0049681

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 640357

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [X] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	M. J. Kupfer, LMHC, MSIN H5-49	[] Yes [X] No	8/4/97
	6. Project Title/No./Work Order No. Tank 241-BX-101	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-408, 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 C, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-BX-101.

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-BX-101 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	L. L. Buckley	R2-12
File	H5-49		
R. T. Winward	H5-49		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

RELEASE STAMP

AUG 25 1997

DATE: HANFORD RELEASE

STA: 37

ID. 73

A-7900-013-2 (05/96) GEF095

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) 640357

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.	M. J. Kupfer	8-18-97	PE		
Cog. Mgr.	K. M. Hodgson	8-18-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other	L. L. Buckley	8-18-97	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-BX-101

M. J. Kupfer
Lockheed Martin Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 640357 UC: 712
Org Code: 74610 Charge Code: N4G3A
B&R Code: EW3120074 Total Pages: 92

Key Words: TCR, best-basis inventory

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-BX-101 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: Document Control Services, P.O. Box 950, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

AUG 25 1997
DATE:
STA: 37
HANFORD RELEASE
ID. 73

Release Approval — Date — Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-408	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-BX-101

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 07/20/95 on EDT-611428.	N.J. Milliken	J.G. Kristofzski
0-A RS	Incorporate per ECN-623841.	L.M. Sasaki	J.G. Kristofzski 8/31/95
0-B RS	Incorporate per ECN-625691.	S.E. Kelly	J.G. Kristofzski JK 9/18/95
0C RS	Incorporate per ECN-640357	M.J. Kupfer 8-15-97	K.M. Hodgson 8-18-97

A-7320-005 (08/91) WEF168

APPENDIX C

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BX-101

This page intentionally left blank.

APPENDIX C

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BX-101

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-BX-101 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.

C1.0 CHEMICAL INFORMATION SOURCES

Available waste (chemical) information for tank 241-BX-101 includes:

- Data from two auger mode samples taken in 1994 for safety screening which consists of only limited analytical results. The data consists only of total alpha, DSC and percent water (see Section 4.0).
- Data from Tank Characterization Reports (TCRs) from other tanks in the BX Tank Farm, Tank 241-BX-104 (Hu and Stephens 1996), tank 241-BX-105 (Hall and Tran 1995) and tank 241-BX-106 (Sasaki et al. 1996)
- An inventory estimate for this tank (Agnew et al. 1997).
- Data from Data Packages or TCRs from other tanks with the Tri-Butyl Phosphate (TBP) waste type, tanks 241-TY-105 and 241-TY-106 (Weiss 1986) and the cladding waste (CWP) waste type, tank 241-C-105 (Tusler et al. 1995).

C2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The 1995 Safety Screening Sampling produced no best-basis analyte analytical results. The HDW model inventories are listed in Tables C2-1 and C2-2. Table C2-1 lists nonradioactive components on a kilogram (kg) basis and Table C2-2 lists the radioactive components on a curie basis. The HDW model estimates the total waste volume to be 162.8 kL (43 kgal) with a density of 1.66 g/mL. The chemical species, in this appendix, are reported without charge designation per the best-basis inventory convention.

Table C2-1. Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-BX-101.

Analyte[a]	HDW[b] inventory estimate (kg)	Analyte	HDW[b] inventory estimate (kg)
Al	4,180	NO_3	996
Bi	0.688	OH	36,700
Ca	772	oxalate	8.66 E-04
Cl	94.9	Pb	0.942
Cr	18.3	P as PO_4	4,230
F	3.89	Si	3,300
Fe	6,790	S as SO_4	1,160
Hg	0.0057	Sr	0
K	24.4	TIC as CO_3	13,600
La	0.00104	TOC	225
Mn	0.654	U_{TOTAL}	45,800
Na	21,300	Zr	0.0114
NH_3	78	H_2O (wt%)	46.6
Ni	3,490	Density g/mL	1.66
NO_2	1,650		

HDW = Hanford Defined Waste
[a] No sample-based data
[b] Agnew et al. (1997).

Table C2-2. Hanford Defined Waste Predicted Inventory Estimates for Radioactive Components in Tank 241-BX-101.

Analyte[a]	HDW[b] inventory estimate (Ci)	Analyte[a]	HDW[b] inventory estimate (Ci)
^{90}Sr	366,000	^{239}Pu	218
^{137}Cs	595		

HDW = Hanford Defined Waste
[a] No sample-based data
[b] Agnew et al. (1997), decayed to January 1, 1994.

C3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would influence the HDW model component inventories.

