0.00E+00		

Table D-4. Comparison of HDW Model Predicted BT-SltCk Saltcake Solids Composition with Predicted Solids Compositions for BSltCk and T1SltCk. (3 Sheets)

Pred. Sludge ppm	BT-SltCk	BSltCk	T1SltCk	BSltCk vs. BT-SltCk	T1SltCk vs. BT-SltCk
Ni	5.04E+02	4.48E+02	5.71E+02	12%	12%
Sr	1.52E-02	1.52E-02	1.52E-02	0%	0%
Mn	0.00E+00	0.00E+00	0.00E+00		
Cs	1.83E+03	1.60E+03	1.81E+03	13%	1%
K	2.54E+02	2.59E+02	2.50E+02	2%	1%
Balance	1.00E+02	1.00E+02	1.00E+02		
Density	1.70E+00	1.70E+00	1.70E+00	0%	0%
Vol% solids	7.96E+00	8.51E+00	7.51E+00	7%	6%
void frac.	5.07E-01	5.07E-01	5.03E-01	0%	1%
wt.% H2O	4.32E+01	4.15E+01	4.38E+01	4%	1%
TOC wt.%C	1.01E-04	1.06E-04	9.63E-05	5%	5%
free OH-	9.11E+02	8.81E+02	9.54E+02	3%	5%
OH-	6.13E+03	5.48E+03	5.99E+03	11%	2%
NO3-	2.74E+05	2.99E+05	2.65E+05	9%	3%
NO2-	2.54E+03	2.53E+03	2.55E+03	0%	0%
CO3--	5.64E+03	5.05E+03	5.84E+03	11%	3%
PO4---	6.06E+04	5.43E+04	6.13E+04	11%	1%
SO4--	3.38E+04	3.16E+04	3.70E+04	7%	9%
SiO3--	2.09E+03	1.65E+03	1.91E+03	23%	9%
F-	1.10E+03	1.04E+03	1.15E+03	5%	4%
Cl-	1.25E+03	1.28E+03	1.22E+03	2%	2%
C6H5O7---	0.00E+00	0.00E+00	0.00E+00		
EDTA----	0.00E+00	0.00E+00	0.00E+00		
HEDTA---	0.00E+00	0.00E+00	0.00E+00		
	0.00E+00	0.00E+00	0.00E+00		
glycolate-	0.00E+00	0.00E+00	0.00E+00		
acetate-	0.00E+00	0.00E+00	0.00E+00		
oxalate--	0.00E+00	0.00E+00	0.00E+00		
DBP	1.47E+00	1.55E+00	1.41E+00	5%	5%
Butanol	5.19E-01	5.47E-01	4.96E-01	5%	5%
	0.00E+00	0.00E+00	0.00E+00		
NH3	4.72E+02	4.66E+02	4.78E+02	1%	1%
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00		
H-3 (µCi/g)	1.45E-03	1.40E-03	1.47E-03	3%	2%
C-14 (µCi/g)	8.46E-05	8.18E-05	8.72E-05	3%	3%
Ni-59 (µCi/g)	2.04E-04	1.81E-04	2.31E-04	12%	12%
Ni-63 (µCi/g)	2.10E-02	1.86E-02	2.38E-02	12%	13%
Co-60 (µCi/g)	9.74E-05	9.17E-05	1.02E-04	6%	5%
Se-79 (µCi/g)	3.25E-06	3.22E-06	3.29E-06	1%	1%
Sr-90 (µCi/g)	6.78E-01	6.80E-01	6.78E-01	0%	0%
Y-90 (µCi/g)	6.78E-01	6.80E-01	6.78E-01	0%	0%
Zr-93 (µCi/g)	3.01E-04	2.84E-04	4.79E-04	6%	46%
Nb-93m (µCi/g)	2.68E-04	2.53E-04	4.26E-04	6%	45%
Tc-99 (µCi/g)	9.79E-04	9.62E-04	9.96E-04	2%	2%
Ru-106 (µCi/g)	2.12E-13	1.23E-13	2.91E-13	53%	31%
Cd-113m (µCi/g)	1.10E-04	1.08E-04	1.11E-04	2%	2%
Sb-125 (µCi/g)	3.02E-06	2.98E-06	3.05E-06	1%	1%
Sn-126 (µCi/g)	1.22E-05	1.21E-05	1.24E-05	1%	1%

Table D-4. Comparison of HDW Model Predicted BT-SltCk Saltcake Solids Composition with Predicted Solids Compositions for BSltCk and T1SltCk. (3 Sheets)

Pred. Sludge ppm	BT-SltCk	BSltCk	T1SltCk	BSltCk vs. BT-SltCk	T1SltCk vs. BT-SltCk
I-129 (µCi/g)	1.36E-06	1.34E-06	1.37E-06	1%	1%
Cs-134 (µCi/g)	2.40E-08	2.49E-08	2.32E-08	4%	3%
Cs-137 (µCi/g)	2.85E+00	2.84E+00	2.87E+00	0%	1%
Ba-137m (µCi/g)	2.69E+00	2.68E+00	2.71E+00	0%	1%
Sm-151 (µCi/g)	1.50E-01	1.46E-01	1.53E-01	3%	2%
Eu-152 (µCi/g)	5.08E-06	4.95E-06	5.19E-06	3%	2%
Eu-154 (µCi/g)	3.88E-04	3.77E-04	3.97E-04	3%	2%
Eu-155 (µCi/g)	2.27E-04	2.20E-04	2.34E-04	3%	3%
Ra-226 (µCi/g)	1.58E-08	1.59E-08	1.58E-08	0%	0%
Ra-228 (µCi/g)	7.19E-14	7.23E-14	7.16E-14	1%	0%
Ac-227 (µCi/g)	7.11E-08	7.10E-08	7.15E-08	0%	0%
Pa-231 (µCi/g)	2.21E-07	2.13E-07	2.28E-07	4%	3%
Th-229 (µCi/g)	1.30E-11	1.23E-11	1.36E-11	6%	5%
Th-232 (µCi/g)	1.09E-13	1.03E-13	1.15E-13	6%	5%
U-232 (µCi/g)	3.15E-09	2.09E-09	3.83E-09	40%	19%
U-233 (µCi/g)	2.52E-10	1.64E-10	3.10E-10	42%	21%
U-234 (µCi/g)	2.35E-04	1.41E-04	3.08E-04	50%	27%
U-235 (µCi/g)	1.05E-05	6.27E-06	1.37E-05	50%	27%
U-236 (µCi/g)	2.75E-06	1.79E-06	3.40E-06	42%	21%
U-238 (µCi/g)	2.39E-04	1.44E-04	3.13E-04	50%	27%
U-Total (µg/g)	7.18E+02	4.31E+02	9.39E+02	50%	27%
Np-237 (µCi/g)	8.33E-06	8.30E-06	8.38E-06	0%	1%
Pu-238 (µCi/g)	3.48E-04	2.89E-04	3.39E-04	18%	2%
Pu-239 (µCi/g)	4.57E-02	3.86E-02	4.48E-02	17%	2%
Pu-240 (µCi/g)	5.17E-03	4.32E-03	5.05E-03	18%	2%
Pu-241 (µCi/g)	1.04E-02	8.61E-03	1.01E-02	19%	3%
Pu-242 (µCi/g)	7.50E-08	6.20E-08	7.29E-08	19%	3%
Pu-Total (µg/g)	7.58E-01	6.40E-01	7.44E-01	17%	2%
Am-241 (µCi/g)	4.61E-04	4.65E-04	4.58E-04	1%	1%
Am-243 (µCi/g)	6.08E-08	6.26E-08	5.93E-08	3%	2%
Cm-242 (µCi/g)	1.05E-07	1.08E-07	1.11E-07	3%	6%
Cm-243 (µCi/g)	1.24E-09	1.28E-09	1.32E-09	3%	6%
Cm-244 (µCi/g)	2.90E-08	3.00E-08	3.09E-08	3%	6%

Table D-5. Comparison of HDW Model Predicted BT-SltCk Saltcake Liquid Composition with Predicted Liquid Compositions for BSltCk and T1SltCk. (3 Sheets)

pred. su. ppm	BT-SltCk	BSltCk	T1SltCk	BSltCk vs. BT-SltCk	T1SltCk vs. BT-SltCk
Na	9.03E+04	8.97E+04	9.10E+04	1%	1%
Al	2.87E+02	2.82E+02	2.50E+02	2%	14%
Fe	7.29E+01	8.35E+01	8.33E+01	14%	13%
Cr	3.75E+02	3.69E+02	3.83E+02	2%	2%
Bi	6.63E+01	7.65E+01	7.63E+01	14%	14%
La	0.00E+00	0.00E+00	0.00E+00		
Hg	2.34E-01	2.59E-01	2.58E-01	10%	10%
Zr	2.06E+01	1.92E+01	2.14E+01	7%	4%
Pb	0.00E+00	0.00E+00	0.00E+00		

Table D-5. Comparison of HDW Model Predicted BT-SltCk Saltcake Liquid Composition with Predicted Liquid Compositions for BSltCk and T1SltCk. (3 Sheets)

pred. su, ppm	BT-SltCk	BSltCk	T1SltCk	BSltCk vs. BT-SltCk	T1SltCk vs. BT-SltCk
Ni	8.53E+01	8.53E+01	8.51E+01	0%	0%
Sr	4.05E-02	4.07E-02	4.06E-02	1%	0%
Mn	0.00E+00	0.00E+00	0.00E+00		
Ca	1.13E+02	1.20E+02	1.19E+02	6%	6%
K	6.78E+02	6.92E+02	6.70E+02	2%	1%
Balance	1.00E+02	1.00E+02	1.00E+02		
Density	1.26E+00	1.25E+00	1.26E+00	0%	0%
vol% solids	7.96E+00	8.51E+00	7.51E+00	7%	6%
void frac.	5.07E-01	5.07E-01	5.03E-01	0%	1%
wt.% H2O	6.96E+01	6.97E+01	6.95E+01	0%	0%
TOC wt.%C	2.69E-04	2.85E-04	2.58E-04	5%	4%
Species					
OH	2.43E+03	2.36E+03	2.56E+03	3%	5%
NO3	1.73E+05	1.73E+05	1.73E+05	0%	0%
NO2	6.77E+03	6.77E+03	6.82E+03	0%	1%
CO3	7.92E+03	7.28E+03	8.58E+03	9%	8%
PO4	5.09E+03	5.35E+03	5.33E+03	5%	5%
SO4	9.50E+03	9.49E+03	9.47E+03	0%	0%
Si	2.16E+02	2.36E+02	2.35E+02	9%	8%
F	2.93E+03	2.78E+03	3.07E+03	5%	5%
Cl	3.33E+03	3.42E+03	3.27E+03	3%	2%
C6H5O7	0.00E+00	0.00E+00	0.00E+00		
EDTA	0.00E+00	0.00E+00	0.00E+00		
HEDTA	0.00E+00	0.00E+00	0.00E+00		
NTA	0.00E+00	0.00E+00	0.00E+00		
Glycolate	0.00E+00	0.00E+00	0.00E+00		
Acetate	0.00E+00	0.00E+00	0.00E+00		
Oxalate	0.00E+00	0.00E+00	0.00E+00		
DBP	3.93E+00	4.15E+00	3.77E+00	5%	4%
Butanol	1.39E+00	1.46E+00	1.33E+00	5%	4%
	0.00E+00	0.00E+00	0.00E+00		
NH3	1.26E+03	1.25E+03	1.28E+03	1%	1%
NiFe(CN)6--	0.00E+00	0.00E+00	0.00E+00		
H-3 (µCi/g)	3.86E-03	3.76E-03	3.95E-03	3%	2%
C-14 (µCi/g)	2.26E-04	2.19E-04	2.34E-04	3%	3%
Ni-59 (µCi/g)	3.45E-05	3.45E-05	3.44E-05	0%	0%
Ni-63 (µCi/g)	3.55E-03	3.54E-03	3.55E-03	0%	0%
Co-60 (µCi/g)	2.60E-04	2.46E-04	2.75E-04	6%	5%
Se-79 (µCi/g)	8.69E-06	8.61E-06	8.82E-06	1%	1%
Sr-90 (µCi/g)	1.81E+00	1.82E+00	1.82E+00	1%	0%
Y-90 (µCi/g)	1.81E+00	1.82E+00	1.82E+00	1%	0%
Zr-93 (µCi/g)	8.05E-04	7.61E-04	8.25E-04	6%	2%
Nb-93m (µCi/g)	7.17E-04	6.78E-04	7.34E-04	5%	2%
Tc-99 (µCi/g)	2.61E-03	2.58E-03	2.67E-03	2%	2%
Ru-106 (µCi/g)	5.66E-13	3.28E-13	7.79E-13	53%	32%
Cd-113m (µCi/g)	2.93E-04	2.88E-04	2.99E-04	2%	2%
Sb-125 (µCi/g)	8.07E-06	7.99E-06	8.19E-06	1%	1%
Sn-126 (µCi/g)	3.27E-05	3.24E-05	3.31E-05	1%	1%

