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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635508

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 [] Temporary [] Standby [] Supersedure [] Cancel/Void []	Leela M. Sasaki, Data Assessment and Interpretation, R2-12, 373-1027	[] Yes [X] No	07/25/97
	6. Project Title/No./Work Order No. Tank 241-BY-102	7. Bldg./Sys./Fac. No. 241-BY-102	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-630, Rev. 0	10. Related ECN No(s). N/A	11. Related PO No. N/A

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)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

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

This ECN was generated to include additional explanatory text in the best-basis narrative, and to update the comprehensive radionuclide inventory estimates for the tank.

14a. Justification (mark one)

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

14b. Justification Details

Initial release of this document was deficient.

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

See attached distribution.

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1. ECN (use no. from pg. 1) ECN-635508

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
N/A		

21. Approvals

Signature	Date	Signature	Date
Design Authority	8/5/97	Design Agent	
Cog. Eng. L.M. Sasaki L.M. Sasaki	8/5/97	PE	
Cog. Mgr. K.M. Hall L.M. Sasaki for KMH		QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other		Other	

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-BY-102

Leela M. Sasaki
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ECN-635508 UC: 2070
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Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-BY-102, 241-BY-102, BY-102, BY Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-BY-102. This report supports the requirements of the Tri-Party Agreement Milestone M-44-10.

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(2) Title
Tank Characterization Report for Single-Shell Tank 241-BY-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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3.0 BEST-BASIS INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address regulatory issues. Waste management 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 the wastes into a form that is suitable for long-term storage.

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1997). Not surprisingly, information derived from these two different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). Appendix D contains the complete narrative regarding the derivation of the inventory estimates presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	67,500	S	
Bi	100	E	Used ave. conc. from other tanks in BY Farm. Note if an unexpected sludge layer of 1C/CW waste is present this value may be over 2,600 kg
Ca	552	E	
Cl	1,920	S	
CO_3	219,000	S	TIC = 43,800
Cr	2,940	S	
F	28,300	S	
Fe	965	E	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)[1]	Comment
Hg	8.6	M	
K	3,050	E	Used ave. conc. from other tanks in BY Farm
La	0.353	M	
Mn	70	E	
Na	420,000	S	
Ni	190	E	
NO_2	21,900	S	
NO_3	149,000	S	
OH	175,000	C	Derived from charge balance
Pb	147	E	Used ave. conc. from other tanks in BY Farm
P as PO_4	42,400	S	
Si	6,840	S	
S as SO_4	90,800	S	
Sr	115	E	Used ave. conc. from other tanks in BY Farm
TOC	6,860	S	
U_{TOTAL}	671	E	Used ave. conc. from other tanks in BY Farm. May be low. Sample < 15,900.
Zr	15.6	E	Used ave. conc. from other tanks in BY Farm

[1]S = Sample-based
M= Hanford Defined Waste model-based
E = Engineering assessment-based
C = Derived from charge balance
NR = Not reported.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	159	M	
^{14}C	41.2	M	
^{59}Ni	4.31	M	
^{60}Co	38.9	M	
^{63}Ni	428	M	
^{79}Se	3.45	M	
^{90}Sr	38,000	E	HDW = 1.52E+05 Ci
^{90}Y	38,000	E	Referenced to ^{90}Sr
^{93}Zr	16.7	M	
^{93m}Nb	12.0	M	
^{99}Tc	231	M	
^{106}Ru	7.69E-03	M	
^{113m}Cd	88.4	M	
^{125}Sb	174	M	
^{126}Sn	5.16	M	
^{129}I	0.448	M	
^{134}Cs	1.92	M	
^{137}Cs	1.40E+05	E	HDW = 1.83E+05 Ci
^{137m}Ba	1.33E+05	E	Referenced to ^{137}Cs
^{151}Sm	1.19E+04	M	
^{152}Eu	5.39	M	
^{154}Eu	652	M	
^{155}Eu	327	M	
^{226}Ra	1.74E-04	M	
^{227}Ac	2.33E-03	M	
^{228}Ra	2.03	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{229}Th	4.68E-02	M	
^{231}Pa	1.19E-02	M	
^{232}Th	7.63E-02	M	
^{232}U	11.2	M	
^{233}U	43.0	M	
^{234}U	12.4	M	
^{235}U	0.534	M	
^{236}U	0.161	M	
^{237}Np	0.776	M	
^{238}Pu	3.02	M	
^{238}U	15.9	M	
^{239}Pu	140	S	Based on total alpha measurement
^{240}Pu	18.9	M	
^{241}Am	53.8	M	
^{241}Pu	217	M	
^{242}Cm	2.88E-03	M	
^{242}Pu	1.05E-03	M	
^{243}Am	1.86E-03	M	
^{243}Cm	2.12E-04	M	
^{244}Cm	1.68E-03	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based
NR = Not reported.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BY-102

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BY-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 single-shell tank 241-BY-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.