See Section 2.3 of this TCR for a detailed waste transfer history of tank 241-BX-101.

A brief summary of the waste transfer history follows, based on Section 2.3:

- Received metal waste (MW), 1948 through 1951
- MW waste was sluiced from the tank and the tank was declared empty in June 1954
- Received tri-butyl phosphate (TBP or UR) supernatant waste, 1956 through 1967
- Received Plutonium-Uranium Extraction (PUREX) CWP supernatant, 1962 through 1967
- Received evaporator bottoms (EB), 1967 through 1968
- Received and transferred miscellaneous waste such as B Plant Low-Level (BL), ion exchange (IX), organic solvent wash waste (OWW), CWP, Thoria high-level waste (HLW) or cladding waste (TH), Thoria low-level waste (THL) from 1969 through 1976.

In the fourth quarter of 1977, a salt well was installed in the tank. The tank was deactivated in 1978.

C3.1 CONTRIBUTING WASTE TYPES

The following are reported waste types in tank 241-BX-101

Agnew et al. (1995 and 1997): MW, BL
Hill et al. (1995): TBP (UR), CWP, BL, IX

Abbreviations:

CWP	=	PUREX cladding waste (aluminum clad fuel)
MW	=	Metal waste
TBP (UR)	=	Tri-Butyl Phosphate (Uranium Recovery)
BL	=	B Plant low-level waste
IX	=	ion exchange waste

The tank volume used to generate the HDW inventory is 162.8 kL (43 kgal) total waste (Agnew et al. 1997). Hanlon (1997) reports a sludge layer of 159 kL (42 kgal), no salt cake, and 3.8 kL (1 kgal) of supernatant. Agnew et al. reports 109.8 kL (29 kgal) of MW, 49.2 kL (13 kgal) of BL, and 3.8 kL (1 kgal) supernatant. The HDW density used in the model to calculate the inventory was 1.66 g/mL.

Rodenhizer (1987) indicates that MW was sluiced from tank 241-BX-101 from January to June 1954. Tank 241-BX-101 was declared empty by the end of the June 1954. Little or no MW remained in tank 241-BX-101. Several wastes were transferred to the tank after that time. The two wastes that appear most likely to be the main sources of solids in tank 241-BX-101 are TBP and CWP. Other sources may have contributed to the waste in this tank such as BL and IX but production and transfer records are not adequate to predict exactly which waste types and amounts were contributors.

Production records reviewed by Anderson (1990), Agnew et al. (1995), and Hill et al. (1995) show a lot of similarity between tanks 241-BX-101 through 241-BX-106 as to the waste histories associated with the tanks. Tanks 241-BX-101 through 241-BX-106 received mostly B Plant MW, U Plant waste, and PUREX cladding waste. Tanks 241-BX-101 through 241-BX-103 formed a first cascade in the BX Tank Farms and tanks 241-BX-104 through 241-BX-106 formed a second cascade. Several transfers occurred both ways between tanks of the two cascades. Tank 241-BX-102 received a significant amount of diatomaceous earth (DE) which makes it the major outlier in terms of analyte profiles in the tanks. The assignment as to what was left in these tanks is very different between Agnew at al. and Hill et al.

Agnew et al. (1995) lists MW as the major waste in all these tanks, with the exception of DE in tank 241-BX-102 and BYSltCk in tank 241-BX-106. Rodenhizer (1987) lists these tanks to have been emptied of MW. Tanks 241-BX-104 and 241-BX-105 have been sampled and, based on these results, the Agnew et al. assumption of large quantities of MW is judged

incorrect. Hill et al. (1995), Agnew et al. (1995), and Anderson (1990) all show large quantities of TBP and CWP waste entering each of these tanks. Lesser quantities of other waste such as BL, IX, EB, R, and OWW entered some of the tanks in both cascades. Hill et al. (1995) lists the primary waste in each of these tanks as being TBP and CWP (excluding the predominate DE in tank 241-BX-102).

C3.2 ASSUMPTIONS

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

- Tank waste mass is calculated using the measured average density estimated in comparison TCRs (1.66 g/mL. This is also the same density used in the HDW model inventories. The total tank volume used is listed in Hanlon (1997) as 162.8 kL (43 kgal) and is the same volume as reported by Agnew et al. (1997)

- The average analyte concentrations determined for tanks 241-BX-104, 241-BX-105 (including 241-BX-106 for supernatant estimates) can be used to estimate the average analyte concentrations in tank 241-BX-101. These concentrations are assumed to be the closest predictors of the unknown analytical data for tank 241-BX-101.

