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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 644481

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [X] Temporary [] Standby [] Supersedure [] Cancel/Void []	M. J. Kupfer, LMHC, H5-49, 376-6631	[] Yes [X] No	7/15/98
	6. Project Title/No./Work Order No. Tank 241-AZ-102	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-411, Rev. 0~~0~~ B	10. Related ECN No(s). NA	11. Related PO No. NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

This ECN compiles all reconciliation changes to the Best-Basis Inventory made in FY98. Revisions were made to Appendix E, Evaluation to Establish Best-Basis Inventory for Double-Shell Tank 241-AZ-102. Changes were made to both text and tables. The inventory estimates of several waste components were revised. The reconciliation process involved correction of errata, reassessment of data outlyers, verification of uranium isotopic distribution and other alpha isotope distribution, and removal of "less than" values, etc.

14a. Justification (mark one)

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

14b. Justification Details

Tank waste inventory estimates are being provided as standard source term for the various waste management activities. FY 1997 evaluation of available information for all 177 underground storage tanks was performed and published in TCRs, preliminary TCRs, or revisions to existing TCRs. In FY 1998, a reconciliation process is being performed to update the best-basis inventories. This process ensures that the latest inventory estimates are available as a consistent source-term to support the activities of TWRS disposal and other users.

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

Central Files	B1-07
DIMC	H6-15
DOE Reading Room	H2-53
TCSRC	R1-10
K. M. Hall	R2-12
K. M. Hodgson	R2-11
M. J. Kupfer	H5-49
M. D. LeClair (3)	H5-49
R. D. Schreiber	R2-12

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JUL 29 1998 DATE: STA: 57 HANFORD RELEASE ID. 73

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A-7900-013-1

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1. ECN (use no. from pg. 1): 644481

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]	Other	[X]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng.	M. J. Kupfer JWKammann for	7/22/98	PE		
Cog. Mgr.	K. M. Hodgson K.M. Hodgson	7/22/98	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other	R. D. Schreiber R2-12 Rudolph Schreiber	7/22/98	Other		
			DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

S

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

S. L. Lambert
COGEMA Engineering, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 644481 UC: 721
Org Code: 7A110 Charge Code: N4G3A HJ 212600
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Key Words: TCR, best-basis inventory, standard inventory

Abstract: The best-basis inventory provides waste inventory estimates that serve as standard characterization source terms for the various waste management activities. To establish a best-basis inventory for double-shell tank 241-AZ-102, an evaluation of available information was performed. This work follows the methodology established in *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0A (Kupfer et al. 1997).

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

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

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
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0B RS	Incorporate per ECN 612283	MJ Kupfer	KM Hodgson
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		MJ Kupfer 7/22/98 for	K.M. Hodgson 7/22/98

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APPENDIX E

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AZ-102

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APPENDIX E

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AZ-102

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for double-shell tank 241-AZ-102 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

E1.0 CHEMICAL INFORMATION SOURCES

Considerable information is available concerning the contents of double-shell tank 241-AZ-102. Data sources include the following:

- The analytical data based primarily on one core sample and three supernatant samples (Gray et al. 1993, Rollison 1995a, 1995b, and 1995c)
- The Plutonium-Uranium Extraction (PUREX) flowsheet (Allen et al. 1985)
- PUREX operating data including essential material usage, fuel charging records and uranium rework
- The Hanford Defined Waste (HDW) model (Agnew et al. 1997).
- The ORIGEN2 model for predicting radionuclides in N Reactor fuels.

The data available allows preparation of both a sample-based estimate and a process estimate based on PUREX Plant operation/flowsheets. The results will then be compared to the HDW model prediction.

E2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Section 4.0 of this Tank Characterization Report (TCR) contains inventory estimates based on a core sample taken in 1989 and three supernatant samples taken in 1995. The HDW model (Agnew et al. 1997) provides an additional inventory estimate based on process

knowledge and historical information. The chemical and radionuclide inventories in tank 241-AZ-102, based on the sample data and the HDW model, are included in Table E2-1. The chemical species are reported without charge designation per the best-basis inventory convention.

Table E2-1. Existing Tank 241-AZ-102 Inventory Estimates. (2 Sheets)

Analyte	HDW model[a] (kg)	Sample-based (1995)[b] (kg)
Ag	NR	242
Al	15,600	24,200
Bi	1.56	NR
Ca	1,880	1,080
Cd	NR	5,360
Cl	3,140	61
CO_3	6,100	127,000
Cr	63.8	3,930
F	855	3,510
Fe	16,900	46,800
Hg	0.0124	NR
K	769	918
La	0.0121	1,610
Mn	19.9	1,030
Na	122,000	198,800
Ni	114	3,160
NO_2	35,000	95,100
NO_3	23,200	78,500
OH	93,000	6,070
Pb	2.25	394
PO_4	520	167
Si	8,560	3,390
SO_4	20,600	59,900
Sr	0	117
TOC	5,913	6,170
U	4,270	9,670
Zr	0.104	6,470

Table E2-1. Existing Tank 241-AZ-102 Inventory Estimates. (2 Sheets)

Analyte	HDW model[a] (Ci)	Sample-based (1995)[b] (Ci)
Radionuclide[c] (Ci)		
^{241}Am	13,400	36,300
^{14}C	182	0.08
^{137}Cs	4.01 E+06	4.02 E+06
^{237}Np	11.1	49.2
^{238}Pu	134	175
^{241}Pu	12,300	16,400
^{90}Sr	3.97 E+06	6.94 E+06
^{99}Tc	764	220

HDW = Hanford Defined Waste
NR = Not reported
[a] Agnew et al. (1997)
[b] Section 4.0 of this Tank Characterization Report
[c] Radionuclides decayed to January 1, 1994.

E3.0 COMPONENT INVENTORY EVALUATION

E3.1 CONTRIBUTING WASTE TYPES

The chemical and radionuclide inventory of tank 241-AZ-102 consists primarily of neutralized current acid waste (NCAW) resulting from PUREX processing of 1,420 MTU of zirconium-clad N Reactor fuel elements. The tank was sluiced to remove a residual solids level before introduction of NCAW but a sludge inventory of 102,300 L remained. NCAW from the PUREX Plant operation was routed to this tank between March 1986 and February 1990. Additionally, dilute PUREX Plant wastes (such as cell drainage) that contained unusually high levels of radionuclides were also routed to the aging waste tanks on an infrequent basis.