Table D-5. Comparison of HDW Model Predicted BT-SltCk Saltcake Liquid Composition with Predicted Liquid Compositions for BSltCk and T1SltCk. (3 Sheets)

pred. su. ppm	BT-SltCk	BSltCk	T1SltCk	BSltCk vs. BT-SltCk	T1SltCk vs. BT-SltCk
I-129 (µCi/g)	3.62E-06	3.59E-06	3.68E-06	1%	1%
Cs-134 (µCi/g)	6.41E-08	6.67E-08	6.23E-08	4%	3%
Cs-137 (µCi/g)	7.61E+00	7.60E+00	7.68E+00	0%	1%
Ba-137m (µCi/g)	7.19E+00	7.18E+00	7.25E+00	0%	1%
Sm-151 (µCi/g)	4.00E-01	3.91E-01	4.11E-01	2%	3%
Eu-152 (µCi/g)	1.36E-05	1.32E-05	1.39E-05	2%	3%
Eu-154 (µCi/g)	1.04E-03	1.01E-03	1.06E-03	2%	3%
Eu-155 (µCi/g)	6.07E-04	5.89E-04	6.26E-04	3%	3%
Ra-226 (µCi/g)	4.23E-08	4.26E-08	4.24E-08	1%	0%
Ra-228 (µCi/g)	1.92E-13	1.94E-13	1.92E-13	1%	0%
Ac-227 (µCi/g)	1.90E-07	1.90E-07	1.91E-07	0%	1%
Pa-231 (µCi/g)	5.90E-07	5.70E-07	6.11E-07	3%	4%
Th-229 (µCi/g)	3.47E-11	3.28E-11	3.65E-11	6%	5%
Th-232 (µCi/g)	2.92E-13	2.76E-13	3.08E-13	6%	5%
U-232 (µCi/g)	1.02E-10	1.20E-10	1.01E-10	16%	2%
U-233 (µCi/g)	8.16E-12	9.41E-12	8.15E-12	14%	0%
U-234 (µCi/g)	7.61E-06	8.09E-06	8.07E-06	6%	6%
U-235 (µCi/g)	3.39E-07	3.59E-07	3.61E-07	6%	6%
U-236 (µCi/g)	8.92E-08	1.03E-07	8.93E-08	14%	0%
U-238 (µCi/g)	7.76E-06	8.25E-06	8.22E-06	6%	6%
U-Total (µg/g)	2.32E+01	2.47E+01	2.47E+01	6%	6%
Np-237 (µCi/g)	2.23E-05	2.22E-05	2.25E-05	0%	1%
Pu-238 (µCi/g)	2.98E-05	3.12E-05	3.14E-05	5%	5%
Pu-239 (µCi/g)	3.91E-03	4.16E-03	4.15E-03	6%	6%
Pu-240 (µCi/g)	4.43E-04	4.67E-04	4.68E-04	5%	5%
Pu-241 (µCi/g)	8.92E-04	9.30E-04	9.39E-04	4%	5%
Pu-242 (µCi/g)	6.43E-09	6.70E-09	6.75E-09	4%	5%
Pu-Total (µg/g)	6.50E-02	6.91E-02	6.89E-02	6%	6%
Am-241 (µCi/g)	1.23E-03	1.25E-03	1.23E-03	1%	0%
Am-243 (µCi/g)	1.62E-07	1.68E-07	1.59E-07	3%	2%
Cm-242 (µCi/g)	2.80E-07	2.89E-07	2.98E-07	3%	6%
Cm-243 (µCi/g)	3.30E-09	3.42E-09	3.52E-09	3%	7%
Cm-244 (µCi/g)	7.76E-08	8.02E-08	8.28E-08	3%	7%

The overall volume and mass balance associated with these two saltcakes is well within balance, and there appears to be little practical impact except for the noted uranium and plutonium impacts; therefore, the combination of the two is a reasonable practice.

D5.0 WASTE STATUS AND TRANSACTION RECORD SUMMARY

This appendix documents changes made to the WSTRS file to support development of the HDW Model Rev. 5.0. The modified file is named WSTRS5_245c.

The HDW Model Rev. 4.0 generated defined waste streams for B, T1, R, and BY saltcakes. The SMM generated saltcake composition estimates for the rest of the evaporator systems on a tank by tank basis. This modeling feature made it necessary to change the WSTRS spreadsheets and the HDW Model such that defined saltcake waste streams were also modeled for the T2, S1, S2, A1, and A2 saltcakes as well. The method that was utilized was the same system as previously used in the HDW Model for the earlier evaporator modeling. This representation incorporates taking all waste coming into an evaporator feed tank, sending it out to a faux evaporator supertank, concentrating it, then bringing it back into the evaporator feed tank This is done on a quarter-by-quarter basis. The HDW Model is then run and the resulting supertank profiles for each evaporator are loaded into the HDW waste stream spreadsheet and the recycle or amount of waste relabeled as itself multiple times is removed from the calculation. This method simplifies the compositions specific to a tank, because the solution equilibrium conditions (especially temperature) change as a function of the tank. Although differential precipitation is observed in sample data, this condition is very difficult to represent in the model with its current level of sophistication.

The changes seen in the WSTRS5_245c file are pairs of outx/xins waste transfers that re-label the waste in the evaporator feed tanks for the time periods that the main feed tanks are active for each evaporator campaign. There are multiple in/out pairs within a quarter when segregation of waste with high organic levels is occurring.

A small amount of re-labeling was done in order to send all of the waste from the B and T1 separate evaporator feed tanks to same supertank in order to combine the saltcakes as described in the main text.

The other changes made to the WSTRS file are with reference to the allocation of the TH1 and TH2 waste stream inputs and the CWP2 and CWZr1 waste stream inputs. These changes are documented in the change log, Appendix B.

D6.0 REFERENCES

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APPENDIX E

BACKGROUND AND APPROACH FOR REVISION 4.0 OF THE HANFORD DEFINED WASTE MODEL

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This appendix summarizes the background and approach of the Hanford Defined Waste Model published in *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4 (*Agnew et al. 1997).

E1.0 Background

One of the most important tasks associated with the Hanford waste tanks is an adequate estimation of those tank's contents. Such estimates are very important for four reasons: 1) To establish safety limits during intrusive activities; 2) To establish a planning basis for future disposal; 3) To allow assays from one tank's waste to be used to validate, compare, and assess hazards among other tank's with similar waste inventories; and 4) To make sense out of the highly variable results that often come from a tank's waste assays, it is necessary to couch assay results in terms of the particular process and storage history of each tank.

It is clear that direct assays of tank wastes will always be an important and ongoing need for the Hanford tanks. However, it is equally clear that it will not be possible to adequately address all waste issues by sampling and assay alone. Obtaining a set of samples that is representative of the waste heterogeneity within a tank is undoubtedly the most difficult aspect of deriving tank inventories from assays alone. Both the extremely heterogeneous nature of tank waste and the limited access provided by riser pathways to waste in these seventy-five foot diameter underground tanks contribute to difficulties in using assays alone to derive tank inventories. The chemical and radiological hazards of the waste impose rigorous safety requirements on sampling.

E2.0 Approach

The Hanford Defined Waste (HDW) model is described in Fig. 1 (Schematic of Overall Strategy). The model begins with a process and transaction dataset that derives from a variety of sources. From this dataset, a balanced tank-by-tank quarterly summary transaction spreadsheet is derived called the Waste Status and Transaction Record Summary (WSTRS).

Using these fill records, the Tank Layer Model (TLM) provides a definition of the sludge and salt cake layers within each tank. The TLM is a volumetric and chronological description of tank inventory based on a defined set of waste solids layers. Each solids layer is attributed to a particular waste addition or process, and any solids layers that have unknown origin are assigned as such and contribute to the uncertainty of that tank's inventory. The TLM simply associates each layer of sludge within a tank with a process waste addition. As indicated in (Fig. 1), the TLM analysis depends only on information from WSTRS.

The Supernatant Mixing Model (SMM) is an algorithm written in C++ and installed as a spreadsheet macro under Excel (a Dynamic Linked Library or dll module) that calculates the supernatant concentrates within each of the tanks. The SMM uses information from both WSTRS and the TLM and describes supernatant concentrates in terms of original

waste volume in kgal (1 kgal = 1,000 gal) for each of the process waste additions. The original waste volume in addition to the present tank volume give the amount of concentration (water removal) or dilution that a tank has seen in its history.

The WSTRS, TLM, and SMM altogether determine each tank's waste inventory as a linear combination of HDW sludge and supernatant volumes (TLM and SMM volumes). In order to provide information on the elemental composition of each tank, the HDW compositions describe each waste stream based on process historical information. Each HDW has both supernatant and sludge layers and derives its total waste volume from WSTRS and its sludge volume from the TLM. Thus, the HDW compositions depend on all prior model components—process/transaction dataset, WSTRS, TLM, and SMM.

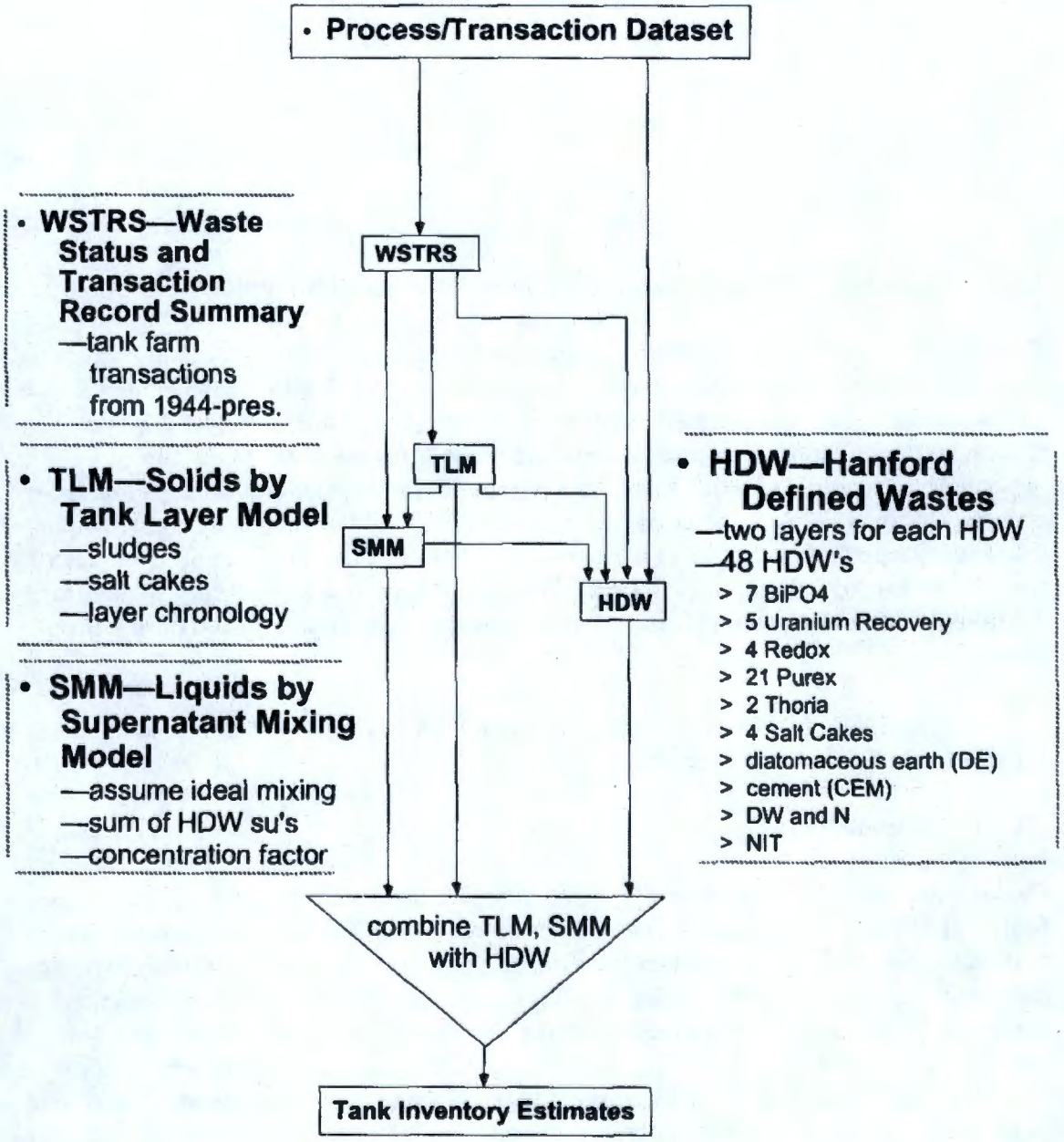
Each tank's total inventory is then calculated as superposition of waste components as

$$\mathbf{tank}_i = \frac{\sum_j \mathrm{tlm}_{ij}\,\mathbf{hdw}_j^{sl}}{\mathrm{slVol}_i} + \frac{\sum_j \mathrm{smm}_{ij}\,\mathbf{hdw}_j^{su}}{\mathrm{suVol}_i}$$

where

$\mathbf{tank}_i$	= composition vector for tank i
$\mathbf{hdw}_j^{sl}$	= composition vector for HDW sludge j
$\mathbf{hdw}_j^{su}$	= composition vector for HDW supernatant j
tlm_{ij}	= kgal of hdw sludge j for tank i
smm_{ij}	= kgal of hdw supernatant j for tank i
slVol_i	= sludge kgal for tank i
suVol_i	= supernatant concentrate kgal for tank i.

Figure E-1. Schematic of Overall Strategy.



The first term is the TLM solids inventory and is reported as

$$\mathbf{tank}_i^{sl} = \frac{\sum_j \mathrm{tlm}_{ij}\,\mathbf{hdw}_j^{sl}}{\mathrm{slVol}_i}$$

while the second term is the SMM inventory reported as

$$\mathbf{tank}_i^{su} = \frac{\sum_j \mathrm{smm}_{ij}\,\mathbf{hdw}_j^{su}}{\mathrm{suVol}_i}$$

E2.1 Approach—Waste Status and Transaction Record Summary

The WSTRS is an Excel spreadsheet of qualified fill records[3] with information extracted from Jungfleisch-83[4] and Anderson-91[5], and checked by Ogden Environmental and LANL against quarterly summary reports and the Logbook Dataset.[6] The WSTRS reports, although largely representative of the waste histories of the tanks, are nevertheless incomplete in that there are a number of unrecorded transactions that have occurred for many tanks. Included within the WSTRS report, then, is a comparison of the tank volume that is calculated based on the fill records that are present in WSTRS with the measured volume of each tank. This comparison is made for each quarter to record any unknown waste additions or removals that may have occurred during that quarter.

After 1980, the Waste Volume Projection (WVP) project has provided an excellent set of ordered transactions.