- The TBP and CWP waste type concentrations from other tanks can be used to predict the waste inventory for tank 241-BX-101.

- No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion purposes are factored into this evaluation.

C3.3 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

Table C3-1. Engineering Evaluation Approaches Used On 241-BX-101. (2 sheets)

Type of waste	How calculated	Check method
Supernatant Volume = 3.785 kL (1 kgal) Density not needed in calculations (concentration in terms of conc./mL)	BX Tank Farm Engineering Assessment - Used the average concentrations for the supernatants from tanks 241-BX-104, 241-BX-105 and 241-BX-106. This is done to demonstrate that this amount of supernatant is not of significance in the total inventory.	Not calculated for the TBP/CWP Engineering Assessment. One could use the inventory from the BX Tank Farms Engineering Assessment, which is of no significance in the total tank inventory.

Table C3-1. Engineering Evaluation Approaches Used On 241-BX-101. (2 sheets)

Type of waste	How calculated	Check method
Salt cake None expected	Not applicable	Not applicable
Sludge Total solids volume = 159 kL (42 kgal) Density = 1.66 g/mL	BX Tank Farm Engineering Assessment - Used the average concentrations for the solids from tanks 241-BX-104 and 241-BX-105.	TBP/CWP Engineering Assessment - Sample concentrations from other tanks with TBP and CWP sludge were used to predict the sludge inventories. Assumed 41.6 kL (11 kgal) TBP and 117.3 kL (31 kgal) CWP.

CWP = PUREX Cladding Waste
TBP = Tri-Butyl Phosphate
TCR = Tank Characterization Report.

Since tanks 241-BX-101 through 241-BX-103 have not been sampled, no chemical inventory information is available for this cascade. However Anderson (1990) and Hill et al. (1995) indicate tanks 241-BX-101 through 241-BX-106 had similar waste histories involving the same major waste types (TBP and CWP) and tanks 241-BX-104 and 241-BX-105 have been sampled. In addition the supernatant of tank 241-BX-106 also has been sampled.

An Engineering Assessment was performed that simply averaged the sample-based analyte concentrations for tanks 241-BX-104 and 241-BX-105 and used the average concentration to estimate the inventory for tanks 241-BX-101 through 241-BX-103. Another Engineering Assessment was performed that used TBP and CWP concentrations from other tanks (241-TY-105 and 241-TY-106 for TBP and 241-C-105 for CWP) to compare to tanks 241-BX-104 and 241-BX-105. An assumed volume of 41.6 kL (11 kgal) of TBP and 117.3 kL (31 kgal) CWP was used for this Engineering Assessment for tank 241-BX-101. This ratio was determined by varying the ratio until this inventory agreed as close as possible to the inventory calculated using 241-BX-104 and 241-BX-105 data. For tanks 241-BX-104 and 241-BX-105, these two waste types best modeled the tank contents when compared to the sample data.

The first assessment (based on the average of tanks 241-BX-104 and 241-BX-105) was applied as the best-basis inventory for the closely associated cascade forming 241-BX-101 through 241-BX-103. The second assessment was also done for comparison purposes. Because of the lack of sampling in this cascade, the certainty of these assessments are very low but represent the best estimate that can be made at this time. A sample from this

cascade would be very helpful in gaining confidence as to the best-basis for the tank inventory.

The TBP inventory was estimated by using the average TBP waste concentrations found in tanks 241-TY-105 and 241-TY-106 from Weiss (1986) (Table C3-2). Table C3-2 shows this concentration expressed in terms of kg/kgal, because this is how the average concentration in these tanks was expressed. The third column shows the analyte inventory from TBP based on the assumed 41.6 kL (11 kgal) of TBP waste.

The CWP inventory was estimated by using the CWP waste concentration found in tank 241-C-105 (Tusler et al. 1995). Column five shows the analyte inventory from CWP and column four was multiplied by 0.22963 which represents 117.3 kL/511 kL (31 kgal/ 135 kgal) (which is the ratio of waste in each tank). The last column in Table C3-2 shows the total inventory estimated by the TBP/CWP Engineering Assessment.