The HDW model (Agnew et al. 1996) lists the following waste types for tank 241-AZ-102:

SMMA1	=	Supernatant mixing model--salt slurry from 242-A evaporator
UNK	=	Unknown (sometimes assigned to SRR, sludge from A and AX Tank Farms)
PL2	=	PUREX Plant low-level waste (1983 to 1988)
Z	=	Z Plant Waste (1974 to 1988)
P3	=	PUREX Plant high-level waste (HLW) (1983 to 1988).

P3 would be the predominant waste type for the aging waste tanks. The PL2 designation was used to account for the non-NCAW transfers that occurred during the PUREX Plant operation.

The Z designation is questionable since cross-site waste transfers were decanted from tank 241-SY-102 and contained no solids. It is assumed that SMMA1 and SRR accounted for most of the tank heel at the start of PUREX Plant NCAW additions.

E3.2 RECOMMENDED ADJUSTMENTS TO TANK CHARACTERIZATION REPORT INVENTORIES

Improvement to the sample-based inventories can be made based on waste layer analyses of the 1989 core samples, analyses of the interstitial liquid in the core samples, and unreported supernatant analyses of the three 1995 supernatant samples. The recommended adjustments are discussed in Sections E3.2.1 through E3.2.4. The results of these adjustments are summarized in the "Adjusted Sample-based Inventory" column of Table E3-11 (see Section E3.4).

E3.2.1 Sludge Volume Measurement

The sludge volume used for sample-based inventory estimates in Table 4-2 was 333 kL (86 kgal). The average sludge level measured on May 30, 1989, was 80.4 cm (equivalent to 329 kL [87 kgal]). This is sufficiently close to the 333 kL (88 kgal) used for the sample-based calculations and no correction is needed.

E3.2.2 Significant Waste Transfers

There were two significant inputs to the tank after the 1989 core sample was taken but before the 1995 supernatant analyses were done:

1. The PUREX Plant solvent extraction system processed approximately 50 MTU in February 1990. A correction of 4 percent (50 MTU/1,366 MTU) will be added to sample-based insoluble materials inventory resulting from PUREX processing the first 1,366 MTU.

2. On January 13, 1993, the PUREX neptunium product inventory was transferred to tank 241-AZ-102. This transfer included 12,728 g of Np, 67,765 g of U, and 6 g of Pu. These materials will be added to the sample-based inventory estimate.

B Plant also returned solids transferred from tank 241-AZ-101 for a 1986 solids/liquid separation process test to tank 241-AZ-102. Exact information for the material transferred is unavailable, but the transfer from tank 241-AZ-101 was 37.8 kL (10 kgal) and contained a disproportionately low solids content. The impact on the tank 241-AZ-102 chemical and radionuclide inventory would be negligible.

E3.2.3 Additional Supernatant Inventories

The sample-based inventories reported for K and ^{99}Tc included only the contribution from the sludge layer. Inductively-coupled plasma analytical results for K are actually available for the 1995 supernatant samples (three samples). Technetium-99 analyses were performed on the interstitial liquid for the core sample, which should be fairly comparable to the supernatant. The additional inventory can be calculated from the supernatant volume (3,230 kL [853 kgal]), the supernatant density (1.10 g/mL), and the average concentration.

Table E3-1. Additional Supernatant Inventories, Tank 241-AZ-102.

Analyte	Average supernatant concentration	Additional inventory
K	3,144 μg/ml	10,160 kg
^{99}Tc[a]	0.100 μCi/g	355 Ci

[a] Measured in August 1991.

E3.2.4 Core Sample Adjustments

The layer analyses from the core sample provide an opportunity to check and adjust analytical results. The layer analyses indicate problems with several anions (F, Cl, NO_2, NO_3, PO_4, and SO_4). The grab sample supernatant concentrations (Rollison 1995a, 1995b, and 1995c) are generally much higher than the core composite, reinforcing the conclusion that the anion analyses for the core composite concentrations (Gray et al. 1993) are in error since the sludge is approximately 80 percent interstitial liquid (Schofield 1991) with a composition similar to the supernatant. Chloride ion is the exception; the layer samples indicate a 48 percent lower inventory. The recommended adjustments are tabulated in Table E3-2.

Table E3-2. Core Sample Adjustments for Anions, Tank 241-AZ-102.

Anion	Core composite mean (μg/g)	Mean of layers (μg/g)	Percent increase	Additional inventory (kg)
F	538.1	877	63	168
Cl	122.6	63.7	48 decrease	-29
NO_2	11,877.6	28,600	241	8,290
NO_3	3,424.4	5,310	55	936
PO_4	335.6	906	270	283
SO_4	8,040.8	12,100	50	2,000

E3.3 INVENTORY ESTIMATE BASED ON PUREX FLOWSHEET/ OPERATING RECORDS

The NCAW from 3,890 MTU of N Reactor fuel processed between 1983 and 1990 contained essentially all of the chemicals used for fuel dissolution, solvent extraction separations, and plutonium oxide conversion. Additionally, most of the non-volatile radionuclides present in the irradiated N Reactor fuel would be contained in the NCAW. The flowsheet for processing these fuels was well established and the amount of cold U rework is known. It is, therefore, possible to make a reasonable flowsheet estimate of the waste composition for the two aging waste tanks (241-AZ-101 and 241-AZ-102).

For chemical species, the process estimate consists of the estimated initial tank 241-AZ-102 sludge heel, plus chemical additions based on the PUREX Plant flowsheet or actual essential material usage when available, plus estimated corrosion of the PUREX processing vessels (Fe, Cr, and Ni). For radionuclides, the process estimate consists of the estimated initial tank 241-AZ-102 heel, plus additions based on the ORIGEN2 model. The overall process estimate for tank 241-AZ-102 is summarized in the "Process Estimate" column of Table E3-11 (see Section E3.4).

E3.3.1 PUREX Operations Summary

A summary of pertinent information for PUREX Plant operations between 1983 and 1990 is provided in Table E3-3.

Table E3-3. PUREX Processing Summary 1983 to 1990.