E2.1.1 Cascade Transfers

Cascade lines were underground 3" pipes between tanks that were generally offset one foot of elevation between tanks. These lines allowed a tank to overflow into the next tank in the cascade series, and then from that tank to the next, and so on, from two to six tanks total in a given cascade series. WSTRS includes explicit transactions for each cascade transfer based on the following rules. If a tank's Total_vol exceeds its rated capacity, then check to see if a CSEND SET and CREC SET pair are present in the records of Tank_n and Trans_tank, respectively. If a pair is present, insert a "send" and "rec" pair of transactions of the appropriate volume. When cascading out to a crib "send" and "outx" pair are inserted. In the SE Quadrant (i.e. for DST's) there is no cascading.

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[3] (a) Agnew, S. F., et al., "Waste Status and Transaction Record Summary for the NE Quadrant" WHC-SD-WM-TI-615, Rev. 1, October 1994. (b) Agnew, S. F., et al. "Waste Status and Transaction Record Summary for the SW Quadrant, " WHC-SD-WM-TI-614, Rev. 1, October 1994. (c) Agnew, S. F., et al. "Waste Status and Transaction Record Summary for the NW Quadrant, " WHC-SD-WM-TI-669, Rev. 1, October 1994.

[4] (a) Jungfleisch, F. M. "Hanford High-Level Defense Waste Characterization—A Status Report," RH-CD-1019, July 1980. (b) Jungfleisch, F. M. "Supplementary Information for the Preliminary Estimation of Waste Tank Inventories in Hanford Tanks through 1980," SD-WM-TI-058, June 1983. (c) Jungfleisch, F. M. "Preliminary Estimation of Waste Tank Inventories in Hanford Tanks through 1980," SD-WM-TI-057, March 1984.

[5] Anderson, J. D. "A History of the 200 Area Tank Farms," WHC-MR-0132, June 1990.

[6] Agnew, S.F.; Corbin, R.A.; Duran, T.B.; Jurgensen, K.A.; Ortiz, T.P. "Hanford Tank Logbook Dataset," LA-UR-96-3387, September 1996.

E2.1.2 Transaction Ordering

The chronological ordering of the transactions in WSTRS prior to 1981 is not clearly defined. Hanford's quarterly summarization of transactions tended to truncate much of the individual transaction ordering information. From 1976 to 1981, the Logbook Dataset was used to help re-establish transaction order and to resolve many other transaction questions. Transactions with no additional information (i.e. pre-1976) were arranged in the following order for each quarter:

1) Xin's from primary sources
2) Tank to tank transfers not involved in evaporator operations
3) Tank to tank transfers involved in evaporator feeds
4) Concentration of wastes involved in evaporators
5) Tank to tank transfers for the bottoms receivers
6) Outx's to processes and cribs (no condensates)

Some corrections to this initial order were required to prevent the total volume of the tanks from going negative and to minimize tank overfills. Further corrections will be necessary as more information as to the segregation of the organic wastes is compiled.

The transaction order for post-1980 transactions were left as represented by the WVP report. Many of these dates are summaries of transactions and some are nominal, so there exists the possibility that some reordering may be necessary as more information on these transactions surface.

E2.1.3 HDW Evaporator Model

An essential part of defining the waste history of Hanford wastes is understanding the operation of the many evaporator campaigns at Hanford, since the greatest uncertainties within WSTRS are associated with evaporator campaigns. In other words, the volume reductions and continuous transfers of concentrates and condensates that occurred during these campaigns are not very well represented in WSTRS.

Much of the transaction information associated with evaporator operations was derived by Jungfleisch-83 with several models for various evaporator campaigns that were embedded within the WSTRS Rev. 1 data set.

In the WVP data set, the evaporation model transferred a volume from the feed tank to a bottoms receiver tank. The volume received by the bottoms receiver tank, however, would be less than the volume sent from the feed tank. This difference was the condensate that was evaporated, which was not specifically included.

In WSTRS Rev. 2, 3 and 4, all evaporator transactions are assumed to take place from the evaporator feed tank. Therefore, all implicit condensate that is evaporated from the

feed tank is explicitly included as transactions from the feed tank to a crib. We have inserted these condensate transactions for the feed tank and have changed the transaction volume (when necessary) to be equal to the volume received in the bottoms tank. This same model has been imposed on all evaporator operations at Hanford within WSTRS.

This evaporator model reduces significantly the unknown transactions for the history of Hanford operations. One must bear in mind, though, that the assumptions that have been made are meant to be approximations that allow the bounding of waste compositions for all site operations. We have found, for example, that the transaction order within each quarter is not well defined and our assumptions about that order are very approximate.

E2.1.4 Resolution of Unknown Transactions

Transactions from the Logbook Dataset were added to WSTRS to resolve the many unexplained level changes for each quarter according to a set of rules resulting in an updated WSTRS that is known as Rev. 4. This unknown transaction resolution was only completed for all unknowns larger than 50 kgal, although many smaller transaction unknowns were accommodated as well. The following rules were used for unknown transaction resolution for the various transaction types:

Evaporator feed and bottoms receivers:

During an evaporator campaign, unknown waste transfers at the end of each quarter are resolved by sending wastes to or receiving wastes from an evaporator feed tank for tanks identified as either bottoms receivers or feed tanks for those campaigns.[7]

Self-concentrating tanks:

Certain tanks in S, SX, A, and AX farms were allowed to self-concentrate. Any losses or additions to these tanks are assigned to condensate or water, respectively.

Sluicing receivers:

For tanks associated with a sluicing campaign (either UR or SRR), unknown transactions are resolved by either sending or receiving from the sluicing receiver tank for that campaign. Unassigned losses from the sluicing receivers, then, are sent directly to the process.

[7]Agnew, S.F.; Corbin, R. A.; Boyer, J.; Duran, T.; Jurgensen, K.; Ortiz, T.; Young, B. "History of Organic Carbon in Hanford HLW Tanks: HDW Model Rev. 3," LA-UR-96-989, March 1996.

Salt-well pumping and stabilization:

If an unknown loss occurs during salt well pumping stabilization of a tank, then the unknown is resolved by sending waste to the active salt well receiver at that time.

Historical use of tank:

If none of the above rules apply, then the historical use of the tank is used to assign the transaction. For example, C-105 was used as a supernatant feed tank for the CSR campaign and supplied ~1,500 kgal per quarter for several years. However, there is one quarter (1971q2) where C-105 loses 1,748 kgal without an assigned transaction. Because of C-105's process history, this transaction is assigned to CSR feed. Likewise, there are a number of large supernatant losses in A and AX Farms during sluicing for sludge recovery. These supernatant losses are assigned as feed to AR, which are the slurries transferred to AR Vault for solids separation, washing, dissolution, and feed to SRR.

There are volume reductions among the S and SX Farm tanks in the fifties and early sixties. We attribute these losses to the Redox waste self-concentrating tanks and these tanks also accumulated solids as they concentrated, which we assign as Redox salt cake. Likewise, the Purex waste tanks in A and AX Farms were self-concentrating, but no salt cake formed from this self-concentration. Volume losses for such tanks are assigned as condensate transactions out of the tank and additions are assigned as water in.

The two Purex cladding waste (CWP) cascades, B-103 and B-109 had large unknown transfers in 1963q4. These were resolved by transferring supernatants to A-102, which was the staging tank for A Farm sluicing as well as a feed for the self-boiling tanks in A and AX Farms. Excess volume added to A-102 amounts to over 2,000 kgal in '63q4, which is assumed to have been associated with the sluicing required for initial feed to HS or SSW (Hot or Strontium Semiworks), and eventually ended up blended into the A/AX self-boiling tanks. Likewise, other later excess losses that accumulated in A-102 are assumed to have been used as feed for the self-boiling tanks in A/AX Farms.

Sluicing of A and AX Farms resulted in many unrecorded transactions for these tanks during that period. We have resolved all large transactions by creating transactions between tanks and the sluicing receiver in A and AX Farms. The sluicing receivers evolved from A-102, A-106, to AX-103 over the course of the campaign.

For each of the evaporator campaigns, we have identified the feed and bottoms receivers. All unknown transactions for the feed and bottoms receivers are sent to or received from the evaporator feed tank. This allows us to resolve all evaporator campaign transactions and to therefore track the waste compositions as a function of time.

Cross-site transfer tanks S-107 to/from BX-104 and BX-105 were used to transfer wastes back and forth to and from west and east areas prior to 1981. We assume this linkage was used for most cross site transactions between East and West areas.

E2.1.5 Verification of WSTRS

Validation for the WSTRS and WVP datasets was performed by Ogden Environmental of Richland, WA. Reference documentation was provided for each transaction that Ogden verified. Validation information for all tanks is shown in (Table E-1) with the numbers and percents validated for transactions and transaction volumes in all quadrants *prior* to Jan. 1981. Validation for DST's in *after* Jan. 1981 is provided by the Waste Volume Projection data source.

Table E-1.
Validation for All Quadrants for Transactions prior to Jan. 1981.

	Number Basis		Volume Basis (kgal)	
	Validated / Total	% Validated	Validated / Total	% Validated
XIN's	1952/3236	60%	279,577/443,102	63%
OUTX's, REC's	2083/3624	57%	551,857/895,564	62%

E2.2 Approach—Tank Layer Model (TLM)

The TLM uses the past fill history of each tank to derive an estimate of the types of solids that reside within those tanks. The TLM[8,9] is generated by reconciling the reported solids levels from WSTRS for each tank with the solids volume per cent expected for each primary waste addition.

The TLM is a volumetric and chronological description of tank inventory based on the HDW sludges and salt cakes. Each solids layer is attributed to a particular waste addition or process, and any solids layers that have unknown origin are assigned as such and contribute to the uncertainty of that tank's inventory. The TLM simply associates layers of solids within each tank with a waste addition or a process campaign.

The TLM uses the information obtained from the transaction history for each tank to predict solids accumulations. These predictions are made for three categories of waste tanks.

[8](a) Brevick, C. H., et al., "Supporting Document for the Historical Tank Content Estimate for A Tank Farm," WHC-SD-WM-ER-308, Rev. 0, June 1994. Likewise, reports and numbers for each farm are as follows: AX is 309, B is 310, BX is 311, BY is 312, C is 313, S is 323, SX is 324, and U is 325. These supporting documents contain much of the detailed information for each tank farm in a concise format, all released as Rev. 0 in June 1994.

[9]Agnew, S. F., et al. "Tank Layer Model (TLM) for Northeast, Southwest, and Northwest Quadrants," LA-UR-94-4269, February 1995.

The first category involves primary waste additions, which are the waste additions from process plants directly into a waste tank. The primary waste transactions are used along with solids volume reports for each tank to derive an average volume percent solids for each HDW type. The solids accumulations are then assigned to a particular HDW for the tanks where the solids information is missing or inconsistent.

A second category of waste is that where solids accumulate as a result of evaporative concentration of supernatants. All solids that accumulate in such tanks occur after they have been designated as "bottoms" receivers. These solids are assigned to one of four salt cakes, which are defined as blends over entire evaporator campaigns. The four salt cakes are BSltCk, T1SltCk, BYSltCk, and RSltCk, and are all defined as HDW's. The latter five evaporator campaigns T2, S1, S2, A1, and A2 all result in waste concentrates that are defined differently for each tank within the SMM. These solids are explained in the section "Solids not included in TLM."

The third category of waste is where solids accumulate due to tank to tank transfers of solids. This category allows solids to cascade from tank to tank, or accounts for solids lost during routine transfers as was common with decladding wastes CWR and CWP as well as 1C and FeCN sludges.

The results of the TLM analysis are a description of each tank's solids in terms of sludge and salt cake layers. Although interstitial liquid is incorporated within the composition for sludges and salt cakes, any residual supernatants that reside in these tanks above the solids are described by the SMM. The output of the TLM, then, can only be used to predict the inventory of the sludges and each of four salt cakes that reside within waste tanks. These TLM results are inserted into the WSTRS record and are used by the SMM in considering excluded volumes for mixing of waste supernatants.

E2.2.1 Sludge Accumulation from Primary Waste

The TLM analysis associates a solids volume percent (vol%) with each primary waste stream. These solids vol% are those that are consistent with the solids volumes reported in Anderson-91 by comparing those solids accumulations with the primary waste additions that are recorded in WSTRS. The result of this analysis is a solids volume percent for each waste type with a range of uncertainty associated with the inherent variability of the process.

Not all of the waste types have adequate solids reports associated with them. For these waste types, a nominal value is assigned based on similarity to other waste types where there exists a solids vol%. For example, a total of 810 kgal of Hot Semi-Works waste (HS) was added to several tanks in C Farm, but these additions only constituted a small fraction of the total solids present in any of these tanks. Therefore, a nominal 5 vol% solids is assigned for that waste type.

Each TLM spreadsheet table shows the primary waste additions and the solids from those additions based on the characteristic vol% for that waste type. The TLM compares this prediction with the solids level reported for the tank and indicates either an unknown gain or loss for this tank. Once a layer is "set" in the tank, its volume appears in the "Pred. layer" column and the type in "Layer type" column, thus comprising a chronological layer order from the bottom of a tank to the top, where each layer is described in terms of a volume and a type. Note that lateral variations are not accounted for in this model, and only derive an average layer thickness. The lateral distribution, in some cases, can be quite extreme.

There are two main sources for variations in the solids vol% for each waste type. First, there is an inherent variability in each process stream, which is largely attributable to process variations. Second, solids can be added to or removed from tanks by inadvertent (or purposeful) entrainment during other supernatant transfers. In addition to these sources of variation, there are a number of other minor sources of solids changes such as compaction, subsidence following removal of salt well liquid, and dissolution of soluble salts by later dilute waste additions. Other solids variations may be due to metathesis and other chemical reactions within the tanks, such as degradation of organic complexants over time.

The TLM assigns solids changes to variability when they fall within the range established. If a change in solids falls outside of this range, the TLM associates the gain or loss of solids with a waste transfer to or from another tank or to dissolution of soluble salts in the upper existing solids layers.