Table C3-2. Tank 241-BX-101 TBP/CWP Sludge Calculations and Total Engineering Assessment Inventory. (2 Sheets)

Analyte	Avg. TBP[a] kg/kgal	241-BX-101 kg TBP[b]	CWP[c] kg/135 kgal	241-BX-101 kg CWP[d]	241-BX-101 Total Sludge TBP + CWP (kg)
Al	13.2	145	31,500	7,233	7,380
Bi	2.8	30.8	340	78.1	109
Ca	NR	NR	3,970	912	>911
Cl	7.53	82.8	NR	NR	>82.8
Cr	0.9	9.9	680	156	166
F	<4.29	<47.2	<1.02	<0.234	<47.4
Fe	159.4	1,750	5,400	1,240	2,990
Pb	1.83	20.1	480	110	130
Mn	1.04	11.4	1,260	289	301
Ni	0.42	4.62	1,090	250	255
NO_3	1,039	11,400	11,300	2,590	14,000
NO_2	34.8	383	NR	NR	>383
PO_4	533.5	5,870	5,300	1,217	7,090
P	174.1	1,920	NR	NR	>1,920
K	NR	NR	840	193	>193
Si	2.13	23.4	20,300	4,661	4,680
Na	665.7	7,320	56,500	12,974	20,300

Table C3-2. Tank 241-BX-101 TBP/CWP Sludge Calculations and Total Engineering Assessment Inventory. (2 Sheets)

Analyte	Avg. TBP[a] kg/kgal	241-BX-101 kg TBP[b]	CWP[c] kg/135 kgal	241-BX-101 kg CWP[d]	241-BX-101 Total Sludge TBP + CWP (kg)
Sr	NR	NR	90	20.9	>20.9
SO_4	73.5	809	<11,800	<2,710	<3,520
TIC as CO_3	6.18	68.0	NR	NR	>68.0
TOC	8.49	93.4	1,010	232	325
U	41.7	459	5,180	1,189	1,650
Zr	2.15	23.7	430	98.7	122
Radionuclides[e] (Ci)					
^{90}Sr	2,918	32,100	365,000	83,815	116,000
^{137}Cs	80.7	888	125,000	28,704	39,600
$^{239/240}Pu$	0.19	2.09	459	105	107

CWP = PUREX Cladding Waste

TBP = Tri-Butyl Phosphate

[a] Average kg/kgal TBP from tanks 241-TY-105 and 241-TY-106 (Si. from 241-TY-105 only) (Weiss 1986)

[b] kg/kgal from column 1 multiplied by 11 kgal (assumed volume of TBP)

[c] CWP inventory from 241-C-105 (Tusler et al. 1995)

[d] CWP Inventory in 241-BX-101 (31 kgal/135 kgal = 0.22963)

[e] Radionuclide concentrations reported as of sample analysis date.

The BX Tank Farm Engineering Assessment used the average analytical solids concentrations from tanks 241-BX-104 and 241-BX-105 to estimate the solids inventory for tank 241-BX-101. Table C3-3 shows the average analytical concentrations for each analyte, in the two reference tanks. Also shown is the HDW model estimate for tank 241-BX-101 and the total inventory reported in kg for each analyte for tank 241-BX-101. The HDW concentration values are shown for comparison. The tank 241-BX-101 solids volume of 159 kL (42 kgal) and the average density from tanks 241-BX-104 and 241-BX-105 of 1.66 g/mL were used to calculate the inventory reported in kg.

Table C3-3. BX Farm Engineering Assessment Tank 241-BX-101 Solids Inventory. (2 Sheets)

Analyte	241-BX-104[a] (μg/g)	241-BX-105[b] (μg/g)	Average of BX-104 and BX-105[c] (μg/g)	HDW 241-BX-101[d] (μg/g)	241-BX-101 Total (kg)
Al	115,000	33,800	74,400	15,300	19,600
Bi	551	772	662	0	175
Ca	1,900	6,210	4,055	2,920	1,070
Cl	1,040	NR	1,040	294	274
Cr	6,330	8,620	7,475	29.5	1,970
F	<882	NR	<882	0	<233
Fe	6,400	5,940	6,170	25,700	1,630
K	NR	1,460	1,460	70.5	385
La	<138	NR	<138	0	<37
Mn	1,540	1,490	1,515	0	400
Na	72,700	110,000	91,350	78,300	24,100
Ni	NR	147	147	13,200	39
NO_2	24,200	NR	24,200	5,160	6,390
NO_3	47,800	33,300	40,550	1,900	10,700
Pb	946	564	755	0	199
PO_4	8,490	61,000	34,745	15,900	9,170
P	2,340	19,900	11,120	NR	2,930
Si	1,880	41,500	21,690	12,500	5,720
SO_4	1,750	NR	1,750	4,130	461
Sr	51	56.2	54	0	14
TIC as CO_3	24,200	NR	24,200	51,200	6,390
TOC	5,210	2,780	3,995	733	1,050
U	38,400	4,400	21,400	173,000	5,650
Zr	<646	490	335	0	88
Density (g/mL)	1.73	1.58	1.655	1.66	1.66
wt% H_2O	29.5	57	43.2	46.6	43.2