Process data	Total PUREX processing	Tank 241-AZ-101	Tank 241-AZ-102
Hot Fuel Charged	3,890 MTU	2,470 MTU	1,420 MTU
Cold Uranium Charged	30 MTU	30 MTU	0 MTU
Cold Uranium Recycled	2,480 MTU	1,630 MTU	855 MTU
Processed for Neptunium Recovery[a]	2,500 MTU	229 MTU	2,270 MTU
Fraction 12 percent ^{240}Pu	8.63%	8.53%	8.81%

PUREX = Plutonium-Uranium Extraction
[a] Schofield (1991).

E3.3.2 Chemical Additions Per the PUREX Plant Flowsheet

The PUREX Plant flowsheet for reprocessing of N Reactor fuels (Allen et al. 1985) provides a basis for estimating waste composition. Minor chemical contributions for radionuclides in the fuel elements (Ag, Cd, La, Sr, and Zr) can be predicted from the ORIGEN2 model. The chemical additions per MTU processed is provided in Table E3-4.

Table E3-4. Chemical Additions per PUREX Flowsheet. (2 Sheets)

Chemical/source	Flowsheet usage	
	6% ^{240}Pu (kg/MTU)	12% ^{240}Pu (kg/MTU)
ANN-Head End	177.7	177.7
ANN-Solvent Extraction	30.0	30.0
ANN-Pu Oxide Line	0.77	0.77
Total ANN	208	208
$Cd(NO_3)_2$	2.25	2.25
$Fe(SO_3NH_2)_2$ - "1BX" Stream	7.05	15.8
HSO_3NH_2	3.94	9.72
NaF	0.03	0.03
NaOH	137	172

Table E3-4. Chemical Additions per PUREX Flowsheet. (2 Sheets)

Chemical/source	Flowsheet usage	
	6% ^{240}Pu (kg/MTU)	12% ^{240}Pu (kg/MTU)
$NaNO_2$	10.1	8.43
Additions for Np Recovery		
$Fe(SO_3NH_2)_2$ - "2N" Scrubber Stream[a]	6.49	7.49
$NaNO_2$ - "HA" Column	0.42	0.41
Fission Products[b]		
Ag	0.0013	0.0052
Cd	0.0019	0.0059
La	0.044	0.109
Sr	0.033	0.077
Zr	0.141	0.338

ANN = Aluminum nitrate nonahydrate - $Al(NO_3)_3 \cdot 9H_2O$
PUREX = Plutonium-Uranium Extraction
[a] Usage rate 3 times flowsheet: a compromise between usage rates reported by PUREX process engineers and the factor of four assumed in Schofield (1991).
[b] Fission product contributions based on ORIGEN2.

The total essential material usage can be calculated based on the PUREX processing history (Table E3-3) and the chemical additions per the PUREX Plant flowsheet (Table E3-4). The results are summarized in Table E3-5.

Table E3-5. PUREX Plant Chemical Additions to the Aging Waste. (2 Sheets)

Chemical	Tank 241-AZ-101 (kg)	Tank 241-AZ-102 (kg)	Total (kg)
Ag (FP)	4	2	7
ANN	570,700	320,900	891,600
Cd (FP)	6	3	9
$Cd(NO_3)_2$	5,570	3,190	8,750
$Fe(SO_3NH_2)_2$	33,700	32,700	66,400
HSO_3NH_2	18,300	10,100	28,400
La (FP)	123	80	202
NaF	74	42	117

Table E3-5. PUREX Plant Chemical Additions to the Aging Waste. (2 Sheets)

Chemical	Tank 241-AZ-101 (kg)	Tank 241-AZ-102 (kg)	Total (kg)
NaOH	579,900	319,100	899,000
$NaNO_2$	41,200	22,600	63,800
Sr (FP)	91	52	143
Zr (FP)	390	224	614

ANN = Aluminum nitrate nonahydrate - $Al(NO_3)_3 \cdot 9H_2O$
FP = fission product
PUREX = Plutonium-Uranium Extraction.

The waste analytes were calculated from the chemical compounds and tabulated in Table E3-6.

Table E3-6. Waste Analytes Additions per PUREX Plant Flowsheet.

Analyte	Tank 241-AZ-101 (kg)	Tank 241-AZ-102 (kg)	Total (kg)
Ag (FP)	4	2	7
Al	41,000	23,100	64,100
Cd	2,650	1,520	4,170
F	34	19	53
Fe	7,580	7,360	14,900
La (FP)	123	80	202
Na	347,200	191,000	538,200
SO_4	44,200	35,300	79,600
Sr (FP)	91	52	143
Zr (FP)	390	224	614

FP = fission product
PUREX = Plutonium-Uranium Extraction.

E3.3.3 PUREX Chemical Usage Per Essential Material Records

The quantities of aluminum nitrate nonahydrate [$Al(NO_3)_3 \cdot 9H_2O$ or ANN], ferrous sulfamate [$Fe(NH_2SO_3)_2$] and sulfamic acid (NH_2SO_3H) used for PUREX processing between 1983 and 1990 are known. The actual chemical usage provides a basis for estimating Al, Fe (that portion added as an essential material) and sulfate in the aging waste tanks.

Table E3-7. PUREX Plant Essential Material Usage.

Chemical	Usage
Aluminum nitrate nonahydrate	935,400 kg
Ferrous sulfamate	103,300 kg
Sulfamic acid	54,500 kg

PUREX = Plutonium-Uranium Extraction.

The Al, sulfate, and Fe waste analytes can be calculated from the essential material usage and distributed between the two NCAW tanks based on the flowsheet estimate in Section E3.3. The results are provided in Table E3-8. These numbers will replace those calculated from the PUREX Plant flowsheet for the process estimate.

Table E3-8. Tank 241-AZ-102 Waste Inventories Based on PUREX Plant Essential Materials.

Analyte	Tank 241-AZ-101 inventory (kg)	Tank 241-AZ-102 inventory (kg)	Total NCAW (kg)
Al	43,100	24,300	67,400
Fe	11,800	11,500	23,300
SO_4	74,700	59,600	134,300

NCAW = Neutralized current acid waste
PUREX = Plutonium-Uranium Extraction.

Additionally, the PUREX head-end usage of rare earth nitrate (lanthanum-neodymium nitrate mixture) is known from operating data (see Kupfer et al. 1997, Section 5.11). These rare earth nitrates were precipitated as a fluoride, dissolved in nitric acid, and combined with the feed to solvent extraction. The rare earth nitrate additions contributed 1,130 kg of La to tank 241-AZ-102, which will be added to the fission product La present in the irradiated fuel elements.