E2.2.2 Saltcake Accumulation

Once a tank becomes a "bottoms" receiver, the TLM assumes from that point on that any solids that accumulate are salt cake or salt slurry. Salt cake can be any one of four different types, depending on which evaporator campaign created it. These are: 1) B for 242-B, 2) T1 for early 242-T, 3) BY for ITS #1 and #2 in BY Farm, and 4) R for Redox self-concentrating tanks. Overview of Hanford Waste Volume (Table E-3) describes the various evaporator campaigns that resulted in concentration of waste and precipitation of solids at Hanford. For salt cake accumulation, the TLM assumes that all of the solids reported are salt cake. Two other minor evaporation campaigns involved use of Redox and B Plant evaporators for tank wastes. These minor campaigns have been associated with T2 or S1 campaigns, respectively.

The HDW model assigns waste of the five later campaigns for 242-T, 242-S, and 242-A evaporators as concentrates within the SMM. These later concentrates correspond roughly to what is known as double-shell slurry (DSS) or double-shell slurry feed (DSSF), although their early concentrates are often referred to as salt cake as well.

E2.2.3 Diatomaceous Earth/Cement

Diatomaceous Earth was added to the following waste storage tanks BX-102 (1971), SX-113 (1972), TX-116 (1970), TX-117 (1970), TY-106 (1972), and U-104 (1972). The additions of diatomaceous earth were used to immobilize residual supernatant liquid in tanks where the liquid removal by pumping was not feasible. The conversion factor in the TLM for Diatomaceous Earth (DE) is 0.16 kgal/ton and Cement (CEM) is 0.12 kgal/ton. The CEM waste was only added to one tank, BY-105 (1977).

E2.2.4 Solids Not Included in TLM

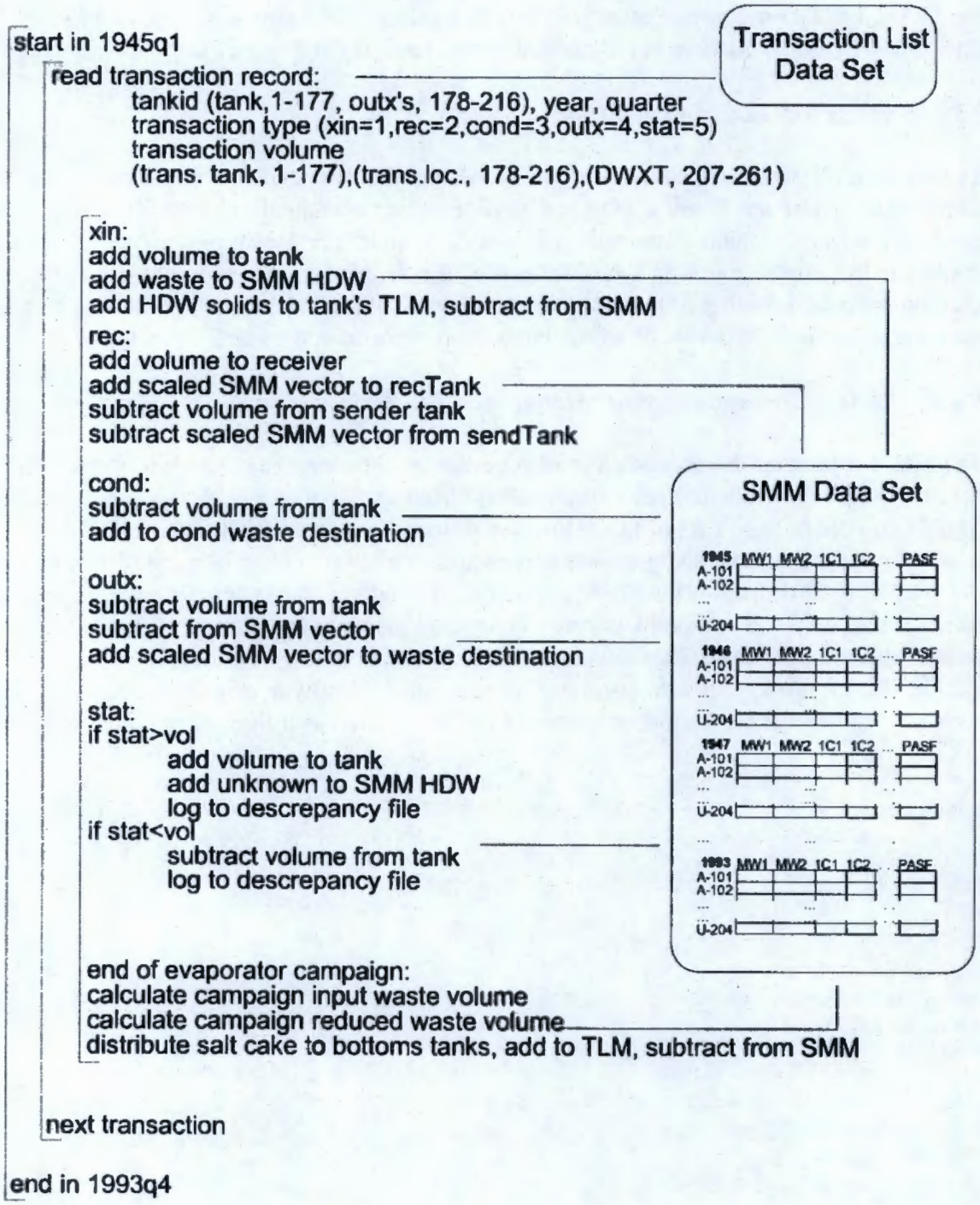
The TLM predicts the salt cake layers for the B, early T, BY, and R evaporator campaigns. These are HDW wastes and are defined on a campaign basis. The concentrated supernatants associated with the A, S, and latter T evaporator campaigns are treated as free supernatants and thus defined by the SMM. The SMM tracks the concentration and mixing of these supernatants on a tank-by-tank quarterly basis. This is necessary due to the complexity of the latter evaporator scenarios and waste types.

E2.3 Approach—Supernatant Mixing Model (SMM)

The SMM calculates the composition of supernatant concentrates within each tank. The result is a table of waste in kgal of original HDW supernatants for each of the tanks. The SMM is a very critical part of the definition of waste in double-shell tanks (DST's) where a large fraction of supernatants now reside. The Supernatant Mixing Model Block Diagram (Fig.2) illustrates the SMM approach. A fundamental assumption within the SMM is the ideal and complete mixing of each tank's supernatant following each transaction. In this approach, the volume of TLM solids layers within each tank are excluded from mixing with any supernatant additions. However, any solids that form as a result of waste concentration within the SMM are treated as if they were liquid.

Figure E-2. Block Diagram of SMM Algorithm.

Supernatant Mixing Model
Block Diagram

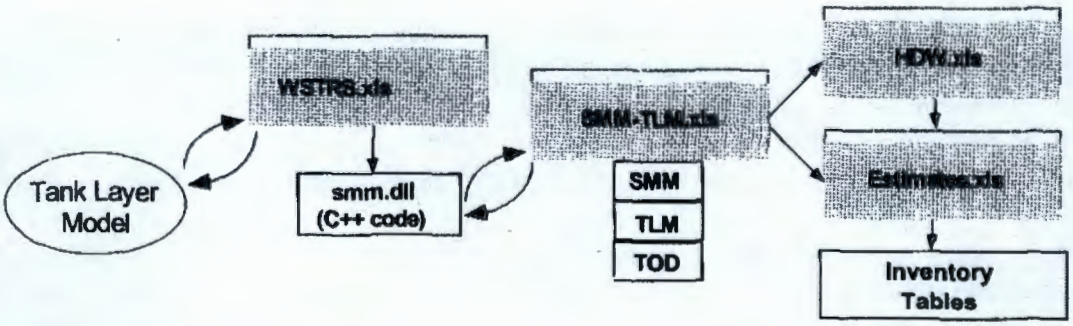


The SMM module reads transaction information from WSTRS, sorts it to an absolute chronological order, and performs a transaction by transaction accounting of all of the tank waste supernatant for the history of Hanford. The SMM provides a description of each tank's supernatant concentrate as a linear combination of Hanford Defined Waste (HDW) supernatants. The HDW type is specified within WSTRS for each transaction from plant to tank. This HDW supernatants within a tank represent a total volume that is usually larger (and sometimes smaller) than the actual volume of supernatant concentrate within that tank. This is due to active evaporation (or dilution) of the waste during its history. Each tank's SMM waste is expressed in terms of a linear combination of HDW supernatants (a waste vector), which in turn are used to calculate a chemical and radionuclide inventory with compositions for each tank.

E2.3.1 Implementation of SMM

The SMM is implemented as two Microsoft Excel workbooks and an extension to Excel (called a Dynamic Linked Library). Figure E-3 shows the relationship of the SMM components to each other as well as to the overall tank inventory prediction strategy. The transaction data source for the SMM program is the WSTRS workbook, which is not modified during operation. A second workbook (SMM-TLM.xls) provides additional input, program control, and storage for formatted SMM output. The smm.dll is written in the 'C++' programming language.

Figure E-3. Diagram of the HDW Model Components.



E2.3.2 Transaction Processing

The smm.dll tracks the tank waste contents (in HDW component basis) based on transaction bookkeeping. The model achieves ideal mixing by assuring that a withdrawal from a tank is an HDW vector proportional to the HDW vector of the tank supernatant contents. The general algorithm is to process the information on waste transfers and level measurements in transaction order while keeping track of the HDW components in each tank. The processing details are determined by the transaction type. Since transactions are summarized rather than detailed, there can be apparent overfills.

If there is insufficient supernatant in a source tank, the shortage is accounted for by addition of an unknown waste type. The additions of unknowns are treated as if they were HDW waste additions. These unknowns measure one uncertainty in the tank HDW vector. Apparent overfills are less important as they generally result from miss-phasing due to the granularity of the dataset and tend to correct themselves. Transaction processing is relatively straight forward. There are five basic transaction types.
1) The XIN and xin transactions represent the transfer of waste from process to storage and simply record the transfer of HDW waste to the storage tanks. The xin designation identifies an assumed rather than a documented transaction. 2)The REC and rec transactions are tank to tank or tank to process transactions with the rec designating an assumed transaction. 3)The outx is a transfer to process or CRIB and is essentially another variation of the REC transaction. The last three transactions move HDW waste vectors between tanks and processes. 4)The cond transaction removes water from the tank without changing the HDW waste vector. 5)The stat transaction serves to realign the tank volume with physical measurements.

E2.3.3 Ancillary Information

In addition to the tank compositions, the SMM also generates a variety of other important information. These include volumes of waste from assumed transactions, total traffic in a tank, traffic from assumed transactions, and various other information.[6]

E2.4 Approach—Hanford Defined Wastes (HDW) Compositions

The determination of chemical and radionuclide concentrations for each of the HDW's begin with inputs of radionuclides and stable chemicals, both of which are used to define the total species in each waste stream as shown by the Block Diagram of HDW Spreadsheet (Figure E-4). These total species are then separated into two layers, a sludge and a supernatant, that result in different concentrations of species for the two layers.

Each species is precipitated according to a single point solubility. Ions precipitated in more than one salt are simply successively precipitated. Thus, the solids that precipitate are merely representative and are not meant to reflect the actual solids distribution. Because the supernatant is also present in the interstices of the sludge layer, this "supernatant" is included as part of the sludge composition. The solubility of each species is set by a macro that when run on the HDW spreadsheet, adjusts the fraction precipitated parameter so that the supernatant concentration is equal to or less than the target solubility.

The sludge and supernatant compositions are each expressed in mol/L for the stable chemicals, with water and TOC as wt% and radionuclides in μCi/g and Ci/L, respectively. Each waste is kept in ion and mass balance according to the oxidation states assumed for that species. The sludge and supernatant layers are also expressed in terms of ppm composition. However, the mass balances are limited by differences among water, oxide, and hydroxide with the various solids to only within ±2%.

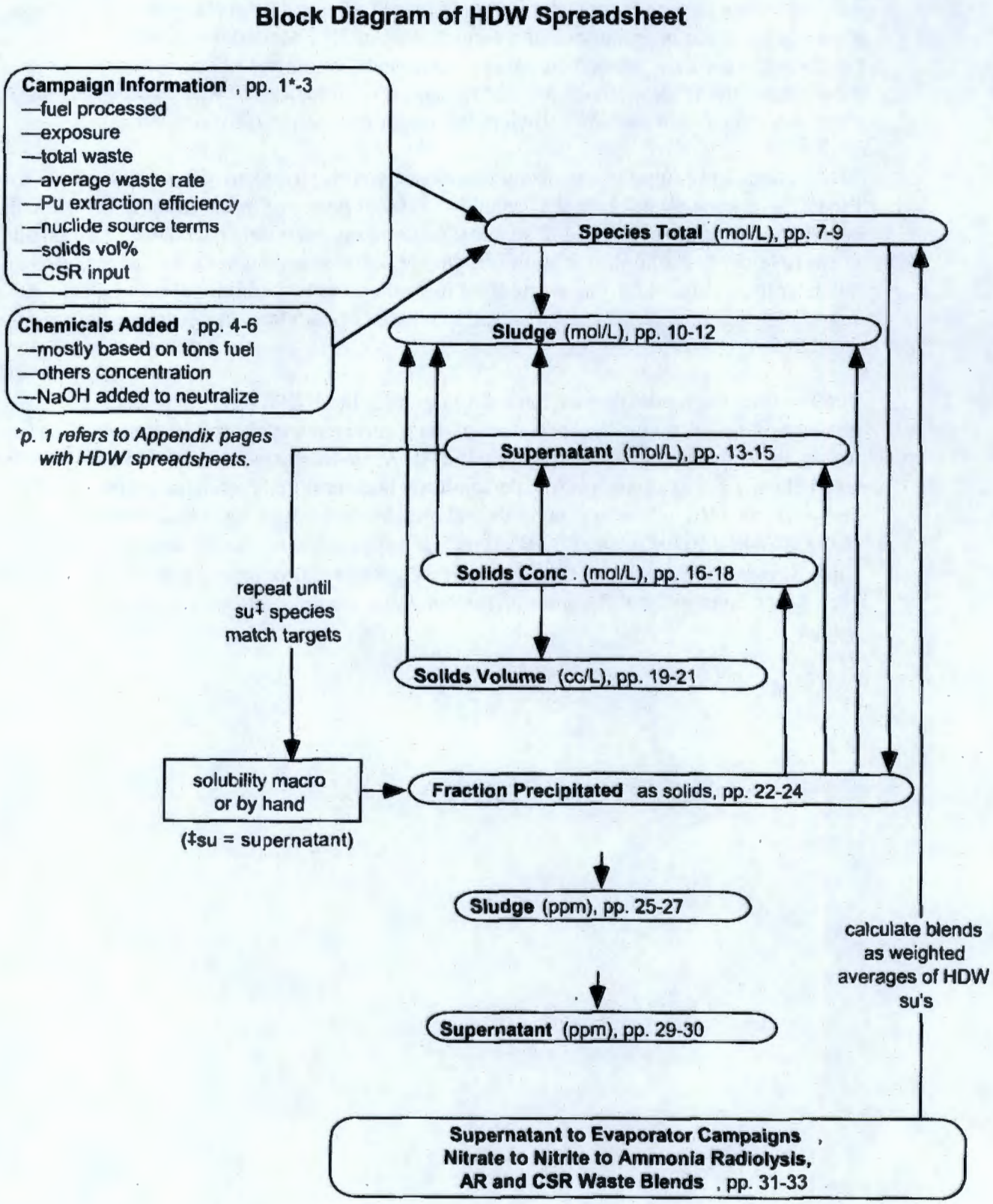
E2.4.1 Three Methods for Establishing Defined Wastes

There are three distinct methods that have been used by previous workers to set the concentrations of each component in the various waste streams at Hanford. These three methods are based on either one or a combination of (1) knowledge of process, (2) chemical used and waste volume produced, and (3) analysis of characteristic waste. However, while these methods provide necessary information for waste stream definition, these methods do not provide sufficient information to define the waste streams.