Table C3-3. BX Farm Engineering Assessment Tank 241-BX-101 Solids Inventory. (2 Sheets)

Analyte	241-BX-104[a] (μg/g)	241-BX-105[b] (μg/g)	Average of BX-104 and BX-105[c] (μg/g)	HDW 241-BX-101[d] (μg/g)	241-BX-101 Total (kg)
Radio-nuclides[e]	μCi/g	μCi/g	μCi/g	μCi/g	kCi
^{90}Sr	NR	136	136	1380	35.9
^{137}Cs	73.1	54	64	0.935	16.9
$^{239/240}Pu$	NR	0.279	0.279	1	0.074

NR = Not Reported
(NRs and < (less than) not included in the average unless < is the only value)

[a] Hu and Stephens (1996)
[b] Hall and Tran (1995)
[c] Average only includes reported values, NR not included
[d] Agnew et al. (1997), radionuclides decayed to January 1, 1994
[e] Sample radionuclide concentrations reported as of sample analysis date.

The BX Tank Farm Engineering Assessment used the average analytical supernatant concentrations from tanks 241-BX-104, 241-BX-105, and 241-BX-106 to estimate the supernatant inventory for tank 241-BX-101. Table C3-4 shows the average analytical concentrations for each analyte, the HDW model estimate for tank 241-BX-101 and the supernatant inventory reported in kg. The HDW values are shown only for comparison. Table C3-5 shows the total analyte inventory for the BX Tank Farm Assessment. The supernatant volume assumed in these calculations is 3.785 kL (1 kgal).

Table C3-4. BX Tank Farm Engineering Assessment Tank 241-BX-101 Supernatant Inventory. (3 Sheets)

Analyte	241-BX-104[a] (μg/mL)	241-BX-105[b] (μg/mL)	241-BX-106[c] (μg/mL)	Average[d] (μg/mL)	HDW 241-BX-101[e] (μg/mL)	241-BX-101 (kg)
Al	2,840	5,930	6,720	5,163	24,100	20
Bi	6.9	0.783	NR	3.84	135	0.014
Ca	19.1	144	NR	82	201	0.31

Table C3-4. BX Tank Farm Engineering Assessment Tank 241-BX-101 Supernatant Inventory. (3 Sheets)

Analyte	241-BX-104[a] (μg/mL)	241-BX-105[b] (μg/mL)	241-BX-106[c] (μg/mL)	Average[d] (μg/mL)	HDW 241-BX-101[e] (μg/mL)	241-BX-101 (kg)
Cl	2,800	NR	3,410	3,105	3,360	12
Cr	2,970	249	NR	1,610	2,060	6.1
F	300	NR	336	318	763	1.2
Fe	2.05	4.37	<20	<8.81	62.4	<0.0333
Pb	<16.3	51.4	NR	<33.9	185	<0.128
Mn	<1.63	<22.0	NR	<11.8	129	<0.0447
Ni	8.9	93.6	NR	51.3	59	0.19
NO_3	135,000	117,000	111,000	121,000	97,000	458
NO_2	63,800	NR	64,400	64,100	55,500	243
PO_4	4,780	5,210	NR	4,995	4,700	19
P	1,780	1,700	NR	1,740	NR	6.6
K	2,010	2,600	NR	2,305	1,120	8.7
Si	82.4	139	NR	111	533	0.42
Na	140,000	124,000	157,000	140,000	123,000	531
Sr	<0.488	1.8	NR	<1.14	0	0.0043
SO_4	3,930	NR	NR	3,930	13,400	15
TIC as CO_3	44,750	NR	61,500	53,100	12,400	201
TOC	3,190	9,440	2,360	5,000	5,250	19
U	<65.0	0.00451	NR	<32.5	532	<0.123
Zr	<1.63	<5.06	NR	<3.35	2.24	<0.0127
Density (g/mL)	1.29	1.29	1.27	1.283	1.34	1.283
wt% H_2O	59.1	NR	61.3	60.2	57.6	60.2

Table C3-4. BX Tank Farm Engineering Assessment Tank 241-BX-101 Supernatant Inventory. (3 Sheets)