E3.3.4 Estimated PUREX Corrosion

Corrosion of the PUREX process equipment, in particular the reactor fuel dissolvers and the process concentrators, contribute Fe, Cr, and Ni to the NCAW waste stream. Schofield (1991) estimates this corrosion loosely based on the PUREX tank F15 waste analyses and equipment failure history. Corrosion was estimated to be 0.84 kg stainless steel/MTU charged to the dissolvers, plus up to an additional 6.4 kg stainless steel/MTU processed through solvent extraction. Estimated corrosion for the waste concentrators was

highly uncertain due the reliance on PUREX Plant dilution samples of tank F15 waste and would normally be considered an upper bound.

Chromium concentration data from tank 241-AZ-102 also can be used to calculate the PUREX Plant corrosion since most equipment in the PUREX Plant is 304L stainless steel, which has a fixed composition of 71 wt% Fe, 19 wt% Cr, and 10 wt% Ni. Chromium was chosen over Ni for this estimate since approximately 80 percent of the Cr is soluble in tank 241-AZ-102 and is, therefore, less subject to sampling/analytical error than the almost totally insoluble Ni. The resulting corrosion product inventories are given in Table E3-9.

Table E3-9. Estimated Corrosion Products.

Corrosion analyte	PUREX corrosion products[a]
Cr (adjusted sample-based inventory minus heel)	3,630 kg
Ni (calculated)	1,910 kg
Fe (calculated)	13,600 kg

PUREX = Plutonium-Uranium Extraction
[a] Corrosion calculated from Schofield (1991) would be 18 percent less.

The PUREX Plant corrosion during filling of tank 241-AZ-102 appears to have been three times higher than for tank 241-AZ-101. The reason for an increase in corrosion rates is unknown, but may be related to more extensive Np recovery processing or efforts to reduce NCAW waste volume by minimizing the excess Al added to prevent fluoride corrosion.

The ratio of corrosion products for tank 241-AZ-102 also, is not consistent. The Ni inventory calculated from Cr (1,910 kg) is not in agreement with 3,050 kg calculated by subtracting the initial heel (Table E3-10) from the adjusted sample-based inventory (Table E3-11). The corrosion Fe inventory predicted from Cr (13,600 kg) is also considerably less than the 30,300 kg estimated by subtracting the initial heel (Table E3-10) and Fe added as an essential material (Table E3-8) from the adjusted sample-based inventory (Table E3-11). The discrepancies cast some doubt on the validity of the analytical data for these metals.

E3.3.5 Estimated Initial Tank Heel

Although tank 241-AZ-102 was sluiced before reuse as a NCAW receiver, a significant solids layer remained in the tanks. Sludge measurements taken on March 11, 1986, show a heel of 24.9 cm (9.8 in.) (average of 6 readings).

Layer analyses were included for the core sample of tank 241-AZ-102. The bottom layer (L3 in Gray et al. 1993), taken 8 cm (3 in.) from the rotary valve of the sampler,

should be representative of the initial tank heel. The estimated initial tank inventory is provided in Table E3-10. Process estimates include an allowance for the initial heel.

Table E3-10. Estimated Composition of the Initial Tank 241-AZ-102 Sludge Heel. (2 sheets)

Analyte	Layer L3 ($\mu g/g$)	Heel inventory (kg)
Ag	496	76
Al	43,500	6,630
Ca	2,020	308
Cd	146	22
Cl	60.3	9
Cr	2,870	438
F	847	129
Fe	43,400	6,620
La	945	144
Mn	1,270	194
Na	114,000	17,400
Ni	1,490	227
NO_2	19,200	2,930
NO_3	7,940	1,210
Pb	995	152
PO_4	1,690	258
Si	4,020	613
SO_4	9,100	1,390
Sr	96.4	15
U	56,000	8,540

Table E3-10. Estimated Composition of the Initial Tank 241-AZ-102 Sludge Heel. (2 sheets)

Analyte	Layer L3 (μg/g)	Heel inventory (kg)
Zr	930	142
Radionuclide[a]	Layer L3 (μCi/g)	Heel inventory (Ci)
^{60}Co	1	152
^{134}Cs	16.5	2,520
^{137}Cs	749	114,200
^{154}Eu	18.5	2,820
^{155}Eu	320	48,800
^{106}Ru	16	2,440
^{125}Sb	31	4,730
Sludge Level	24.9 cm (9.8 in.)	
Volume	102.3 kL (27 kgal)	
Density	1.49 g/mL	

[a] Radionuclides measured in August 1991.

E3.3.6 Suspended Solids

Five supernatant samples taken from three different depths in tank 241-AZ-101 (Peterson 1990) indicate that the average suspended solids was 0.73 vol% during a time period when the tank air lift circulators were operated routinely. Similar measurements are not available for tank 241-AZ-102, but the process estimates for Al are likely to account for most of the mass of any suspended solids that might have existed.

E3.3.7 Radionuclide Estimates

The radionuclide inventories can be estimated from the reactor fuel exposure and the date that the fuel was reprocessed at the PUREX Plant. The radionuclide estimates are provided in Table E3-11. These estimates are based on the same ORIGEN2 calculations submitted for inclusion in Revision 4 of the HDW model (Agnew et al. 1997) (data version referred to as U6). The development of the ORIGEN2 estimate is described in more detail in Section 6.1 of Kupfer et al. (1997). The only adjustments made for the tank 241-AZ-102 process estimate were as follows:

- The fraction of ^{134}Cs, ^{137}Cs, and ^{137}Ba originally present in the reactor fuel and lost to the neutralized cladding removal Waste (NCRW) coating wastes was

revised to 4.8 percent based on data from the PUREX Plant campaigns A03 and A04. The value assumed by the ORIGEN2 model was 2 percent.

- The small fraction of Np recovered during the filling of tank 241-AZ-101 (4.1 percent) was credited to tank 241-AZ-102. All recovered Np stored at the PUREX Plant transferred to tank 241-AZ-102 on January 13, 1993.

E3.4 EVALUATION/RECONCILIATION OF INVENTORY ESTIMATES

The HDW model, sample-based, adjusted sample-based, and process estimates of tank 241-AZ-102 chemical and radionuclide inventories are provided in Table E3-11. In general, there is reasonable agreement between the adjusted sample-based and the process estimate for major components, but the HDW model values for the major chemical species are usually significantly lower.