That is, once the component concentrations (i.e., source terms) are determined for each of the HDW's, one still needs to determine two critical pieces of information to calculate the actual compositions of solids and supernatant components within each tank. That is, one needs to know the solubility of each component in the supernatant as well as the total solids volume percent for that waste stream. With these two additional parameters the waste stream source terms can be related to what is in each tank that received those wastes.

Furthermore, the model that we have developed for the HDW compositions uses *representative* values for the speciation of the components in the solids phases. In other words, the solids that precipitate within the HDW model are those listed in Methodology (see below). For example, phosphate solubility is determined by the ranges observed in tank supernatants, but the solid phases that precipitate are limited to a combination of $BiPO_4$, $Na_3PO_4 \cdot 10H_2O$, and $Na_3PO_4 \cdot 12H_2O$, depending on the circumstances of the waste stream. We argue that this approach adequately approximates the major features of each solids layer without the complexity that undoubtedly exists in the actual waste sludge.

Figure E-4. Block Diagram of HDW Spreadsheet .



Another example is Cs-137, which is precipitated within our model formally as the zero valent metal, when in fact we fully realize that it is actually precipitated as a monopositive cation as some kind of salt.

E2.4.1.1 Knowledge of Process

Basically, this strategy uses process information, such as flowsheets, to derive waste compositions based on a process driver. At Hanford, the driver for HLW was tons of uranium fuel processed per quarter. Therefore, based on this feed, a certain amount of waste was generated for a given Hanford process, such as Purex, and expressed as gallons of waste per ton fuel.

The advantages of this strategy are its simplicity and straightforward application to waste streams. The disadvantages are that often the flowsheet information is incorrect or incomplete. In fact, ancillary or cleanup operations not described explicitly within the flowsheet can end up creating larger waste volumes, and add different constituents to the waste as well.

Specifically, actual waste volumes usually differ from predicted waste volumes based on flowsheet information, and it is not clear how to scale the composition of the primary stream. For example, if a Purex flowsheet indicates that 51 gal. of P waste is generated per ton of uranium, but actually 275 gal/ton occurred, how do the constituents within the stream scale? Is the additional volume just water?

E2.4.1.2 Chemicals Used/Waste Volume Produced

This approach uses observed waste stream volumes, both liquid and settled solids, to establish an actual waste generation rate in gallons of waste per ton of uranium processed for each waste stream. Thus, volume conservation is enforced from the beginning. Then, total chemicals added during processing allow one to unambiguously derive *average* waste compositions. Thus, total mass is always conserved with this approach. (Note that this is the approach that Allen used[10] in his report in 1976.)

The disadvantage of this approach is that it concentrates on only the total amount of chemical used during a campaign. There is often limited information about how the chemicals used changed *during* a campaign. As a result, while this Chemicals Used/Waste Produced approach provides an accurate average waste composition, variations in the compositions of the waste streams are not represented unless one has independent information about the amounts of chemicals used during each of those process variations within the campaigns.

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[10]Allen, G. K. "Estimated Inventories of Chemicals Added to Underground Waste Tanks, 1944 through 1977," ARH-D-6108, March 1976.

E2.4.1.3 Analysis of Characteristic Waste

Deriving waste inventories from analytical information of course begs the whole issue of determining a waste type composition. If a tank's waste is fairly homogeneous, straightforward sampling and analysis will provide an inventory for that tank. The real issue, then, is how can the information from an analysis of tank A's waste be used to predict the contents of tank B. On the one hand, direct analytical information constitutes the bottom line for any tank inventory. On the other hand, there are mitigating factors that show that this approach also has severe limitations.

Sampling has been and will continue to be a very uncertain source of waste composition information for many different reasons, not the least of which is that it is a very difficult and expensive thing to achieve for 177 tanks. For example, pulling a sample from a waste tank is in and of itself a very difficult task, but even when that is done, the question of whether that sample is representative of the tank waste is sometimes impossible to answer—even with additional sampling.

Then, there are the inevitable analytical errors that derive from the procedures used to homogenize, dissolve, and finally analyze each sample. And there is the over arching uncertainty, once these other issues are resolved, of exactly which waste type a tank's waste is representative. In other words, given that SY-101 is a mixture of DSS and CC wastes, what does the analysis of that tank's waste tell us about either of these two waste types?

E2.4.2 Method used for HDW model

We believe that the Chemicals Used/Waste Produced approach is the best for defining waste compositions, therefore, will favor that method. However, much use will be made of Knowledge of Process, since it is necessary to change the manner in which the chemicals are partitioned in the waste stream over the years in order to account for changes in the process. Unfortunately, these two sources of information are often in severe disagreement. For example, there was 3.3 Mmol (1 Mmol = one million moles) of citrate reportedly used in B Plant, but the flowsheets suggest that 32 Mmol would have been used, based on the flowsheet concentration and volumes of waste produced. We do not feel that it will ever be possible to resolve all of these discrepancies between these two sources of information. Therefore, we will only use Knowledge of Process to account for notable changes in the waste processes. For example, in 1962, the Purex waste (termed P) decreased from 844 gal/ton to 288 gal/ton—a factor of 2.9 reduction. Obviously there was a change in the process in 1962 that had a dramatic affect on the volume of P waste that was generated. At that same time, CWP volume stayed at 291 gal/ton, but OWW volume went from 108 gal/ton to 336 gal/ton, an increase of a factor of 3.1.

E3.0 Reference

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

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APPENDIX F

RADIONUCLIDE BEST BASIS INVENTORY (BBI) WORKSHOP EXECUTIVE SUMMARY REPORT MARCH 2002

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RADIONUCLIDE BEST BASIS INVENTORY (BBI) WORKSHOP

EXECUTIVE SUMMARY REPORT

March 4, 18-19, 2002

HAMMER Facility, Room 12

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EXECUTIVE SUMMARY

Introduction

Recently a re-baseline exercise was completed for the Best Basis Inventory (BBI). The re-baseline was conducted using "rules" set forth in RPP-7625, Rev. 1, *Accelerated Best-Basis Inventory Baselining Task.* However, RPP-7625 pertained primarily to protocols for handling sample-based concentrations. Assumptions and rules underlying creation of best basis inventories from HDW model estimates were not addressed in the document. Users of best basis inventories are still concerned that the model–based inventories for critical, mobile, long-lived radionuclides are unduly conservative and, therefore, designs for waste disposal may be unnecessarily conservative and expensive. These concerns did not primarily surround the methods used to calculate the inventories but rather the technical judgments and assumptions underlying the HDW model estimates.

To address these concerns, Jim Field, Manager of BBI, requested a three-day workshop involving key users, customers, and technical staff responsible for the derivation of the best basis numbers, to resolve issues surrounding the assumptions used in estimating inventories for radionuclides. Richard Harrington facilitated and Robin Kummer provided technical support for the three-day workshop. Users, customers, and technical staff representing the BBI, Tank Farm Operations and Projects, Waste Treatment Project, and balance of Hanford site participated in the workshop conducted on March 4, 18-19, 2002, at the HAMMER Facility, Room 12. The purpose of the workshop was to obtain consensus on required radionuclide BBI enhancements, their basis, and a path forward implementation plan.

Appendix A contains the objective, agenda and participants attendance going into and followed throughout the three-day workshop.

Session Results

The workshop was successful in developing the list of needed BBI enhancements and a path forward implementation plan. The BBI enhancements consisted of 13 element area upgrades that ranged from technetium 99, Iodine 129, and Uranium, to TRU. In all 13 areas, inventories could be adjusted to take in account various activities, such as: waste shipped offsite; incorporation of atmospheric losses; and transfers to cribs. The ORIGEN2 model can be re-run with new cross-section data and fission product yields. Upon final evaluation the team ranked each of the 13 enhancements as low, medium, or major upgrades. As such, two upgrades were identified as minor, with the balance split between medium and major upgrades. Appendix B, Solutions and Criteria, contain the 13 BBI enhancements.

The path forward implementation plan consisted of seven actions: a four-point action plan developed on March 19th, and three additional actions carried over from March 4, 2002. In brief the four-point action plan identified the need to 1) use current nuclear data for ORIGEN2, update process split factor assumptions and rerun the HDW model, 2) obtain and use 1gram of uranium from single-pass reactors to conduct assay for ^{59}Co., 3) develop and issue an accuracy, validation, and documentation document on BBI, and 4) develop an approach to show HDW model improvements over time.

The three carry-over actions from the March 4, 2002 portion of the workshop identified the need to 1) define (with examples) how the HDW and BBI calculates losses to past practice discharges, 2) calculate the estimated error by each method via Action Item #1, and 3) validate the WTP (BNI) critical list and isotope proportions with scaling factors. Appendix C, Path Forward Actions, contains the four actions from March 19th, and the three carried over from March 4, 2002.

This three-day workshop began on March 4, 2002, with the team solidifying the list of HDW issues/needed changes and information required for the next two days: March 18 and 19, 2002. On March 19th, the team concluded with solutions (13 enhancements/upgrades) and the path forward implementation plan to resolve the issues and complete the needed upgrades.

Session Process

The facilitator opened the session with team member introductions followed by reviews of the agenda, process guidelines and expectations, and a review of the team's purpose to ensure the team's understanding of the process and targeted results of the three-day session. Jim Field of CHG gave the opening remarks. Mr. Field overviewed the results from the October 2001 Value Engineering Study that identified several needs/improvements for both HDW and ORIGEN2 models. He clarified the BBI limitations such as the reliance on historical and sampling data, the need to validate/confirm correct assumptions, and the need to frame issues and develop solutions as well as identify what is wrong with the current numbers. This workshop is to frame the issues/needs and define the improvements to the HDW model to improve model-based BBI estimates.

Following opening remarks the team reviewed the current criteria and identified the critical radionuclides and non-radionuclides contained in the BBI. During this process, any parking-lot type information such as memories, assumptions, issues/concerns, and/or action items, were recorded by the facilitator.

At this point several team members asked to review the information flows of the current BBI and HDW/BBI interface (Appendix D). The current BBI information flow was presented to identify how the BBI currently obtains the information and data for its database. The HDW/BBI

information flow was given to ensure the team understood where and how the databases interfaced to obtain the current radionuclide data available to the customers. Throughout this process redline upgrades were made to both flow diagrams to ensure accuracy and full understanding of the processes.

After review of the information flow, the team returned to the critical list of radionuclides that were divided into rad or non-rad, and by environmental, process, toxicity characteristic leaching procedure (TCLP), or safety related. The environmental list was further divided into either groundwater, inadvertent intruder, or airborne. Then, the team identified specific issues and/or needed changes for each element area. The team further identified whether the issues and/or needed changes were global or tank specific.

The March 4, 2002, day one, portion of the workshop concluded with an 11-point action plan. The action items included: explain changes in the S-102 inventory, explain changes in SY-102 ^{241}Am inventory, define why Sm is so high in global total inventory, obtain additional solubility and insolubility issues information, obtain information on liquid/solid splits, and supply current discharges to ground.

On March 18th, day two, the workshop reconvened and began with a review of the March 4, 2002 actions and status. The team members provided a status and disposition for each of the 11 actions (i.e., closed or still open awaiting additional information). Following the status of the previous action plan the team established a priority ranking set of value-added evaluation criteria. The prioritized value-added evaluation criteria were developed to determine how each issue and/or needed change would have a positive impact on the overall BBI and its customers.

On March 19th, day three, the team developed specific solutions/enhancements for each of the March 4, 2002 listing of Issues/Needed Changes. Further, the team evaluated and identified each solution/enhancement as low, medium, or high (major) impact by project area: Tanks, WTP, or Ground Water Vadose Zone. Throughout this process any additional parking-lot items were recorded for supporting the final step: path forward implementation plan.

The path forward implementation was developed through a review and re-validation of the parking-lot information sheets (Appendix E: memories, assumptions, potential model improvements, etc.), the March 4th open action items, and identification of any new actions. The team concluded with four additional actions, in addition to the three carry over actions from March 4, 2002. The three-day workshop concluded with a round-robin close out, where each team member was engaged to comment on any last minute items and meeting utility.