Analyte	241-BX-104[a] (μg/mL)	241-BX-105[b] (μg/mL)	241-BX-106[c] (μg/mL)	Average[d] (μg/mL)	HDW 241-BX-101[e] (μg/mL)	241-BX-101 (kg)
Radio-nuclides[a,f]	μCi/L	μCi/L	μCi/L	μCi/L	μCi/L	Ci
^{90}Sr	NR	11,200	277	5,739	19	21.7
^{137}Cs	NR	175,000	166,000	170,500	68.4	645
$^{239/240}Pu$	NR	17.1	NR	17.1	0.00744	0.065

HDW = Hanford Defined Waste
NR = Not Reported
[a] Hu and Stephens (1996)
[b] Hall and Tran (1995)
[c] Sasaki et al. (1996)
[d] The average of tanks 241-BX-104, 241-BX-105, and 241-BX-106 only includes reported values, NR is not included
[e] Agnew et al. (1997), radionuclides decayed to January 1, 1994
[f] Sample radionuclide concentrations reported as of sample analysis date.

The BX Tank Farm Engineering Assessment Total Inventory including both solids and supernatant is shown in Table C3-5.

Table C3-5. BX Tank Farm Engineering Assessment Tank 241-BX-101 Engineering Assessment Total Inventory Calculations. (2 Sheets)

Analyte	241-BX-101 Supernatant (kg)	241-BX-101 Solids (kg)	241-BX-101 Tank Total (kg)
Al	20	19,600	19,600
Bi	0.014	175	175
Ca	0.31	1,070	1,070
Cl	12	274	286
Cr	6.1	1,970	1,980
F	1.2	<233	<234
Fe	<0.0333	1,630	1,630

Table C3-5. BX Tank Farm Engineering Assessment Tank 241-BX-101 Engineering Assessment Total Inventory Calculations. (2 Sheets)

Analyte	241-BX-101 Supernatant (kg)	241-BX-101 Solids (kg)	241-BX-101 Tank Total (kg)
Pb	<0.128	199	199
Mn	<0.0447	400	400
Ni	0.19	39	39
NO_3	458	10,700	11,200
NO_2	243	6,390	6,630
PO_4	19	9,170	9,190
P	6.6	2,930	2,940
K	8.7	385	394
Si	0.42	5,720	5,720
Na	531	24,100	24,600
Sr	<0.0043	14	14
SO_4	15	461	476
TIC as CO_3	201	6,390	6,590
TOC	19	1,050	1,070
U	<0.123	5,650	5,650
Zr	<0.0127	88	88
Radionuclides[a] (Ci)			
^{90}Sr	21.7	35,900	35,900
^{137}Cs	645	16,900	17,500
$^{239/240}Pu$	0.065	74	74

[a] Sample radionuclide concentrations reported as of sample analysis date.

C3.3.3 Inventory Comparisons

The TBP/CWP Engineering Assessment-based inventory, BX Tank Farm Engineering Assessment-based inventory values and the HDW model values are compared in Table C3-6.

Table C3-6. Comparison of Selected Component Inventory Estimates for Tank 241-BX-101 Waste. (2 Sheets)

Component	TBP/CWP Engineering Assessment (kg)	BX Tank Farm Engineering Assessment (kg)	HDW[a] estimated (kg)
Al	7,380	19,600	4,180
Bi	109	175	0.688
Ca	>912	1,070	772
Cl	>82.8	286	94.9
Cr	166	1,980	18.3
F	<47.4	<234	3.89
Fe	2,990	1,630	6,790
K	>193	394	24.4
Mn	301	400	0.654
Na	20,300	24,600	21,300
Ni	255	39	3,490
NO_2	>383	6,630	1,650
NO_3	14,000	11,200	996
Pb	130	199	0.942
PO_4	7,090	9,190	4,230
Si	4,680	5,720	3,300
SO_4	<3,520	476	1,160
Sr	>20.9	14	0
TIC as CO_3	>68.0	6,590	13,600
TOC	325	1,070	225
U	1,650	5,650	45,800
Zr	122	88	0.0114

Table C3-6. Comparison of Selected Component Inventory Estimates for Tank 241-BX-101 Waste. (2 Sheets)

Component	TBP/CWP Engineering Assessment (kg)	BX Tank Farm Engineering Assessment (kg)	HDW[a] estimated (kg)
Radionuclides[b] (Ci)			
^{90}Sr	116,000	35,900	366,000
^{137}Cs	39,600	17,500	595
^{239}Pu	107	74	218
H_2O (percent)	43.2	43.2	46.6

CWP = PUREX Cladding Waste
HDW = Hanford Defined Waste
NR = Not reported
TBP = Tri-Butyl Phosphate
[a] Agnew et al. (1997), radionuclides decayed to January 1, 1994
[b] Sample radionuclides reported as of sample analysis date.

