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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 643405

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [ ] KN ~~[X]~~ Direct Revision [X] Change ECN [ ] Temporary [ ] Standby [ ] Supersedure [ ] Cancel/Void [ ]	M. J. Kupfer, LMHC, H5-49 376-6631	[] Yes [X] No	08/18/97
	6. Project Title/No./Work Order No. Tank 241-C-111	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-475, Rev. 0B	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

Add Appendix E, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-C-111.

SEP 1998 RECEIVED EDMC

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

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-C-111 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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

Central Files	A3-88	K. M. Hall	R2-12
DOE Reading Room	H2-53	K. M. Hodgson	R2-11
TCSRC	R1-10	R. T. Winward	H5-49
File	H5-49	J. G. Field	R2-12
R. E. Stout	H5-49		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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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	[]		[]
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
NA		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. N. J. Kupfer	N J Kupfer	8-18-97	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	8-19-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J. G. Field	J G Field	8-19-97	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

A-7900-013-3 (05/96) GEF096

Tank Characterization Report for Single-Shell Tank 241-C-111

R. E. Stout (Meier Associates), R. T. Winward (Meier Associates), and M. J. Kupfer
Lockheed Martin Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-C-111 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-475	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-C-111

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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0-B RS	Incorporate per ECN-625701.	S.E. Kelly	J.G. Kristofzski 9/21/95
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APPENDIX E

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-C-111

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APPENDIX E

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-C-111

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 single-shell tank 241-C-111 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

Available waste (chemical) information for tank 241-C-111 includes the following:

- Analytical data from 1994 push mode core sample (Rice 1994).
- Analytical data from 1995 auger sample data (WHC 1995).
- The Hanford Defined Waste (HDW) model document (Agnew et al. 1997a) provides tank content estimates in terms of component concentrations and inventories.

E2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Tank inventories, based on the HDW model and core composite sample data (Appendix A) are shown in Tables E2-1 and E2-2. (The chemical species are reported without charge designation per the best-basis inventory convention.) The tank volume used to calculate these inventories is 216 kL (57 kgal) of sludge waste (Agnew et al 1997a), which is the same as Hanlon (1997). The HDW model density for the sludge waste was estimated to be 1.39 g/ml while the sample-based density was 1.30 g/ml, resulting in a relative percent difference of 6.7 percent for analytes with roughly the same concentration.

Table E2-1. Sample-Based and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-C-111.

Analyte	Sampling[a] inventory estimate (kg)	HDW[b] inventory estimate (kg)	Analyte	Sampling[a] inventory estimate (kg)	HDW[b] inventory estimate (kg)
Al	35,800	10,600	NO_2	NR	5,330
Bi	462	1,780	NO_3	NR	10,900
Ca	3,280	1,310	Pb	1,600	1,480
Cd	10.5	NR	P as PO_4	9,520	15,100
Cl	NR	194	Si	2,500	885
Cr	622	43	S as SO_4	822	768
F	NR	360	Sr	55	0
Fe	15,300	3,620	TOC	350	486
FeCN	43	1,830	U_{TOTAL}	4,230	8,610
K	NR	46.6	Zn	42.3	NR
La	121	0	Zr	28.8	2.97
Mn	86	0	H_2O (Wt%)	21.1	62.4
Na	7,560	20,600	density (kg/L)	1.30	1.39
Ni	5,800	737			

NR = Not reported
[a]See Appendix A or Table 4-2 of this document
[b]Agnew et al. (1997a).

Table E2-2. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Selected Radioactive Components in Tank 241-C-111.

Analyte	Sample-based[a] inventory estimate (Ci)	HDW[b] inventory estimate (Ci)	Analyte	Sample-based[a] inventory estimate (Ci)	HDW[b] inventory estimate (Ci)
^{14}C	NR	0.0315	^{155}Eu	NR	2.89
^{90}Sr	1.16E+06	16,000	$^{239/240}Pu$	248	107
^{137}Cs	12,100	18,000	^{241}Am	NR	0.0529

HDW = Hanford Defined Waste
[a]See Appendix A or Table 4-2 of this document, reported as of date of analysis
[b]Agnew et al. (1997a).