Table E3-11. Comparison of Tank 241-AZ-102 Inventory Estimates. (4 Sheets)

Analyte	HDW model[a] (kg)	Sample-based[b] (kg)	Adjusted Sample-based (kg)	Process estimate (kg)
Ag	NR	242	248	78
Al	15,600	24,200	24,700	30,900
Bi	1.56	NR	NR	NR
Ca	1,880	1,080	1,110	308
Cd	NR	5,360	5,570	1,540
Cl	3,140	61	32	9
CO_3	6,100	127,000	128,500	NR
Cr	63.8	3,930	3,950	3,950[c]
F	855	3,510	3,690	148
Fe	16,900	46,800	48,400	31,200[c]
Hg	0.0124	NR	NR	NR
K	769	918	11,100	0
La	0.0121	1,610	1,670	1,360
Mn	19.9	1,030	1,060	194
Na	122,000	198,800	199,200	211,800
Ni	114	3,160	3,280	2,070[c]
NO_2	35,000	95,100	103,900	NR

Table E3-11. Comparison of Tank 241-AZ-102 Inventory Estimates. (4 Sheets)

Analyte	HDW model[a] (kg)	Sample-based[b] (kg)	Adjusted Sample-based (kg)	Process estimate (kg)
NO_3	23,200	78,500	79,500	NR
OH	93,000	6,070	6,070	NR
Pb	2.25	394	403	152
PO_4	520	167	457	258
Si	8,560	3,390	3,430	613
SO_4	20,600	59,900	62,100	61,000
Sr	0	117	121	67
TOC	5,913	6,170	6,220	NR
U	4,270	9,670	9,580	8,540
Zr	0.104	6,470	6,720	366
Radionuclide (Ci)[d]				
^{227}Ac	0.022	NR	NR	4.83 E-04
^{241}Am	13,400	36,300	37,700	14,800
^{243}Am	2.57	NR	NR	4.42
^{137m}Ba	3.98 E+06	NR	NR	4.09 E+06
^{14}C	182	0.8	0.832	178
^{113m}Cd	1,320	NR	NR	1,220
^{242}Cm	13.1	NR	NR	11.2
^{243}Cm	2.11	NR	NR	1.77
^{244}Cm	49.9	NR	NR	42.1
^{60}Co	2,400	NR	NR	3,420
^{134}Cs	30,000	NR	NR	41,200
^{137}Cs	4.01 E+06	4.02 E+06	4.03 E+06	4.32 E+06
^{152}Eu	167	NR	NR	142
^{154}Eu	18,600	NR	NR	23,100
^{155}Eu	26,600	NR	NR	66,900
^{3}H	14,700	NR	NR	15,600
^{129}I	1.53	NR	NR	1.52
^{93m}Nb	165	NR	NR	43.3

Table E3-11. Comparison of Tank 241-AZ-102 Inventory Estimates. (4 Sheets)

Analyte	HDW model[a] (Ci)	Sample-based[b] (Ci)	Adjusted Sample-based (Ci)	Process estimate (Ci)
Radionuclide (Ci)[(4)]				
^{59}Ni	69.2	NR	NR	10.8
^{63}Ni	6,970	NR	NR	1,250
^{237}Np	11.1	49.2	60.1	11.7
^{231}Pa	0.036	NR	NR	0.0018
^{238}Pu	134	175	181	97.5
^{239}Pu	2,070	NR	NR	797
^{240}Pu	476	NR	NR	237
^{241}Pu	12,300	16,400	17,100	9,520
^{242}Pu	0.053	NR	NR	0.034
^{226}Ra	4.21 E-03	NR	NR	8.50 E-05
^{228}Ra	2.7 E-03	NR	NR	6.0 E-09
^{106}Ru	33,600	NR	NR	76,200
^{125}Sb	61,700	NR	NR	92,700
^{79}Se	53.2	NR	NR	22.8
^{151}Sm	19,400	NR	NR	80,200
^{126}Sn	85	NR	NR	35.4
^{90}Sr	3.97 E+06	6.94 E+06	7.22 E+06	3.70 E+06
^{99}Tc	764	220	599	611
^{229}Th	6.7 E-05	NR	NR	6.80 E-07
^{232}Th	2.9 E-05	NR	NR	9.39 E-09
^{232}U	8.2 E-03	NR	NR	6.48 E-04
^{233}U	2.99 E-03	NR	NR	3.20 E-04
^{234}U	2.07	NR	NR	2.00
^{235}U	7.86 E-02	NR	NR	0.079
^{236}U	0.17	NR	NR	0.164
^{238}U	1.42	NR	NR	1.37
^{90}Y	3.97 E+06	NR	NR	3.70 E+06

Table E3-11. Comparison of Tank 241-AZ-102 Inventory Estimates. (4 Sheets)

Analyte	HDW model[a] (Ci)	Sample-based[b] (Ci)	Adjusted Sample-based (Ci)	Process estimate (Ci)
^{93}Zr	240	NR	NR	111

HDW = Hanford Defined Waste
NR = Not reported
[a] Agnew et al. (1997)
[b] Section 4.0
[c] The adjusted sample-based inventory for chromium was used to estimate Fe and Ni corrosion products, consequently, the process estimate for Cr is not independent of the adjusted sample-based estimate.
[d] Radionuclides decayed to January 1, 1994.

E3.4.1 Hanford Defined Waste Model Discussion

The HDW model assumes a waste volume of 263 gal/ton U, whereas, solvent extraction rework of U and Pu increased this to about 351 gal/ton U (excluding transfer line flush). Additionally, there needs to be a distinction between chemicals added to the fuel dissolvers (Aluminum nitrate nonahydrate [ANN] and HNO_3) and those chemicals added to the solvent extraction system and, therefore, subject to increases with product rework.

The HDW model assumes a constant vol% solids for the NCAW waste stream, while the actual value is highly dependant on the OH concentration which in turn controls Al solubility. The OH concentration for tank 241-AZ-102 is much lower than tank 241-AZ-101, hence, the solids percent will be much higher even though they are both the same waste type. The sludge volume/MTU for tank 241-AZ-102 was over 4.7 times that for tank 241-AZ-101.

The HDW model Si concentration was selected based on the unexplained presence of Si in previous PUREX Plant HLW. However, the Si actually comes from the bonding layer in aluminum-clad fuel and should not be present when processing zirconium-clad fuel elements. The adjusted sample-based inventory provides a better estimate.