Since there is no analytical data for tank 241-BX-101, a best basis was selected from one of the three inventories compared in Table C3-6. The BX Tank Farm Engineering Assessment was chosen as the best basis, because it is based on the actual analytical data from the three tanks in the next cascade from the same farm. The waste streams that fed these tanks were similar (see Section C3.1). The solids content of the waste streams that entered tank 241-BX-101 and the impact of the transfer history on the tank contents are not well quantified. The two most likely candidate waste streams were TBP and CWP, however, other waste types in smaller quantities may have contributed to the solids formation.

The following observations come from the comparisons of these three inventories.

It was possible to get the two Engineering Assessments to agree well for Bi, Mn, Na, Ni, Pb, phosphate, Si, U, Zr, ^{137}Cs and ^{239}Pu. The two Engineering Assessments show poorer agreement for Al, Cr, Fe, Nitrate, TOC and ^{90}Sr. The HDW model predicts waste streams that are less likely to be those which left the solid wastes in this tank (MW and BL). As such, the HDW does not compare well with either Engineering Assessment for Al, Bi, Cr, K, Mn, Ni, Nitrite, Nitrate, Pb, Phosphate, Carbonate, U, Zr, ^{90}Sr, ^{137}Cs and ^{239}Pu.

Assuming the BX Tank Farm Engineering Assessment to be the best basis, (see Section C3.3) other waste streams contributed to the waste in tank 241-BX-101 besides TBP and CWP. This is assumed because these two waste streams do not match the BX Tank

Farm Engineering Assessment well enough to be the only contributors. For example, it appears that other waste types and/or conditions which favored the deposit of higher amounts of Al and Cr added to the waste found in tank 241-BX-101. It is also apparent that the HDW waste types of MW and BL are not the predominate wastes in the tank, which is consistent with tanks 241-BX-104 and 241-BX-105. Until this tank is sampled and the actual analytical inventory is known, no firm statement regarding its composition/inventory can be made.

Since tank 241-BX-104 showed a small MW heel, a small heel is also projected in this tank and results in a significant amount of uranium to be estimated. However, the estimated amount is much lower than that predicted by the HDW model. On the other hand, since no sampling results are available, it is possible that the uranium is actually under predicted.

The best basis radionuclide values are also the BX Tank Farm Engineering Assessment values. Based on the heat load of tank 241-BX-101 from Kummerer (1995), the Engineering Assessment values may be biased low and account for only 50 percent of the actual inventory for ^{90}Sr and ^{137}Cs.

C4.0 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, processes, 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 results of sample analyses, (2) component inventories are estimated 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 standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available chemical information for tank 241-BX-101 was performed, including the following:

- An inventory estimate generated by the HDW model Agnew et al. (1997).
- An Engineering Assessment which produced inventory estimates based on component concentrations for similar tanks in the BX Tank Farm (241-BX-104, 241-BX-105 and [241-BX-106 for supernatants]).
- An Engineering Assessment produced inventory estimates based on comparisons of TBP and CWP wastes types (Tanks 241-TY-105 and 241-TY-106 for TBP and tank 241-C-105 for CWP), that are expected to be in tank 241-BX-101.

Based on this evaluation, a best-basis inventory was developed for tank 241-BX-101 for which no sampling information was available. The inventory based on the average concentration of analytes in tanks 241-BX-104 through 241-BX-106 was chosen as the best basis for the following reasons:

- The sample-based inventory analytical concentrations of the other tanks in the next cascade are actual measurements and are consistent for what is expected for tank 241-BX-101.
- The waste types represented in tank 241-BX-101 are not well known and probably include other wastes than just TBP and CWP.

- There are no analytical data for any tank in the same cascade as tank 241-BX-101 and the different references (see Section C3.1) do not agree as to which waste types are in tank 241-BX-101.

- For those few analytes where no values were available from the Engineering Assessment-based inventory, the HDW model values were used.

Where available, the BX Tank Farm engineering assessment radionuclide values are the best-basis values. Based on the heat load of tank 241-BX-101 from Kummerer (1995), the Engineering Assessment values may be biased low as they account for only 50 percent of the head load values for ^{90}Sr and ^{137}Cs.

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences 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, significant figures are retained. No such adjustments were necessary in this tank. This charge balance approach is consistent with that used by (Agnew et al.1997).