E3.0 COMPONENT INVENTORY EVALUATION

E3.1 HISTORY OF TANK 241-C-111

A brief synopsis of the most relevant facts regarding the operating history of this tank is provided. Section 2.0 provides a more detailed description of the waste history for tank 241-C-111.

E3.1.1 Process Knowledge

Initially, tank 241-C-111 was used as an evaporator feed tank and received first-cycle decontamination waste (1C) from the bismuth phosphate process conducted at B and T Plants. The tank received four types of waste likely to deposit solids during its operating history (Agnew et al. 1997a). The waste types were as follows:

- Bismuth phosphate first-cycle decontamination waste (1C).
- Ferrocyanide-scavenged waste (FeCN) from scavenging of uranium recovery waste initially stored in other tanks.
- PUREX cladding wastes (CWP).
- Hot (or Strontium) Semi-Works (HS) from the ^{90}Sr pilot plant operation.

E3.1.2 Waste Transfer History

First-cycle waste from the bismuth phosphate process began cascading from tank 241-C-110 into tank 241-C-111 during the third quarter of 1946. In November 1946, the tank was declared full.

During the early 1950's, supernatant was transferred out of tank 214-C-111, and the tank began to receive uranium recovery (UR) waste. In the mid-1950's, tank 241-C-111 served primarily as a settling tank for ferrocyanide waste resulting from in-farm scavenging of ^{137}Cs (Borsheim and Simpson 1991). During the first quarter of 1956, some of the ferrocyanide waste was transferred and the tank received PUREX organic wash waste (OWW) and CWP. Tank 241-C-111 received intermittent transfers of supernatant from 241-C-105 and other sources from late in 1959 until early in 1961.

Waste from the Hot (or Strontium) Semi-Works (HS or SSW) plant was intermittently transferred to tank 241-C-111 for approximately two years in the early 1960's. Final transfers of supernatant out of tank 241-C-111 occurred during the late 1960's and early 1970's. The final waste transfer was completed in approximately 1976.

See section 2.0 or Appendix A for a more detailed report of the waste transfer history.

E3.2 CONTRIBUTING WASTE TYPES

E3.2.1 Major Waste Types in Sludge

The HDW model (Agnew et al. 1997a) predicts that the tank contains a total of 216 kL (57 kgal) of sludge waste. Agnew et al. (1997a) predicts the following major waste types and volumes:

- Bismuth phosphate first-cycle decontamination waste (136 kL (36 kgal), 1C1).
- Ferrocyanide-scavenged waste (FeCN) from scavenging of uranium recovery waste initially stored in other tanks (19 kL [5 kgal]).
- CWP (61 kL [16 kgal]).

The Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) does not quantify specific volumes contributing to the waste; only qualitative estimates of the relative contributions to the waste are provided. It lists tri-butyl phosphate (TBP-F) as the primary waste type in tank 241-C-111. SORWT lists first-cycle decontamination waste (1C) as the secondary waste type, PUREX cladding waste (CWP) as a tertiary waste type and hot semiworks waste (HS) as another contributing waste type in tank 241-C-111.

Hanlon (1997) reports 216 kL (57 kgal) of waste which consists of only sludge. No description of the sludge type or origin is given. Surveillance data taken from Manual Tape readings report a waste level at 41.9 cm (16.5 in), which corresponds to 220 kL (58 kgal) of total waste which corroborates the Hanlon and Agnew waste volume estimates.

E3.2.2 Major Analytes in Contributing Waste Types

First-Cycle Decontamination Waste (1C). The bismuth phosphate first-cycle (1C) waste type is predicted to be the bottom layer of waste in tank 241-C-111. Based on the Tank Layer Model (Agnew et al. 1997a), this waste is expected to completely fill the dished bottom, as well as extend approximately 20.3 cm (8 in.) above the dished bottom. First-cycle waste is the aqueous solution remaining after the first product decontamination cycle of the $BiPO_4$ process. Nearly all of the uranium as well as 90 percent of the fission products were previously removed from the stream as metal waste (MW).