The HDW model Fe concentration for P3 defined waste appears low for tank 241-AZ-102 (0.117*M*). This includes 0.05*M* contribution for corrosion (25 percent more than the fixed 0.04*M* normally used). In contrast, the flowsheet estimate for this report was 0.177*M*, 64 percent of which is due to corrosion. The difference appears to be primarily the result of the accelerated PUREX Plant corrosion experienced during filling of tank 241-AZ-102.

The concentrations of NO_2 and NO_3 ions used by the HDW model are also extremely low compared to sample-based values (see Table E3-11). The HDW model apparently

overestimates the efficiency of the PUREX Plant sugar denitration process. The efficiency of the sugar denitration process varies with reaction time and the composition of the waste stream (RHO 1983), making modeling difficult. For tank 241-AZ-102, the adjusted sample-based inventory for chemical nitrogen (total of NO_2 and NO_3 on a mole basis) is 2.9 times the HDW model estimate.

Although a minor contribution, the HDW model assumes that part of the initial tank 241-AZ-102 sludge heel was attributable to the Z Plant waste. This is unlikely since cross-site transfers were decanted from tank 241-SY-102 and contained negligible solids. The assignment of 98 kL (26 kgal) of the initial tank heel to SRR (sludges from A and AX Tank Farms) is reasonable considering the transfers that were occurring at the time of the sludge level increase and the Fe present in the tank 241-AZ-102 heel after sluicing (Table E3-10).

For these reasons the HDW model estimates will be used for the best-basis inventory only when other process estimates or sample data are not available.

E3.4.2 Reconciliation of Tank Characterization Report and Process Estimates

The individual chemical and radionuclide inventories, as determined from different methodologies, often do not agree. The rationale for selection of a best-basis value is provided in this section.

Silver. Silver NO_2 was used to recharge the dissolver Ag reactors, although this material should not been included with NCAW transfers. The process estimate includes only the Ag present in the initial tank 241-AZ-102 heel and fission product Ag in the fuel. Hence, the sample-based estimate is judged to be more reliable.

Aluminum. The overall NCAW process flowsheet estimate and the essential material usage for Al agreed within about 5 percent. Additional Al was present in the initial tank heel. The process estimate for tank 241-AZ-102 was 25 percent higher than the adjusted sample-based inventory.

A possible explanation for this difference is the precipitation of Al between the 1989 core sample event and the 1995 supernatant sampling. It is extremely likely that additional Al precipitated as the OH was depleted by carbon dioxide absorption from the air (22 air lift circulators were in operation for several years). Analytical data for tank 241-AZ-101 do, in fact, indicate that the supernatant Al concentration declined between 1987 and 1995 (0.449, 0.398, and 0.345*M* in 1987, 1989, and 1995, respectively).

Bismuth. The HDW model predicts an inventory of 2 kg Bi, which is the only available estimate. The source of the Bi is the SMMA1 defined waste type. No Bi was added to the PUREX process during processing of zirconium-clad N Reactor fuels and none would be expected in NCAW.

Calcium. The Ca inventory can not be accurately estimated from the PUREX Plant flowsheet since it originates as an impurity in essential materials. Raw water also contains Ca, but demineralized water was used for PUREX Plant chemical makeups. The adjusted sample-based inventory is the best data source.

Cadmium. The PUREX flowsheet does contain an estimate of Cd nitrate usage. However, this estimate is not based on a routine process stream and is only an approximation. The adjusted sample-based inventory is the best data source.

Chloride. Chlorides may be present in PUREX process essential materials (especially Na OH). It is not a primary constituent of any PUREX process essential material, hence, the adjusted sample-based inventory provides the best data source.

Carbonate. Sodium carbonate was used in the PUREX Plant solvent treatment systems. However, these wastes were disposed separately and were not combined with the NCAW stream. The carbonate ion present in tank 241-AZ-102 results primarily from the absorption of carbon dioxide from the air into the caustic NCAW solution. This process was accelerated by the use of air lift circulators in the aging waste tanks. Since the absorption of carbon dioxide is continuous, sampling is the only way to accurately determine the carbonate inventory. The adjusted sample-based inventory is the best data source.

Chromium. Chromium is not added as an essential material in the PUREX process. Chromium constitutes 10 percent of the 304L used in PUREX process equipment, hence, Cr will be present in the NCAW waste stream as the result of corrosion. Good, independent process, estimates are not possible due to the limited accuracy of the PUREX process dilution samples take of the HLW. It should be noted that the corrosion Fe, Cr, and Ni based on sample analyses adjusted for chemical additions of Fe are not in agreement with the composition of 304L stainless steel (71 wt% Fe, 19 wt% Cr, and 10 wt% Ni). This casts some doubt on the accuracy of the sample data. The adjusted sample-based inventory will be used as the best-basis.

Fluoride. Fluorides could carry-over from the fuel decladding operations to the solvent extraction feed and the NCAW waste. The adjusted sample-based inventory provides the best data source.

Iron. The adjusted sample-based inventory is 55 percent higher than the process estimate. Corrosion Fe, Cr, and Ni based on sample analyses adjusted for chemical additions of iron are not in agreement with the composition of 304L stainless steel (71 wt% Fe, 19 wt% Cr, and 10 wt% Ni). This casts some doubt on the accuracy of the sample data. The sample-based inventory will be used as the best-basis.

Mercury. The HDW model predicts an inventory of 0.01 kg Hg, which is the only available estimate. The HDW model source of the mercury is the SMMA1. No mercury was added to the PUREX process during processing of zirconium-clad N Reactor fuels and none would be expected in NCAW.

Potassium. The process estimate predicts no K while the adjusted sample-based inventory is 11,100 kg. Part of the K might be explained by periodic use of KOH for waste neutralization in place of NaOH or carry-over of small quantities from head-end metathesis processes. However, the 11,100 kg inventory suggests that another source might exist. Sodium hydroxide used at the PUREX Plant might have contained a small fraction of KOH. The essential material specification for NaOH contained no limit for potassium. The adjusted sample-based inventory provides the best-basis.

Lanthanum. The adjusted sample-based estimate is 23 percent higher than the process estimate. This is reasonable agreement considering the relatively low La inventory. To be conservative, the sample-based inventory is selected as the best-basis.