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. (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 for tank 241-BX-101 is presented in Tables C4-1 and C4-2. The inventory values reported in Tables C4-1 and C4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Table C4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BX-101 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	19,600	E	
Bi	175	E	
Ca	1,070	E	
Cl	286	E	
TIC as CO_3	6,590	E	
Cr	1,980	E	
F	<234	E	
Fe	1,630	E	
Hg	0.0057	M	
K	394	E	
La	0.00104	M	
Mn	400	E	
Na	24,600	E	
Ni	39	E	
NO_2	6,600	E	
NO_3	11,200	E	
OH_{TOTAL}	40,700	C	
Pb	199	E	
PO_4	9,190	E	
Si	5,720	E	
SO_4	476	E	
Sr	14	E	
TOC	1,070	E	
U_{TOTAL}	5,650	E	The uncertainty for this analyte is high.

Table C4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BX-101 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Zr	88	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_3, NO_2, PO_4, SO_4 and SiO_3.

Table C4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BX-101, decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	1.40	M	
^{14}C	0.433	M	
^{59}Ni	9.31	M	
^{60}Co	0.245	M	
^{63}Ni	922	M	
^{79}Se	0.0506	M	
^{90}Sr	29,700	E	This value is 50 percent lower than the value determined by heat load.
^{90}Y	29,700	E	Referenced to ^{90}Sr. This value is 50 percent lower than the value determined by heat load.
^{93}Zr	0.233	M	
^{93m}Nb	0.186	M	
^{99}Tc	1.32	M	
^{106}Ru	0.0785	M	
^{113m}Cd	0.816	M	
^{125}Sb	1.28	M	
^{126}Sn	0.0787	M	
^{129}I	0.00254	M	
^{134}Cs	0.00359	M	
^{137}Cs	16,700	E	This value is 50 percent lower than the value determined by heat load.
^{137m}Ba	15,800	E	Referenced to ^{137}Cs. This value is 50 percent lower than the value determined by heat load.
^{151}Sm	184	M	
^{152}Eu	7.42	M	
^{154}Eu	5.22	M	
^{155}Eu	426	M	

Table C4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BX-101, decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{226}Ra	3.25 E-04	M	
^{227}Ac	0.00139	M	
^{228}Ra	0.00187	M	
^{229}Th	4.37 E-05	M	
^{231}Pa	7.36 E-05	M	
^{232}Th	2.31 E-04	M	
^{232}U	0.00418	M	
^{233}U	0.0154	M	
^{234}U	15.1	M	
^{235}U	0.679	M	
^{236}U	0.0964	M	
^{237}Np	0.00504	M	
^{238}Pu	12.4	M	
^{238}U	15.3	M	
$^{239/240}Pu$	74	E	
^{241}Am	201	M	
^{241}Pu	870	M	
^{242}Cm	0.394	M	
^{242}Pu	0.00566	M	
^{243}Am	0.0152	M	
^{243}Cm	0.0419	M	
^{244}Cm	1.12	M	

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

C5.0 APPENDIX C REFERENCES

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young 1995, *Waste Status and Transaction Record Summary (WSTRS Rev. 2)*, WHC-SD-WM-TI-615, -614, -669, and -689, Rev. 2, Los Alamos National Laboratory, Los Alamos, New Mexico.

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, Rev. 4, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Hall, B. W., and T. T. Tran, 1995, *Tank Characterization Report for Single-Shell Tank 241-BX-105,* WHC-SD-WM-ER-406, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending January 31, 1997*, HNF-EP-0182-106, Lockheed Martin Hanford Corporation, Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corporation Richland, Washington.

Hu, T. A., and R. H. Stephens, 1996, *Tank Characterization Report for Single-Shell Tank 241-BX-104,* WHC-SD-WM-ER-599, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Kummerer, M., 1995, *Heat Removal Characteristics of Waste Storage Tanks,* WHC-SD-WM-SARR-010, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^2S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History,* WHC-SD-WM-TI-302, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Sasaki, L. M., T. T. Tran, L. C. Amato, G. P. Westleigh, and J. L. Stroup, 1996, *Tank Characterization Report for Single-Shell Tank 241-BX-106,* WHC-SD-WM-ER-570, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Tusler, L. A., L. C. Amato, and T. T. Tran, 1995, *Tank Characterization Report for Single-Shell Tank 241-C-105,* WHC-SD-WM-ER-489, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Weiss, R. L., 1986, *TY Tank Farm Waste Characterization Data,* RHO-WM-TI-1P, Rockwell Hanford Operations, Richland, Washington.