Facilitator Remarks

In summary, the team concluded with no last minute items and considerable input on the value of the BBI information/knowledge gained, the 13 solutions/enhancements, and the path forward. This entire team (BBI staff, support, and customers) did an outstanding job of staying focused on the complex scope, defining the needed upgrades and solutions/enhancements, and persevering in developing a path forward to make these solutions/enhancements a reality.

Perhaps more importantly, the key to success in this workshop was: the customer's recognition that the model-based information in BBI will not solve every issue, uncertainty or area of risk; and that BBI staff and support personnel recognized that the customers should not support or use information that is not well understood and/or has no basis. Issuance of a BBI accuracy, validation, and documentation document, along with successful tracking of BBI/HDW improvements over time, will create ownership and confidence in the Best Basis Inventory.

APPENDIX A

AGENDA, OPENING REMARKS, LIST OF ATTENDEES

RADIONUCLIDE BEST BASIS INVENTORY (BBI) WORKSHOP
HAMMER Facility, Room 12
March 4, 18-20, 2002

Purpose: Obtain consensus on required radionuclide BBI enhancements, their basis (valued-added), and a path forward implementation plan.

- ***Define radionuclide criteria and critical list***
- ***Identify inventory number enhancements and value-added***
- ***Develop a path forward required to upgrade models (Origen2 & HDW)***

AGENDA

Day 1, Monday, March 4, 2002

7:30 - Welcome/Purpose, Safety Topic, and Introductions
- Review Agenda, Guidelines and Expectations, and Opening Remarks

8:00 - Define Radionuclides Criteria and Critical List
- Review current criteria
- Identify critical radionuclides
- Utilize parking-lot information sheets, as required

9:30 - **BREAK**

9:45 - Review/Confirm BBI Inventory Numbers
- Identify inventory issue areas and/or
- Validate existing inventory numbers

10:45 - Continue BBI Inventory Confirmation
- Confirm existing or identify issue areas
- Formulate new assumptions as required

11:30 - **LUNCH**

12:30 - Continue BBI Inventory Confirmation
- Confirm existing or identify issue areas
- Formulate new assumptions as required

2:30 - **BREAK**

3:45 - Develop Path Forward
- Validate parking-lot information sheets
- Identify/assign needed information to solidify issues
- Define required actions to support 3/18/02 meeting

4:15 - Finish Session with a Round-Robin Closeout
- Last minute items
- Meeting utility

RADIONUCLIDE BEST BASIS INVENTORY (BBI) WORKSHOP
HAMMER Facility, Room 12
March 4, 18-19, 2002

Purpose: ***Obtain consensus on required radionuclide BBI enhancements, their basis (valued-added), and a path forward implementation plan.***

- ***Define radionuclide criteria and critical list***
- ***Identify inventory number enhancements and value-added***
- ***Develop a path forward required to upgrade models (Origen2 & HDW)***

AGENDA

Day 2, Monday, March 18, 2002

7:30 - Review Agenda, Purpose, and Status from March 4, 2002 Session

8:00 - Solidify Inventory Issue Areas
- Review/status actions items and information
- Identify new issues and/or existing revisions
- Utilize parking-lot information sheets, as required

9:30 - **BREAK**

9:45 - Develop Issue Solutions and Value-Added Basis
- Define issue solutions
- Identify basis and confidence level

11:30 - **LUNCH**

12:30 - Continue Issue Solutions and Value-Added Basis
- Define issue solutions
- Identify basis and confidence level

2:30 - **BREAK**

2:45 - Continue Issue Solutions and Value-Added Basis
- Define issue solutions
- Identify basis and confidence level

4:15 - Finish Day 2 with a review of status and Day 2 Agenda

RADIONUCLIDE BEST BASIS INVENTORY (BBI) WORKSHOP
HAMMER Facility, Room 12
March 4, 18-19, 2002

Purpose: ***Obtain consensus on required radionuclide BBI enhancements, their basis (valued-added), and a path forward implementation plan.***

- ***Define radionuclide criteria and critical list***
- ***Identify inventory number enhancements and value-added***
- ***Develop a path forward required to upgrade models (Origen2 & HDW)***

AGENDA

Day 3, Tuesday, March 19, 2002

7:30 - Review Agenda, Purpose, and Status from Day 2

7:45 - Finalize Issue Solutions and Value-Added Basis
- Solidify assumptions
- Identify areas of risk and mitigation

9:30 - **BREAK**

9:45 - Solidify Impacts and Needed Support
- Define interfaces and cost impacts
- Identify organizational support needs

11:30 - **LUNCH**

12:30 - Validate areas of risk and mitigation actions
- Solidify new assumptions and confidence levels
- Identify mitigation needs

2:30 - **BREAK**

2:45 - Develop Path Forward Implementation Plan
- Validate parking-lot information sheets
- Determine actions required to upgrade inventories

4:15 - Finish Session with a Round-Robin Closeout
- Last minute items
- Meeting utility

LIST OF ATTENDEES

Name	Company	3/4/02	3/18/02	3/19/02
Jim Field	CHG/PE	X	X	X
Bruce Higley	NHC/PE	X	X	X
Brett Simpson	CHG	X	X	X
Rob Corbin	Portage Eng.	X	X	X
Mel Adams	CHG	X	X	X
Bob Watrous	CHG	X	X	X
Mike Coony	FDH	X	X	
Steve Lambert	NHC	X	X	
Dave Place	NHC	X	X	X
David Wootan	FH	X	X	X
Nancy Welliver	DMJMHN	X	X	X
Dan Reynolds	CHG	X	X	X
Charles Kincaid	PNNL	X	X	X
Keith Abel	BNI/WGI		X	X
Tom Jones	CHG	X	X	X
Aruna Arakali	BNI/WTP		X	
Karyn Wiemers	DMJMHN	X		
Fred Mann	CHG	X		
Tony Knepp	CHG	X		

OPENING REMARKS

- Thank you for your attendance and participation
  - You are the customer
- October 2001 we had a workshop that identified several needs/improvements for HDW and ORIGEN2
- BBI has a lot of limitations *
  - Relies on historical and sampling data
  - Need to validate/confirm if we have the right assumptions
  - Need to frame the issues and determine the solutions
    - Identify what is wrong with the current numbers
- Keys to success
  - Frame issues/needs
  - Define the issues/solutions
  - Make BBI the best tank inventory estimate

* Users were referred to "Hanford Defined waste Model Limitations and Improvements" HNF-3273 Rev 0A

APPENDIX B

SOLUTIONS AND CRITERIA

- Value-Added Criteria
- Solutions/Enhancements
- Issues/Needed Changes

VALUE-ADDED CRITERIA

Ranking

1. Increase model integrity
   - Technical, justifiable basis
   - Increase public and regulator confidence
2. Improve planning and decision making (the users)
   A. Decrease treatment cost
   B. Decrease disposal costs
3. Increase tank closure opportunities
4. Enhance cost effectiveness
5. Focus characterization
6. Enhance/maintain configuration control

NOTE: The team established this priority ranking based on evaluating each criterion's positive impact on the BBI and its customers.

SOLUTIONS/ENHANCEMENTS

(Developed from the 3/4/02 listing of Issues/Needed Changes)

Solution Ranking: Value-Added Impact
1 = Low
2 = Medium
3 = High (Major)

1. $^{99}Tc = 3$

- Determine losses from:
  1. Tc shipped off-site with uranium
  2. Loss to the cribs and upgrade HDW accordingly
- Need to evaluate and determine amount of ^{99}Tc insoluble form that would remain in tanks (i.e., wash/leach)

  Action: Jim Field/Tony Knepp

  NOTE: Current efforts are taking place to analyze archived samples
  - This effort will feed and upgrade BBI/HDW to better estimate ^{99}Tc inventory and support GWVZ modeling

2. $^{129}I = 3$

1. Upgrade HDW to incorporate losses of ^{129}I prior to receipt in the tank
   - Dose reconstruction project
   - Fuel dissolution
   - Liquid discharge
2. Look at mercury for a relationship to ^{129}I and change solubility factors in HDW model
3. Re-run ORIGEN2 with new yields (-24%)

   NOTE: Validate solubility in tank C-107.

SOLUTIONS/ENHANCEMENTS

(Developed from the 3/4/02 listing of Issues/Needed Changes)

3. U = 3

- Reduce HDW solubility = 3
  - Today 1-2 orders of magnitude too high in the liquids
    - Comparison to sample data
    - Broader technical literature
  - Need to apply separate solubility factors based on chemistry of the waste stream
- Revise/Upgrade HDW model to account for detailed waste loss percentages = 1
  - Have not used historical releases on waste loss
- Reconcile tank waste sample results with accountability (batch by batch from separations in various plants) records and tank transactions = 1
- Revise DKPRO to account for product recovery = 2
  NOTE: Instead of looking at 235 and 233, the team decided to look at all U.

4. ^{79}Se = 2

- Rerun ORIGEN with current half-life data
  - Apply half-life per BBI letter

5. ^{3}H = 3 for GWVZ and 1 for Tanks and WTP

- Account for tritium cribbed in process condensate from the production plants (PUREX, REDOX, etc.)
  - Apply, maybe update, DKPRO
  - Groundwater vadose zone needs to know losses to cribs and atmosphere for an overall material balance
  - Determination to be done by HDW/DKPRO committee

SOLUTIONS/ENHANCEMENTS

(Developed from the 3/4/02 listing of Issues/Needed Changes)

6. ^{60}Co = 2 for WTP and GWVZ, 1 for Tanks
   - Account for uncertainty through ORIGEN2, DKPRO, and HDW using 1 ppm ^{59}Co after confirmation from sample data and cold uranium assay (See Action Item #2)
     - Include ^{60}Co analytical data
7. TRU = 3 for Tanks, 1 for GWVZ and WTP
   - Account for the single pass reactor cross sections in ORIGEN2
     - Increase weight percent of ^{240}Pu, ^{241}Pu, and ^{241}Am
   - Revise/Upgrade HDW model to account for detailed waste loss percentages
   - Reconcile tank waste sample results with accountability (batch by batch from separations in various plants) records and tank transactions
   - Review altered solubility due to complexants in the HDW model
   - **Memory** - Solids carryover should be verified by sampling, and/or consideration on using the HDW tool for probabilistic evaluation of TRU content (Ranking is 3 on tanks, 1 for GWVZ)
8. ^{237}Np = 1
   - By 9/30/02 HDW will be revised to incorporate ORIGEN2 run with time dependent impurities (^{236}U)
     - ORIGEN2 runs will be upgraded/revised by 6/01/02

     Action: David Place and Tom Jones interface with Fred Mann to determine Performance Assessment needs. (Completed 3/20/02)
9. ^{154}Eu = 2 for Tanks and GWVZ, 1 for WTP
   - Accounted for in ORIGEN2 re-runs

     Action: Rob Corbin/Bruce Higley will validate liquids/solids complexants interaction, was incorporated properly in HDW.

SOLUTIONS/ENHANCEMENTS

(Developed from the 3/4/02 listing of Issues/Needed Changes)

10. ^{126}Sn = 2 for Tanks and WTP, 1 for GWVZ
   - Rerun ORIGEN with current half-life data
     - Apply half-life per BBI letter

11. ^{14}C = 2
   - Rerun ORIGEN2 with new modeling parameters
   - Incorporate best estimate of atmospheric loss in HDW
   - Evaluate the solvent pathway uptake to establish overall material balance and challenge past ^{14}C analytical methods.
     NOTE: A C-103 sample is at the 222S Laboratory
     Action: Bruce Higley

12. ^{125}Sb = 1
   - Rerun ORIGEN with current half-life data
     - Apply half-life

13. Hg = 2 for Tanks and WTP, 1 for GWVZ
   - Correct the waste stream assignment in HDW

ISSUES/NEEDED CHANGES

(Identified on 3/4/02 for Solutions/Enhancements)

- ^{99}Tc
  - 1 - Take credit for Tc shipped off site
    - Look at first and second cycle waste streams
  - 2 - Liquids/solids split in waste streams
    - $BiPo_4$
    - Tc processing through evaporator (salt/liquid partitioning)
    - Ax-104 (Define ^{99}Tc basis)

- ^{129}I
  - 1 - Treatment of air releases
    - Solid burial
    - Silver reactor flushes
    - Hg relationship
    - Liquid discharges (i.e., PUREX and REDOX)
  - 2 - Liquid/solids
    - Fission product yield
    - ✓ TY-105/106 - Latest BBI resolves this issue

- ^{235}U
  - 2 - Solubility: uranium isotopes

- ^{79}Se
  - 1 - Half-life

- ^{3}H
  - 1 - Production
    - How much produced
    - Quantity crib from plant and evaporator

ISSUES/NEEDED CHANGES

(Identified on 3/4/02 for Solutions/Enhancements)

- ^{60}Co
  - 1 - How much produced
    - Quantity cribbed
  - 2 - Solid/liquid split
    - Association with complexants

- TRU
  - 1 - How much produced/lost in processing
  - 2 - Split factor
    - Solubility
    - Transaction records
    - Solids carryover in the cascade tanks
    - TX farm

- ^{237}Np
  - 2 - Transaction records

- ^{154}Eu
  - 1 - 10% change in production
  - 2 - Check liquid/solids complexants

- ^{126}Sn
  - 1 - Half-life

- ^{233}U
  - 2 - Tank transaction (C-104)
    - Solubility

ISSUES/NEEDED CHANGES

(Identified on 3/4/02 for Solutions/Enhancements)

- ^{14}C
  - 1 - How much produced and why
    - Not as much as ORIGEN2 predicts; perhaps PUREX releases to atmosphere
    - Air releases
  - 2 - Carbonate or organic path for distribution
    - Tank specific?