Bismuth phosphate waste is expected to contain appreciable (approximately 1 wt% or greater) amounts of Bi, Al, Fe, and PO_4 resulting from additions to the product stream in earlier $BiPO_4$ stages. These four analytes are characteristic of all $BiPO_4$ wastes. Bi and PO_4

were added because the plutonium separation process involved coprecipitation of bismuth phosphate. Iron was added in the form of ferrous ammonium sulfate as a Pu reducing agent. Aluminum was introduced from high alkaline Coating Waste (CW) generated from the removal of aluminum cladding from the fuel slugs. CW was added to the first-cycle waste, comprising approximately 24 percent of the 1C waste stream. The aluminum cladding was dissolved in a solution of sodium nitrate/sodium hydroxide.

Ferrocyanide Scavenged Waste. The in-farm ferrocyanide scavenging waste forms the middle layer of waste in the tank (just above the first-cycle waste). The tank layering model predicts approximately 19 kL (5 kgal) of this waste type to be in this tank (Agnew et al. 1997a). However more of this waste may be present. The ferrocyanide waste is expected to contain large (approximately 1 wt% or larger) quantities of iron, nickel, calcium, and uranium. Because the ferrocyanide scavenging process binds the aqueous cesium to the sludge as a precipitant, the quantity of cesium included in the layer of scavenging waste is large enough to be significant and distinctive. The activity of this layer is expected to be much greater than the first cycle or PUREX cladding waste layers.

PUREX Cladding Waste. The PUREX cladding waste is expected to be the top layer of the waste and initially was approximately 150 mm (6 in.) thick. This waste is highly flocculent and may have compressed significantly over time. The PUREX cladding waste should be rich in aluminum, sodium nitrates, nitrites, and uranium. The inventory of uranium present in this layer is expected to be lower than the ferrocyanide scavenging waste layer but significantly higher than the first-cycle bismuth phosphate waste layer. Cesium and strontium are present in the cladding waste, but the quantities are such that the activity in this layer will be the relatively low. The cladding waste layer can further be distinguished from the other two layers by the absence of iron and nickel (contained in ferrocyanide scavenging waste) and the presence of a small to moderate amount of phosphate (not contained in scavenging waste, but present in large quantities in first-cycle waste).

Other Waste Types. If significant quantities of Hot Semi-Works (HS) waste are present, elevated concentrations of TOC, ^{90}Sr, and lead (Pb) will be observed. Increased manganese concentration may indicate the presence of organic wash waste (OWW), since permanganate was used to wash the PUREX solvent. OWW, HS, and UR wastes were not identified as significant contributors in the HDW tank layer model.

E3.3 ASSUMPTIONS USED

For this evaluation, the following assumptions and observations are made:

- Tank volume listed in Hanlon (1997) 216 kL (57 kgal) will be used as the volume for the best basis calculations. Hanlon waste volume agrees with both Agnew et al. (1997a) and surveillance data for tank 241-C-111.

- Waste volumes listed in Agnew et al. (1997a) for the three waste types assumed to be present in the tank (TFeCN, 1C1, and CWP sludge) will be used for the best-basis calculations. Agnew et al. (1997a) is the only source that gives an assumed volume to individual waste types.

- The core composite mean values from the sample analysis were considered adequate and appropriate for calculation of an overall inventory.

E3.4 BASIS FOR SLUDGE ASSESSMENT OF WASTE INVENTORIES

Tank 241-C-111 waste is classified as being sludge waste. Sample data and tank historical analyte concentrations were available and evaluated for the best-basis inventory for tank 241-C-111.