Manganese. The adjusted sample-based inventory is nearly a factor of 5.5 higher than process estimate. Manganese is not a significant fission product. Potassium permanganate is added to the solvent treatment systems, but this waste stream is not combined with the NCAW. There is no logical explanation for the higher Mg inventory, although a similar Mg inventory discrepancy exists for tank 241-AZ-101. The sample-based inventory will be used for the best-basis to be conservative.

Sodium. The process estimate and the adjusted sample-based inventories are in excellent agreement (within 6 percent). For tank 241-AZ-102, a record of NaOH additions to tank F15 was kept. A total of 428 kL (113 kgal) of 50 wt% NaOH were added. When added to the flowsheet $NaNO_2$ contribution, the total is 194,400 kg Na, which further confirms the sample-based inventories. The adjusted sample-based inventory will be used as the best-basis.

Nickel. The adjusted sample-based inventory is 63 percent higher than the process estimate. Corrosion Fe, Cr, and Ni based on sample analyses adjusted for chemical additions of Fe are not in agreement with the composition of 304L stainless steel (71 wt% Fe, 19 wt% Cr, and 10 wt% Ni). This casts some doubt on the accuracy of the sample data. The adjusted sample-based inventory will be used as the best-basis.

Nitrite. There are currently no process models capable of accurately predicting the NO_3 concentration after the sugar denitration process. The adjusted sample-based inventory will be used as the best-basis.

Nitrate. There are currently no process models capable of accurately predicting the NO_2 concentration after the sugar denitration process. The adjusted sample-based inventory will be used as the best-basis.

Lead. The adjusted inventory is 2.7 times the process estimate. No Pb is added as PUREX process essential material and none would be expected in the NCAW. Since the process estimate accounts for only the Pb originally present in the tank heel, the adjusted sample-based inventory is still more reliable and conservative and will be used as the best-basis.

Phosphate. Phosphate is a constituent of the PUREX Plant solvent (as tri-butyl phosphate). Solvent degradation could easily add OH to the NCAW waste which could not be predicted from the PUREX Plant flowsheet. The adjusted sample-based inventory will be used for the best-basis.

Silicon. Silicon is not a primary constituent of PUREX process essential materials. A defoaming agent used in the HLW treatment system contained approximately 3 wt% Si, but the usage was only 0.65 L/operating day. The Si, indicated from the adjusted sample-based inventory, results from the initial 241-AZ-102 tank heel and incidental sand-like material either infiltrating through ventilation systems or present as an impurity in the PUREX Plant essential materials. The adjusted sample-based silicon inventory for tank 241-AZ-102 is 2.5 times that for tank 241-AZ-101, although the reason for this difference is unknown. The adjusted sample-based inventory will be used for the best-basis.

Sulfate. The adjusted sample-based inventory and the process estimate are in excellent agreement (within 2 percent). This was not expected since the tank 241-AZ-101 process estimate and adjusted sample-based inventories did not agree and both tanks 241-AZ-101 and 241-AZ-102 sulfate process estimate inventories were based on the same essential material usage. Tank 241-AZ-102 sulfate inventory predicted from the PUREX Plant flowsheet (35,300 kg) is also much lower than that predicted from the essential material usage (59,600 kg). The agreement between the adjusted sample-based sulfate inventory and the process estimate may be is just coincidental. The adjusted sample-based inventory will be used for the best-basis.

Strontium. The adjusted sample-based inventory is 1.8 times the process estimate. Both estimates indicate that Sr is a very small fraction of the total waste inventory in tank 241-AZ-102. The sample-based adjusted sample-based inventory will be used for the best-basis.

Total Organic Carbon. The process estimate includes only the TOC present in the initial tank heel, which was not measured for tank 241-AZ-102. Undigested sugar from the PUREX denitration process, as well a solvent degradation products, would add to the TOC inventory. Sampling is the only reasonable method for determining this TOC inventory. The adjusted sample-based inventory will be used for the best-basis.

Uranium. The process estimate is based on the assumed loss fraction for the ORIGEN2 radionuclide estimates (0.29 percent of U charged). Actual PUREX process solvent extraction U losses were usually well below 0.1 percent. However, for tank 241-AZ-102 the higher loss rate is in good agreement with the adjusted sample-based inventory (approximately 11 percent less). Accountability records indicate U losses of only 1,360 kg. The adjusted sample-based inventory is possibly high, but it will be used for the best-basis to be conservative.

Zirconium. The adjusted sample-based inventory for Zr is 18 times the process estimate. This is somewhat expected since Zr solids were detected in the U feed to the solvent extraction systems during PUREX Plant operations. Based on the adjusted sample-based inventories, it appears that approximately 5 percent of the Zr in the cladding was included in NCAW. The adjusted sample-based inventory will be used for the best-basis.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997).

Radionuclides. Due to the limited number of radionuclides that were analyzed in both the sludge and supernatant, most best-basis inventories are based on the process estimate which includes the initial tank inventory and PUREX additions based on the ORIGEN2 model.

The ORIGEN2 model is only a rough estimate of PUREX solvent extraction plutonium process losses. Therefore, the adjusted sample-based inventories were selected as the best-basis inventory when available. Since separate ^{239}Pu and ^{240}Pu analyses were not made, HDW model isotopic ratios was used to estimate the ^{240}Pu inventory.

Similarly, ^{232}U, ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U analyses were not completed. The HDW model isotopic ratios with the ^{238}U sample data were used to estimate the uranium isotopic concentrations.

The pathway of several radionuclides within the PUREX process is not precisely known due to volatility or extraction by the PUREX process solvent. These include ^{3}H, ^{14}C, ^{99}Tc, and ^{129}I. The sample-based inventory value would normally be preferred for these radionuclides if available. A best-basis estimate for ^{3}H is not reasonable since sample data are not available. The adjusted sample-based inventory for ^{99}Tc was within 2 percent of the process estimate. However, it is known that approximately 31 percent of the ^{99}Tc was contained in the PUREX Plant U product or was released to the PUREX process condensates (Colby and Petersen 1995). Consequently the adjusted sample-based inventory was used as the best-basis inventory for ^{99}Tc, but should be considered an upper bound.

The adjusted sample-based inventory for ^{137}Cs was only 7 percent lower than the process estimate. The adjusted sample-based inventory for ^{90}Sr is two times the process estimate, which is not credible. The process estimate was selected as the best-basis inventory for ^{90}Sr and for ^{137}Cs in order to maintain consistency between these two major radionuclides.