- ^{125}Sb
  - 1 - Confidence in ORIGEN2
    - Air release
  - 2
    - Solid/liquid split

- Hg
  - 1 - How much added
  - 2 - Correct waste stream
    - Correlation with ^{129}I

APPENDIX C

PATH FORWARD ACTIONS

- Path Forward Action Plan – March 19, 2002
- March 4, 2002 Actions, Status, and Disposition

PATH FORWARD ACTION PLAN
March 19, 2002

WHAT	WHO	WHEN
1. Use current split factor assumptions and rerun HDW model	Bruce Higley/ Rob Corbin	8/1/02
2. Obtain 1g of U from single-pass reactors and conduct assay tests	Bob Watrous – Obtain U sample Tom Jones – Conduct tests	TBA
3. Develop and issue an accuracy, validation, and documentation document on BBI • Ensure templates and assumptions between HDW and BBI are defined	Jim Field/ Mel Adams	9/30/02
4. Develop approach to show BBI improvement over time	Bob Watrous/ Jim Field	5/1/02

MARCH 4, 2002 ACTIONS, STATUS, AND DISPOSITION

WHAT	WHO	WHEN	DISP.
1. Define (with examples) how the HDW and BBI calculates losses to past practice discharges **STATUS:** Examples show no difference in HDW discharge volumes are accounted for; they do handle compositions differently • Need to reevaluate use of Appendix B vs. E.	Jim Field/ Rob Corbin **POC: David Place**	~~3/18/02~~	**Due 4/2/02**
2. Calculate the estimated error by each method via Action Item 1. **STATUS:** Examples show no difference in HDW discharge volumes are accounted for; they do handle compositions differently • Need to reevaluate use of Appendix B vs. E.	Jim Field/ Rob Corbin/ Bob Watrous **POC: David Place**	~~3/18/02~~	**Due 4/2/02**

MARCH 4, 2002 ACTIONS, STATUS, AND DISPOSITION

WHAT	WHO	WHEN	DISP.
3. Define why the new inventory takes credit for S-102 **STATUS:** A series of changes, via BBI re-baselining, were a function of a new volume number and sample data (which cut the prior number by nearly half) (See Table on Inventories of Mobile Radionuclides) • Today we communicate changes better; meetings, e-mail, and future "What's new" in TWINS	Brett Simpson	3/18/02	**Closed**
4. Explain changes in SY-102 ^{241}Am inventory **STATUS:** Inventory upgraded with new core sample results revealed a higher Am, concentration, and sludge volumes in the tank • Reanalyze with archived sample to correct for lab analysis problems (e.g., drying out) Given, that the most recent sample process was flawed; BBI will re-evaluate past sampling	Bruce Higley	3/18/02	**Closed**

MARCH 4, 2002 ACTIONS, STATUS, AND DISPOSITION

WHAT	WHO	WHEN	DISP.
5. Define why Sm is so high in global total inventory **STATUS:** ^{151}Sm is the third highest contributor (total curies); is not mobile, is a weak beta emitter, without any dose consequence • Current BBI calculations are OK	Bob Watrous	3/18/02	**Closed**
6. Validate WTP (BNI) critical list **STATUS:** Critical list: refer to pages 8 and 9 from the 3/4/02 meeting list and include ^{59}Ni, ^{63}Ni, Pb, and noble metals • In addition, need to: - Validate isotope proportions (i.e., we need to first develop scaling factors, then validate)	Karyn Wiemers/ Mike Johnson	~~3/18/02~~	**On-Going**
7. Obtain additional solubility and insolubility issues information **STATUS:** New information (contained in reports and tank characterization) needs to be reviewed/validated as a basis to update model • This upgrade will be completed by 9/30/02 - Will upgrade with a good estimate	Bruce Higley	3/18/02	**Closed**

MARCH 4, 2002 ACTIONS, STATUS, AND DISPOSITION

WHAT	WHO	WHEN	DISP.
8. Obtain information on liquid/solid splits **STATUS:** Some splits are not modeled (e.g., crib losses than plant waste concentration) • HDW and DKPRO code use different split factors • PNNL labs have in an on-going split factor efforts, including $BiPO_4$ process separation assumptions (See New Action Item #1)	Bruce Higley	3/18/02	**Closed**
9. Supply current discharges to ground **STATUS:** From 195 sites out of 300: • Well quantified/short-duration discharge to soil; (will be published by 9/02) • 0.2 → 6.5% of the total BBI inventory can be said to have gone to the ground (which varies by analyte) • Long-term large volume waste sites have NOT been quantified NOTE: This will be quantified in FY03 via groundwater vadose zone project.	Brett Simpson	3/18/02	**Closed**

MARCH 4, 2002 ACTIONS, STATUS, AND DISPOSITION

WHAT	WHO	WHEN	DISP.
10. Develop (draft) plan to achieve accuracy, validation, and documentation. **STATUS:** Still pending; need new date	Mel Adams/ Jim Field	~~3/18/02~~	**See new Action Item #3**
11. Develop approach to show BBI improvement over time **STATUS:** Still pending; TBD • Emphasis is on further assessing model improvements	Bob Watrous/ Brett Simpson/ Charlie Kincaid	~~3/18/02~~	**See New Action Item #4**

Changes in Tank S-102 Inventories of Mobile Radionuclides

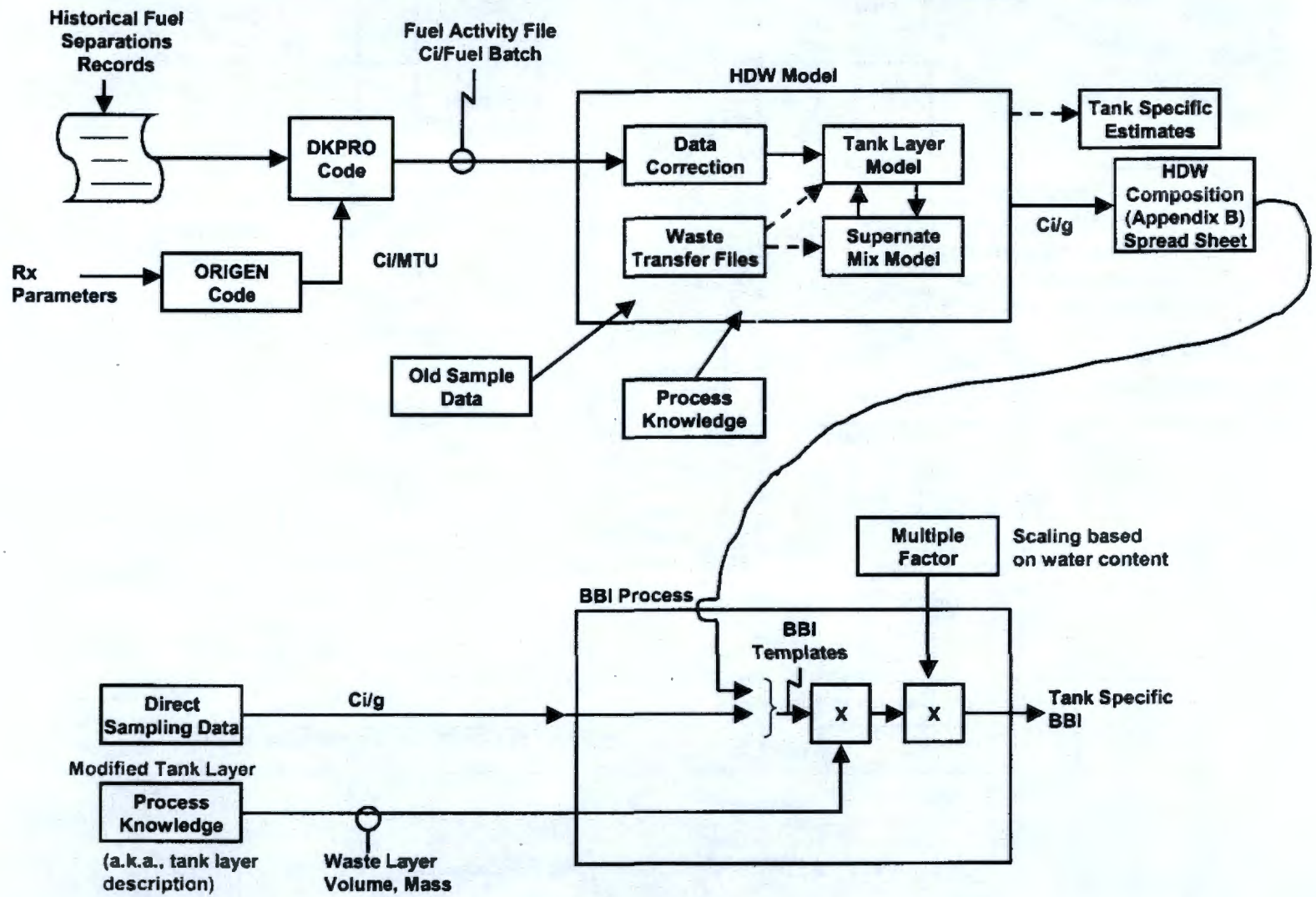
Isotope	Inventory Effective 8/1/2000 (Ci)	Basis	Inventory Effective 1/1/2001 (Ci)	Basis	Ratio New/Old	Reason for Change
C-14	[illegible]	Template	47.8	Template	79%	Template multipliers added
Se-79	[illegible]	Template	0.388	Template	10%	Half-life change (error in Chart of Nuclides)
Tc-99	[illegible]	Template	217	Template/PK Sample Data	53%	Sample data for saltcake (HNF-7031, Saltcake Dissolution FY 2000 Status Report, Herting), multipliers added to liquid templates
I-129	[illegible]	Template	0.681	Template	85%	Template multipliers added
U-232	[illegible]	Distribution from total uranium	1.42	Distribution from total uranium	104%	Template multipliers added, liquid template modified, decay to 2001 rather than 1994
U-233	[illegible]	Distribution from total uranium	5.83	Distribution from total uranium	111%	Template multipliers added, liquid template change
U-234	[illegible]	Distribution from total uranium	1.81	Distribution from total uranium	111%	Template multipliers added, liquid template change
U-235	[illegible]	Distribution from total uranium	0.0735	Distribution from total uranium	111%	Template multipliers added, liquid template change
U-236	[illegible]	Distribution from total uranium	0.0563	Distribution from total uranium	111%	Template multipliers added, liquid template change
U-238	[illegible]	Distribution from total uranium	1.65	Distribution from total uranium	111%	Template multipliers added, liquid template change
Total Curies Mobile	[illegible]	Total Ci Mobile	277	Total Ci Mobile	57%	
Volume (Kgal)	[illegible]	Kgal	447	kgal	95%	Revaluation of waste volume after completion of saltwell pumping
U Total (kg)	[illegible]	Template/Sample	4950	Template/Sample	111%	Template multipliers added, liquid template change
Radionuclide Decay Date	1/1/94		1/1/01			
BBI Updated	8/31/00		9/13/01			
[illegible]	No multipliers, saltcake types combined		Multipliers added for template data.			

APPENDIX D

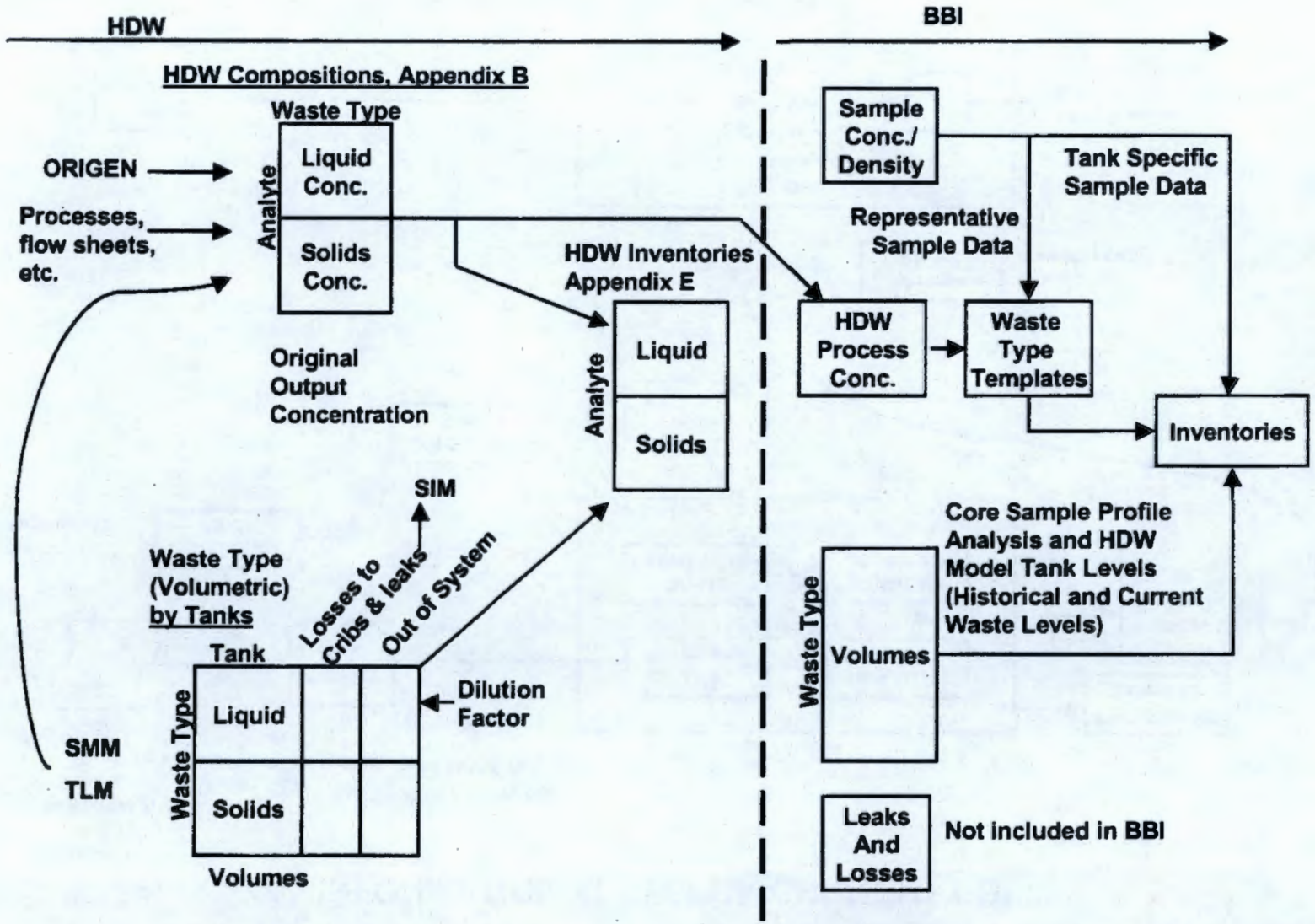
FLOW DIAGRAMS

- Information Flow for Current BBI
- Information for HDW/BBI Flows

INFORMATION FLOW FOR CURRENT BBI



INFORMATION FOR HDW/BBI FLOW



APPENDIX E

PARKING LOT INFORMATION SHEETS

- March 18-19, 2002
- March 4, 2002

MARCH 18-19, 2002 PARKING LOT INFORMATION SHEETS

- Potential Model Improvement
- Memories

POTENTIAL MODEL IMPROVEMENTS

✓ Compare HDW templates with the sample templates

- Criteria for agreement
  - HDW and BBI assumptions would need to be aligned
  - Determine compositions and uncertainties (i.e., start with a single analyte, then move on)
  - Account for changes from cascading transfers