To help evaluate the data from tank 241-C-111, tanks with similar sludge types and available sample data were combined in the ratios predicted for 241-C-111 and compared against tank 241-C-111 analytical data. The tanks used in the comparison contained a single major sludge type that is also assumed to be present in tank 241-C-111.

To match the predicted 1C1 in tank 241-C-111 waste, in tank 241-C-110 (Amato et al. 1994) was evaluated. Tank 241-C-110 is predicted to contain 708 kL (187 kgal) of sludge all of which is 1C1. CWP was taken from 241-C-105 (Tusler 1995), a tank consisting of 568 kL (150 kgal) of sludge of which 15 is an uranium recovery (UR) waste type and the rest is CWP (for this comparison only 511 kL [135 kgal] of CWP was used). The analyte concentration was assumed to be only from the CWP since the core sample for tank 241-C-105 never reached the UR waste). TFeCN was taken from tank 241-C-109 (DeCenso et al. 1995) sample data. Tank 241-C-109 contained small amounts of Hot Semiworks waste and 1C1 waste along with the TFeCN waste. Segment data for the sample in tank 241-C-109 were used to evaluate only the TFeCN waste in the tank. This evaluation is not used for any analyte best basis but is used as a check against the analytes with major differences between tank 241-C-111 sample and HDW data.

E3.4.1 Assessment of Plutonium-Uranium Extraction Cladding Waste Sample Data

Tank 241-C-105 is estimated to contain only CWP. Sample data from tank 241-C-105 were analyzed to determine the mass inventory of selected analytes in the tank. The mass of each component was then multiplied by a volume ratio of CWP (61 kL) waste predicted in tank 241-C-111 verses the CWP in tank 241-C-105 (511 kL), (61 kL / 511 kL = 0.119). The results of selected components are shown in Table E3-1. The use of tank 241-C-105 will bias the inventory of tank 241-C-111 as tank 241-C-105 has no analytical data for any of the anions except for NO_3.

E3.4.2 Assessment of 1C1 Sample Data

Tank 241-C-110 is estimated to contain only 1C1 waste. The same method described for the CW waste in section E3.4.1 was used to determine the mass of selected analytes in tank 241-C-111. The volume ratio used for the 1C1 waste was 0.193 (volume of 1C1 waste predicted in tank 241-C-111 over the volume of 1C1 waste in tank 241-C-110). The results of selected components are shown in Table E3-1. The use of tank 241-C-110 will bias the inventory of tank 241-C-111 as tank 241-C-110 was a primary receiver of 1C1 waste and tank 241-C-111 was a secondary receiver via a cascade from tank 241-C-110.

E3.4.3 Assessment of TFeCN Sample Data

Tank 241-C-109 contained mainly TFeCN waste. Sample data for tank 241-C-109 are broken into quarter segments which allows one to separate the concentrations of the expected TFeCN waste location from the rest of the expected waste types in the tank. This allows for a comparison to be made of the TFeCN waste with other tanks where TFeCN is expected to be present. The same method described for the CW waste in section E3.5 was used to determine the mass of selected analytes in tank 241-C-111 in the TFeCN waste. The volume ratio used for the TFeCN waste was 0.111 (volume of TFeCN waste predicted in tank 241-C-111, 18.9 kL, over the volume of TFeCN waste in tank 241-C-109, 170 kL). The HDW model values were calculated using the defined waste concentrations on page B-17 (Agnew et al. 1997a) and volume of the specific layer estimated by Agnew et al. (1997a).