The adjusted sample-based inventory for Np (60.1 curies) is the equivalent of 85,200 g of ^{237}Np. This is unreasonable since all PUREX Plant NCAW sent to tank 241-AZ-102 was generated while the Np recovery process was operating. The disposal of all PUREX Plant recovered Np on January 13, 1993, included only 12,729 g ^{237}Np, and part of that Np was recovered during the filling of tank 241-AZ-101. The process estimate will be used for the best-basis.

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E4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, process, and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage/disposal. Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the HDW model based on process knowledge and historical information, or (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data. The information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available chemical information for tank 241-AZ-102 was performed, including the following:

- Data from a 1989 core sample (Gray et al. 1993).
- Data from three supernatant samples collected in 1995 (Rollison 1995a, 1995b, and 1995c).
- An inventory estimate generated by the HDW model (Agnew et al. 1997).
- Estimation of the residual tank inventory before NCAW introduction in March 1986.
- Evaluation of the PUREX Plant flowsheet in conjunction with PUREX Plant operating data for the period of March 1986 to February 1990.
- Evaluation of PUREX Plant essential material usage during this operating period.
- Estimation of corrosion in PUREX processing equipment.
- Estimation of radionuclides based on the ORIGEN 2 model and HDW isotopic ratios.

Based on this evaluation, a best-basis inventory was developed. In general, the sample-based results were preferred when they were reasonable and consistent with other results. Process estimates were generally used when the sample-based inventory was not

available or reasonable. Frequently, the more conservative inventory value was selected when there was disagreement between the sample-based inventory and a process estimate. The HDW model contains flaws relating to NCAW waste volume generation rates and the waste composition and was used only for minor components where no other data were available.

The waste in tank 241-AZ-102 consists primarily of the HLW generated by the PUREX process during the processing of 1,420 MTU of irradiated, zirconium-clad N Reactor fuel. The best-basis inventory for tank 241-AZ-102 is presented in Tables E4-1 and E4-2. The inventory values reported in Tables E4-1 and E4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. (1997), Section 6.1.10.

Table E4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AZ-102 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
Al	30,900	E	
Bi	0	E	Bi was not used for N-reactor fuel
Ca	1,100	S/E	
Cl	32	S/E	
TIC as CO_3	128,000	S/E	Concentration will increase as CO_3 is absorbed from the air.
Cr	3,950	S/E	
F	3,690	S/E	
Fe	48,400	S/E	
Hg	0	E	Hg is associated with coating wastes which were not added to this tank
K	11,100	S/E	
La	1,670	S/E	
Mn	1,062	S/E	
Na	199,200	S/E	
Ni	3,280	S/E	
NO_2	103,900	S/E	
NO_3	79,500	S/E	Converted to NO_2 by ionizing radiation.
OH	165,000	C	
Pb	400	S/E	
PO_4	457	S/E	
Si	3,430	S/E	
SO_4	62,100	S/E	IC analysis
Sr	121	S/E	

Table E4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AZ-102 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
TOC	6,220	S/E	
U_{TOTAL}	9,580	S/E	
Zr	6,720	S/E	

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table E4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AZ-102 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	1870	E	Estimate revised to include losses to condensate
^{14}C	0.83	S/E	Sludge layer only.
^{59}Ni	10.8	E	Based on ORIGEN2
^{60}Co	3,420	E	Based on ORIGEN2
^{63}Ni	1,250	E	Based on ORIGEN2
^{79}Se	22.8	E	Based on ORIGEN2
^{90}Sr	3.70 E+06	E	Based on ORIGEN2
^{90}Y	3.70 E+06	E	Referenced to ^{90}Sr
^{93}Zr	111	E	Based on ORIGEN2
^{93m}Nb	43.3	E	Based on ORIGEN2
^{99}Tc	599	S/E	Should be considered an upper bound. Based on ORIGEN2
^{106}Ru	76,200	E	Based on ORIGEN2
^{113m}Cd	1,220	E	Based on ORIGEN2
^{125}Sb	92,700	E	Based on ORIGEN2
^{126}Sn	35.4	E	Based on ORIGEN2
^{129}I	1.52	E	Should be considered an upper bound. Based on ORIGEN2
^{134}Cs	41,200	E	Based on ORIGEN2
^{137}Cs	4.32 E+06	E	Based on ORIGEN2
^{137m}Ba	4.09 E+06	E	Referenced to ^{137}Cs
^{151}Sm	80,200	E	Based on ORIGEN2
^{152}Eu	142	E	Based on ORIGEN2
^{154}Eu	23,100	E	Based on ORIGEN2
^{155}Eu	26,600	M	HDW model estimate appears more reasonable
^{226}Ra	8.5 E-05	E	Based on ORIGEN2
^{227}Ac	4.8 E-04	E	Based on ORIGEN2
^{228}Ra	6.0 E-09	E	Based on ORIGEN2
^{229}Th	6.8 E-07	E	Based on ORIGEN2

Table E4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AZ-102 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{231}Pa	0.0018	E	Based on ORIGEN2
^{232}Th	9.39 E-09	E	Based on ORIGEN2
^{232}U	0.0185	S/M	Based on total U: Used HDW isotopic ratios
^{233}U	0.0671	S/M	Based on total U: Used HDW isotopic ratios
^{234}U	4.64	S/M	Based on total U: Used HDW isotopic ratios
^{235}U	0.177	S/M	Based on total U: Used HDW isotopic ratios
^{236}U	0.382	S/M	Based on total U: Used HDW isotopic ratios
^{237}Np	11.7	E	Based on ORIGEN2
^{238}Pu	181	S/E	Based on ORIGEN2
^{238}U	3.19	S/M	Based on total U: Used HDW isotopic ratios
^{239}Pu	1,250	S/E	
^{240}Pu	372	S/E	
^{241}Am	14,800	E	Engineering based estimate appears more reasonable. Based on ORIGEN2
^{241}Pu	17,100	S/E	Based on ORIGEN2
^{242}Pu	0.0340	E	Based on ORIGEN2
^{242}Cm	11.2	E	Based on ORIGEN2
^{243}Am	4.42	E	Based on ORIGEN2
^{243}Cm	1.77	E	Based on ORIGEN2
^{244}Cm	42.1	E	Based on ORIGEN2

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based.

E5.0 APPENDIX E REFERENCES

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