NOTE: This effort will be satisfied with completing Action Item #3

MEMORIES

✓ = Validated Memory

✓ No direct computation of leaks and losses
- Estimated inventories for tank leaks can be found in a soil inventory model (Defined volumes; POC: Tom Jones)

✓ Consider/re-evaluate BBI rule to use only current sample data (vs. averaging all historical data)

~~Compare model templates against sample templates to determine the best solubility and split factors~~

✓ ^{151}Sm: an environmental risk or not?
- Currently, there are limitations on measurement. WTP is characterizing Sm and will publish the results in ~3 months; via a new technique

✓ Need Tc sample data

✓ Use liquid/solids split waste stream improved information (valance changes and complexants)
- Fraction interstitial liquid

✓ Material balance (^{99}Tc and ^{129}I) (See AI #1 and 2 from 3/4/02)

✓ Rerun ORIGEN2 for all analytes

✓ Solutions (BBI enhancement(s)) ratings:
1 = little value
2 = medium value
3 = major value

✓ Reducing conservatism in one area may increase risk in another (e.g., groundwater vadose zone vs. tanks)

~~Quantify Uranium measurements to correlate isotopic ratios~~

✓ Ensure these results are communicated well
- Eliminate honest, wrong beliefs

MARCH 4, 2002 PARKING LOT INFORMATION SHEETS

- Today's BBI
- Definitions
- BBI "Current Assumptions"
- Inventory Issue
- Model Improvements
- Critical List
- Memories

TODAY'S BBI

- Uses data from HDW Appendix B issued in 1997, for transfer completed through 1/1/94
- BBI does not explicitly treat losses inside tank farm fences/facilities. BBI implicitly treats such losses by adjusting volumes assumed to be in tanks.

DEFINITIONS

- ORIGEN2: a reactor nuclear physics model based on cross-section and fission product yield data from the National Nuclear Data Center Evaluated Nuclear Data Files)
- BBI: for this workshop, BBI refers to the model-based number

BBI "CURRENT ASSUMPTIONS"

- Volatile losses (e.g., ^{129}Iodine) are not accounted for in HDW, hence, model based BBI numbers are bounding estimates only.
- BBI uses a waste layer description to describe various layers of waste

INVENTORY ISSUES

AI # = Action Item Number

AI #1 & 2 HDW Appendix B does include some losses to past-practice discharge sites. BBI uses a different approach to determine tank specific estimate. BBI and HDW <u>may</u> produce inconsistent inventory data (i.e., losses to cribs).

MODEL IMPROVEMENTS

- Review limitations of HDW and ORIGEN2
- Impacts of ORIGEN2 upgrades
  - Fission product yield impact will be < a factor of 2
  - <10% for fission products
  - ≥10X for some activation
  - Factors of 2-10 for transuranics
  - Factors of 10X for half-life (^{79}Sc and ^{126}Sn)
- Need to define impacts of process split factors, waste solubility factors, and miscellaneous factors

CRITICAL LIST

Environmental								
RAD						NON-RAD		
Ground-water		Inadvertent Intruder		Airborne		Ground-water	Inadvertent Intruder	Air-borne
1/2	^{99}Tc		^{90}Sr		^{129}I	No_2	None	None
1/2	^{129}I		^{137}Cs		^{3}H	No_3		
2	^{235}U	1,2	TRU (^{239}Pu, ^{240}Pu, ^{241}Am)	1,2	^{14}C	Cr^{+6}		
	^{238}U	2	^{237}Np in high ^{237}Np tanks (~2)			Na		
	^{79}Se	1	^{126}Sn (lower priority)					
*1	^{3}H							
*1/2	^{60}Co							
*	^{106}Ru							
	^{234}U							
* = Only for History Match								

LEGEND

1. Yes/No
2. If Yes:
   1 = Global
   2 = Tank Specific

CRITICAL LIST

Process			
RAD		**NON-RAD**	
	^{137}Cs		^{4}So
	^{99}Tc		Na
	^{90}Sr		Cs
	^{60}Co		Cr
1/2	^{154}Eu		Fe
	^{155}Eu		Ni
	^{14}C		Mn
	^{129}I		Al
	^{241}Am	1/2	Hg
	^{240}Pu		Zr
	^{239}Pu		U
2	^{233}U		^{4}Po
	^{235}U		Cl
1/2	^{125}Sb		F
	^{59}Ni		Pb *(Note: per p. 22)*
	^{63}Ni		
Ref: PNNL 1.2.1.6.3			

LEGEND

1. Is there an issue and/or change needed: If Yes, go to #2. If no, continue to the next page
2. If Yes, is the issue and/or needed change: 1) Global, or 2) Tank Specific?

TCLP	
RAD	**NON-RAD**
	As
	Ba
	Cr
	Cd
	Hg
	Se
	Ag

CRITICAL LIST

Safety	
RAD	**NON-RAD**
^{90}Sr	
^{137}Cs	
^{241}Am	
^{60}Co	
^{125}Sb	
^{154}Eu	

1. Which Rads/Non-Rads have issues?
2. By Rad/Non-Rad what specific changes are needed?

MEMORIES

AI # = Action item number

✓	Focusing on radionuclides is very limiting
✓	The goal of the BBI is to provide the best basis estimate of current tank inventory • Need to validate the assumptions • Need to validate and/or estimate the uncertainties - Perhaps customer(s) can project the level of uncertainty that is needed
✓	Need to define/convey impacts of: • Updates to process split factors • Updates to waste solubility factors • Miscellaneous fixes (To be addressed with issue solutions.
✓	Look at transaction records for specific tanks and time periods (e.g., Thoria waste and C-104) See ^{233}U✓
TBD	Documented control rules (everybody will sign-up)
AI #9✓	The soil inventory model can be used to improve/refine HDW model input to BBI
✓	Organics are important, but a complex subject for LDR (beyond scope)
AI#10✓	Accuracy, validation and documentation (key customer/user success criteria)
AI #6✓ (beyond	TCLP: do we need information from HDW model current HDW model scope)

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APPENDIX G

REQUIREMENTS FOR CHECKING HANFORD DEFINED WASTE MODEL REV. 5.0 SPREADSHEETS

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SPREADSHEET VERIFICATION FORM

1. SVF 171

2. **Spreadsheet Owner, Organization, MSIN, & Phone No.:**	B. A. Higley, Flowsheet and Process Models, R2-12, 376-5694
3. **Spreadsheet File Name, Rev. No./Version No.**	HDW5_03_397CHG.xls
4. **Location of Spreadsheet:** (Identify where the spreadsheet file is located by checking the boxes to the right. If "Other," provide description of where it is located)	**Personal Computer** ☒ **CD** ☐ **Network Drive** ☒ **Path** \\AP001\STDINV\HDW\HDW Rev5 **Other** ☐ **Description**
5. **Function and Purpose of Spreadsheet:** (Provide a brief description of the purpose of the spreadsheet)	Estimate chemcial and radionulcide compsition of tank waste types based on the ORIGEN2 reactor code output, plant flowsheets and historical data.
6. **Scope of Verification:** (Indicate scope of verification by checking box to right. If "Other" provide description of scope)	**All Formulas in Spreadsheet** ☐ **Input Data only** ☐ **Formulas and Input Data** ☒ **Formula Changes** ☐ **Other** ☐ **Description**

7. **Method of Verification:** (Provide brief description of the method used to verify the spreadsheet. Note multiple methods may be used to verify different parts of a spreadsheet)

Changes were reviewed against input data as revisions were made. Input data and instructions were contained in Internal Correspondence and e-mail messages which are included in an appendix to the HDW model Rev. 5 document. At Rev. 5 completion, the overall spreadsheet was reviewed with emphasis on changes from HDW model Rev. 4. Finally, the spreadsheet was reviewed against the Change Record to verify that all changes had been accuarately implemented. A checklist for the verification requirements was completed. Limitations of the HDW model were identified and are discussed in the HDW Rev. 5 document.

Note: Actual changes to the spreadsheets were made by R. A. Corbin and B. S. Simpson (Portage Environmental and later Technical Resources International, Inc.). The document owner performed a portion of the spreadsheet verification.

8. **Verification Documentation:** (Provide description of where verification documentation may be located. The verification documentation should include a description of all unique intended formulae together with evidence that the interpretation of the formulae in the spreadsheet is correct and that the spreadsheet returns correct results)	**Attached:**	☒	**No. of Pages:** 2
	Electronic Information File:	☒	**Ref:**
	Engineering Document:	☐	**Ref:**

SPREADSHEET VERIFICATION FORM	1. SVF 171

9. Approvals	Name:	Signature:	Date:
Spreadsheet Owner:	B. A. Higley	B. A. Higley	2/5/04
Spreadsheet Verifier:	D. E. Place	D. E. Place	2/5/04
Owner's Manager:	N. W. Kirch	N W Kirch	2/6/04

A-6003-781 (10/03)

REQUIREMENTS FOR CHECKING HANFORD DEFINED WASTE MODEL REV. 5.0 SPREADSHEETS

Provide explanation of method used as appropriate:

CSB Identify all changes relative to Revision 4.0 of the HDW Model (HDW4008.xls spreadsheet).

CSB Verify that computational spreadsheet changes (i.e. non-editorial) are documented and justified.

CSB Verify that Change Record for Revision 5.0 is complete and changes in the spreadsheets are consistent with the Change Record.

CSB Verify that results from supporting spreadsheets are correctly copied into the HDW's spreadsheet.

CSB Verify that units are correct and labeled.

CSB Verify that spreadsheet cell references are correct.

CSB Verify that VLOOKUP, HLOOKUP and SUMPRODUCT ranges are fixed when required to provide desired results ("$" signs before the columns and/or rows).

CSB Check the parentheses in one instance of any added equations to assure that the calculation order will give the desired result.

CSB For equations with mixed units, perform a dimensional analysis to assure that correct conversion factors are used, unwanted units cancel, and the final result has the proper units.

CSB Verify that the sum of uranium isotope mass equals the UTOTAL. Verify that the sum of the plutonium isotopes on a mass basis is equal to the Pu-Total.

CSB Verify that the plutonium and uranium isotope distributions are consistent with ORIGEN2 estimates.

CSB Verify that extraneous data/calculations or obsolete information that do not support the purpose of the spreadsheet is removed or hidden.

CSB Verify that all radionuclides are decay-corrected to January 1, 2001 (including Rev. 4 values being compared to Rev. 5).

CSB Verify that the solubility of isotopes of the same chemical element (and the chemical element if included as an analyte) are consistent.

BAH Confirm that the ^{154}Eu to ^{155}Eu ratios are credible and consistent with the ORIGEN2 input.

BAH Verify that significant radionuclide inventory changes from HDW Rev. 4 have assignable causes.

Approvals:

Owner: B. A. Higley B.A. Higley Date: 2/5/04

Verifier: D. E. Place D.E. Place Date: 2/5/04

Responsible Manager: N. W. Kirch NW KIRCH / NWKirch Date: 2/6/04

Notes:

SPREADSHEET VERIFICATION FORM	1. SVF 170

2. **Spreadsheet Owner, Organization, MSIN, & Phone No.:**	B. A. Higley, Flowsheet and Process Models, R2-12, 376-5694		
3. **Spreadsheet File Name, Rev. No./Version No.**	Compare HDW Rev 4&5_397CHG Final.xls		
4. **Location of Spreadsheet:** (Identify where the spreadsheet file is located by checking the boxes to the right. If "Other," provide description of where it is located)	**Personal Computer**	☒	
	CD	☐	
	Network Drive	☐	**Path**
	Other	☐	**Description**
5. **Function and Purpose of Spreadsheet:** (Provide a brief description of the purpose of the spreadsheet)	Compare global tank radionuclide inventories for Revision 4 and 5 of the HDW Model.		
6. **Scope of Verification:** (Indicate scope of verification by checking box to right. If "Other" provide description of scope)	**All Formulas in Spreadsheet**	☐	
	Input Data only	☐	
	Formulas and Input Data	☒	
	Formula Changes	☐	
	Other	☐	**Description**

7. **Method of Verification:** (Provide brief description of the method used to verify the spreadsheet. Note multiple methods may be used to verify different parts of a spreadsheet)

Input data: Spot check of electronically copied data and 100% manual comparison of hand-entered data.
Formulas: Inspection of all unique formulas in the spreadsheet and verification of resulting units.

8. **Verification Documentation:** (Provide description of where verification documentation may be located. The verification documentation should include a description of all unique intended formulae together with evidence that the interpretation of the formulae in the spreadsheet is correct and that the spreadsheet returns correct results)	**Attached:**	☐	**No. of Pages:**
	Electronic Information File:	☒	**Ref:**
	Engineering Document:	☐	**Ref:**

9. **Approvals**	Name:	Signature:	Date:
Spreadsheet Owner:	B. A. Higley	B. A. Higley	2/3/2004
Spreadsheet Verifier:	D. E. Place	D. E. Place	2/3/2004
Owner's Manager:	N. W. Kirch	NWKirch	2/6/04

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