Table E3-1. Selected Component Waste Inventories for Given Waste Types. (2 Sheets)

Component	CWP sludge based on tank 241-C-105[a] (kg)	CWP sludge based on HDW model (kg)	1C1 sludge based on tank 241-C-110[b] (kg)	1C1 sludge based on HDW model (kg)	TFeCN sludge based on tank 241-C-109[c] (kg)	TFeCN sludge based on HDW model (μg)
Al	5,800	8,480	2,870	2,200	2,700	0
Bi	60	0	3,310	1,780	NR	0
Ca	731	295	227	415	612	605
F	NR	0	1,510	360	22.4	0
Fe	995	560	2,810	2,680	601	380
Na	6,740	2,800	16,300	16,300	2,820	1,500
Ni	202	5	4.72	8	451	725
NO_3	986	2,110	22,000	8,740	1,300	16
NO_2	NR	1,900	1,360	1,480	1,310	1,980

Table E3-1. Selected Component Waste Inventories for Given Waste Types. (2 Sheets)

Component	CWP sludge based on tank 241-C-105[a] (kg)	CWP sludge based on HDW model (kg)	1C1 sludge based on tank 241-C-110[b] (kg)	1C1 sludge based on HDW model (kg)	TFeCN sludge based on tank 241-C-109[c] (kg)	TFeCN sludge based on HDW model (μg)
Pb	84	1,480	51	0	108	0
PO_4	NR	0	5,540	14,900	1,790	210
SO_4	NR	62	2,930	680	248	26
U	923	2,010	293	6,600	414	6.17
Radionuclides (Ci)						
^{90}Sr	81,100	153	990	1,040	24,600	14,900
^{137}Cs	13,800	176	3,850	1,170	26,300	16,700

CWP = PUREX cladding waste
HDW = Hanford Defined Waste, Agnew et al. (1997a)
NR = Not reported
PUREX = Plutonium-uranium extraction
1C1 = First cycle decontamination waste from the bismuth phosphate process, (1944 through 1951)
TFeCN = Ferrocyanide sludge produced by in-tank or in-farm scavenging
[a]Tusler (1995), No anion data are available for tank 241-C-105 except for NO_3
[b]Amato et al. (1994)
[c]DiCenso et al. (1995).

E3.5 ESTIMATED COMPONENT INVENTORIES

The chemical inventory of tank 241-C-111 is estimated from the assumed sludge volumes listed in Agnew et al (1997a). The resulting inventories are provided in Table E3-2. The 1995 core composite data (Appendix A), inventories estimated by the HDW model, and engineering assessment inventories calculated from tanks 241-C-105, 241-C-109, and 241-C-110 are all shown for comparison in Table E3-2. Comments and observations regarding the inventories provided in Table E3-2 are provided by component in the text following the table.

Table E3-2. Comparison of Selected Component Inventory Estimates for Tank 241-C-111.

Component	Engineering evaluation[a] (kg)	Sample core composite data (kg)	HDW estimated[b] (kg)
Bi	3,370	462	1,780
NO_3	24,200	NR	10,900
SO_4	3,170	822	768
Ca	1,570	3,280	1,310
Pb	243	1,600	1,480
PO_4	7,330	9,520	15,100
F	1,530	NR	360
Al	11,400	35,800	10,600
Fe	3,770	15,300	3,620
TOC	344	350	486
Ni	658	5,800	737
Na	25,900	7,560	20,600
Radionuclides[c] (Ci)			
^{90}Sr	107,000	1.16 E+06	16,000
^{137}Cs	43,900	12,100	18,000
H_2O (wt%)	47.8	21.1	62.4

HDW = Hanford Defined Waste (Agnew 1997a)

NR = Not recorded

[a]Based on analyte concentration for 1C, TFeCN, and CWP from tanks 241-C-105 (Tusler 1995), 241-C-109 (Amato et al. 1994), and 241-C-110 (DiCenso et al. 1995)

[b]Agnew et al. (1997a)

[c]Engineering and sample core composite radionuclides are reported as of the analysis date.

Aluminum. The HDW model under predicts the amount of Al in tank 241-C-111 by more than 3 times that reported by the sample data. The engineering assessment agrees with the HDW model. Both the HDW model and engineering assessment use the same assumed volumes for all three waste types. However, the HDW model assumes aluminum to be present only in the 1C and CWP waste types, and not in the TFeCN. Tank samples of FeCN waste typically show aluminum. In addition the high aluminum concentration in the tank may indicate a larger contribution of cladding sludge in the tank than assumed for this assessment.

Calcium. Calcium is seen in all the waste types added to tank 241-C-111. Sample data indicate a higher inventory than both the engineering assessment and the HDW model (Agnew et al. 1997a) which are in close agreement with each other. The reason for the difference between the sample data and the HDW model is not clear at this time. However, calcium was widely used in the ferrocyanide scavenging process. The tank sample may represent a larger contribution of TFeCN waste in the tank than expected. The tank sample is used as the best basis for calcium.

Iron. Iron is seen in all the waste types added to tank 241-C-111. Sample data indicate a higher inventory than both the engineering assessment and the HDW model (Agnew et al. 1997a) which are in close agreement with each other. The reason for the difference between the sample data and HDW model estimates, with the HDW model having less than a quarter of the sample-based inventory, is not totally clear at this time. However, the highest iron concentrations from the engineering assessment and the HDW model are from the TFeCN sludge waste. The waste volume the HDW model (Agnew et al. 1997a) used for TFeCN may account for some of the difference between the HDW model and the sample-based inventory for iron.

Lead. The HDW model suggests a small amount of lead present in a relatively high concentration. The principal source of lead attributed by the HDW model is from lead dipped aluminum cladding waste. The evidence from the sample data supports this description. The sample data and HDW model estimates agree well. A small amount of waste highly concentrated in lead (such as the HS or CWP) was not included in the engineering assessment and may help explain the low inventory.

Sodium. Sample data indicate 7,560 kg of Na in tank 241-C-111 while the HDW model predicts a value almost 2.7 times greater. Sodium is present in all waste types of tank 241-C-111, with the highest concentration in the 1C1 waste and a lower concentration in the TFeCN waste. The tank sample may contain a slightly smaller amount of sodium salts associated with the sludge than exhibited by the samples used for the engineering assessment.

Nickel. Nickel is another analyte that is more predominate in the TFeCN waste than the other two predicted waste types for tank 241-C-111. Sample data indicate 8 times more Ni in the tank than predicted by either the engineering assessment or the HDW model, which are in close agreement with each other.

Nitrate and Nitrite. No sample data were reported for NO_3 or NO_2. The HDW model and the engineering assessment for both are in fair agreement of each other. However, as indicated from other analytes the actual inventory may be slightly different even when the engineering assessment and HDW model inventories agree.

Phosphate. Phosphate inventory from the sample base analysis (9,520 kg) is approximately 63 percent the value predicted by Agnew et al. (1997a). The major contributor of PO_4 is the 1C waste. Since the concentration of PO_4 in the 1C defined waste

and the PO_4 solubility in the HDW model are comparable to that observed from known flowsheets the reason for the discrepancy cannot be determined at this time.

Sulfate. The sample data for SO_4 and the HDW model inventories are in good agreement with each other. In the HDW model, sulfate is found in modest concentrations in the majority of the waste added to tank 241-C-111, particularly in 1C waste.

Strontium-90. Elevated ^{90}Sr levels were observed in the waste sample data (1.16 E+06 Ci) compared to the HDW model (16,000 Ci). Hot semiworks waste was thought to have very high concentrations of ^{90}Sr. Furthermore, in addition to ^{137}Cs scavenging by ferrocyanide, scavenging with $Ca_3(PO_4)_2$ also encompassed ^{90}Sr, suggesting that the HDW model may be underpredicting the amount of ^{90}Sr in the tank.

Uranium. Uranium values from sample data results indicate a U inventory half the amount reported in the HDW model. The higher U concentrations in subsegment B compared to subsegment C indicates uranium settling on top of the TFeCN waste.

Cesium-137. The HDW model and sample data estimates both indicate elevated concentration and inventories of ^{137}Cs from ferrocyanide scavenging. The HDW model inventory (18,000 Ci) is approximately 50 percent higher than the sample data (12,100 Ci).

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valence of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997a).

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

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 chemical information for tank 241-C-111 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.

As part of this effort, an evaluation of available chemical information for tank 241-C-111 was performed, including the following:

- The inventory estimate generated by the HDW model (Agnew et al. 1997a)

- The inventory estimate generated by the HDW model (Agnew et al. 1997a)
- An engineering evaluation that estimates an inventory from only CWP, 1C1, and TFeCN waste.
- An inventory estimate based on a 1995 Auger sample (WHC 1995).

Based on this evaluation, a best-basis inventory was developed for tank 241-C-111. The 1995 auger sample data were chosen as the best-basis inventory for tank 241-C-111 for the following reasons:

- The HDW model appears to under predict the TFeCN waste volume in the tank.
- The HDW model does not credit the HS waste added to the tank for any of the solids formation where sample data indicate HS sludge contributed to the solids formation (this is seen in the Pb and ^{90}Sr data).
- The sample-based inventory agrees with the tank history waste types (from Waste Status and Transaction Record Summary [WSTRS], Agnew [1997b]) for major analytes.
- There were incomplete data from the 1994 push mode core sample for most analytes.

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. 1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

The best-basis inventory estimate for tank 241-C-111 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.

Table E4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-111 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[a]	Comment
Al	35,800	S	
Bi	462	S	
Ca	3,280	S	
Cl	194	M	
TIC as CO_3	1,960	M	
Cr	622	S	
F	360	M	
Fe	15,300	S	
Hg	33.6	M	
K	46.6	M	
La	121	S	
Mn	86	S	
Na	7,560	S	
Ni	5,800	S	
NO_2	5,330	M	
NO_3	10,900	M	
OH_{TOTAL}	81,300	C	
Pb	1,600	S	
PO_4	9,520	S	
Si	2,500	S	
SO_4	822	S	
Sr	55	S	
TOC	350	S	
U_{TOTAL}	4230	S	

Table E4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-111 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[a]	Comment
Zr	28.8	S	

[a]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
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
NR = Not reported.

Table E4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-111 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[a]	Comment
^{3}H	0.166	M	
^{14}C	0.0315	M	
^{59}Ni	0.224	M	
^{60}Co	0.00909	M	
^{63}Ni	20.2	M	
^{79}Se	.00664	M	
^{90}Sr	1.14 E+06	S	
^{90}Y	1.14 E+06	S	Referenced to ^{90}Sr.
^{93}Zr	0.0315	M	
^{93m}Nb	0.0264	M	
^{99}Tc	0.219	M	
^{106}Ru	6.59 E-08	M	
^{113m}Cd	0.0815	M	
^{125}Sb	0.0135	M	
^{126}Sn	0.01	M	
^{129}I	4.13 E-04	M	
^{134}Cs	0.00164	M	
^{137}Cs	12,000	S	
^{137m}Ba	11,300	S	Referenced to ^{137}Cs.
^{151}Sm	24.6	M	
^{152}Eu	0.0409	M	
^{154}Eu	0.18	M	
^{155}Eu	2.89	M	
^{226}Ra	1.88 E-06	M	
^{227}Ac	9.57 E-06	M	
^{228}Ra	1.31 E-10	M	
^{229}Th	2.54 E-08	M	
^{231}Pa	2.06 E-05	M	

Table E4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-111 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[a]	Comment
^{232}Th	8.83 E-12	M	
^{232}U	6.02 E-05	M	
^{233}U	2.7 E-06	M	
^{234}U	2.83	M	
^{235}U	0.126	M	
^{236}U	0.0253	M	
^{237}Np	0.00135	M	
^{238}Pu	1.43	M	
^{238}U	3.41	M	
$^{239/240}Pu$	248	S	
^{241}Am	0.0529	M	
^{241}Pu	104	M	
^{242}Cm	7.61 E-04	M	
^{242}Pu	3.97 E-04	M	
^{243}Am	4.25 E-07	M	
^{243}Cm	1.67 E-05	M	
^{244}Cm	1.69 E-05	M	

[a]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based.

E.5 APPENDIX E REFERENCES

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