D1.0 CHEMICAL INFORMATION SOURCES

Available waste (chemical) information for tank 241-BY-102 include the following:

- Data from a push-mode core sample that was collected in 1996. See Appendix B for data.
- The inventory estimate for this tank generated from the Hanford Defined Waste (HDW) model (Agnew et al. 1997a).
- Tank Characterization Report (TCR) data from other tanks identified as having the same BY saltcake (BYSltCk) waste type.

A list of references used in this evaluation is provided at the end of this appendix (Section D5.0).

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Sampling-based inventories (see Appendix B) derived from the analytical concentration data from the core samples, and the HDW model inventories, are compared in Tables D2-1 and D2-2. Table D2-1 compares nonradioactive components on a kilogram (kg) basis, and Table D2-2 compares the radioactive components on a total curie basis. The chemical species are reported without charge per the best-basis inventory convention. Most conversions and calculations retain three significant figures. All figures were kept until the final result. The HDW model document (Agnew et al. 1997a) provides tank content estimates, in terms of component concentrations and inventories.

Sampling-based inventories listed in the TCR were calculated by multiplying the mean concentration of an analyte by the current waste mass, derived using the current tank volume and the mean density of the waste. However, the sample data are based on a single incomplete core sample (a full profile of the waste was not obtained). The tank is reported to contain 1,050 kL (277 kgal) of saltcake waste (Hanlon 1996) and the mean density is reported to be 1.50 g/mL (Appendix B).

The HDW estimate is based on the 1994 waste levels and does not take into account the 1995 stabilization effort. The estimate includes supernatant and some interstitial liquids that were removed from the tank during stabilization. The HDW model inventory is based on a waste volume of 1,290 kL (341 kgal) and a density of 1.62 g/mL. The waste in the HDW model is partitioned in this manner: 1,180 kL (312 kgal) BY saltcake, 42 kL (11 kgal) from an unspecified source (assigned as an unknown), and 68 kL (18 kgal) metal waste sludge.

The sampling-based inventory was developed by assuming that the last 48 cm (19 in.) of the waste at the bottom of the tank had the same mean concentration as did the rest of the tank. It is possible that a small layer of TBP sludge remains at the bottom of the tank, but no firm documentation is available to support this assumption. The assumption used for this assessment is that there is no sludge layer at the bottom of the tank. Only a sample taken at the bottom of the tank can indicate if this is correct.

Table D2-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-BY-102. (2 Sheets)

Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)	Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)
Al	65,400	68,500	Ni	<7,580	944
Ag	<319	NR	NO_2	21,900	93,700
Bi	<3,190	228	NO_3	149,000	485,000
Ca	<3,320	3,690	OH	NR	212,000
Ce	<3,190	NR	oxalate	30,400	0.293
Cd	<159	NR	Pb	<3,190	1,400
Cl	1,920	5,700	Pd	NR	NR
Co	<638	NR	P as PO_4	42,400	10,500
Cr	2,950	3,490	Sb	<1,910	NR
Cu	<331	NR	Si as SiO_3	6,840	2,580
F[3]	28,300	1,290	S as SO_4	90,800	23,200
Fe	<2,920	1,900	Sr	<319	0

Table D2-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-BY-102. (2 Sheets)

Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)	Analyte	Sampling[1] inventory estimate (kg)	HDW[2] inventory estimate (kg)
Hg	NR	8.64	TIC	43,800	8,860[4]
K	NR	1,900	TOC	6,860	9,160
La	<1,590	0.353	U_{TOTAL}	<15,900	36,000
Mg	<3,190	NR	Zn	<622	NR
Mn	< 585	218	Zr	<319	3.77
Mo	<1,590	NR	H_2O (Wt%)	26.5	37.4
Na	420,000	370,000	density (kg/L)	1.50	1.62
NH_3	NR	282			

HDW = Hanford Defined Waste
NR = Not reported
[1]Appendix B
[2]Agnew et al. (1997a)
[3]Fluoride based on water soluble portion only.
[4]HDW reports carbonate = 44,300 kg. Conversion to TIC is to divide by 5.

Table D2-2. Sampling and Hanford Defined Waste Predicted Inventory Estimates for Radioactive Components in Tank 241-BY-102.

Analyte	Sampling[1] inventory estimate (Ci)	HDW[2] inventory estimate (Ci)	Analyte	Sampling[1] inventory estimate (Ci)	HDW[2] inventory estimate (Ci)
^{90}Sr	NR	1.52E+05	$^{239/240}Pu$	NR	127
^{137}Cs	NR	1.83E+05			

HDW = Hanford Defined Waste
NR = Not reported
[1]Appendix B
[2]Agnew et al. (1997a).

D3.0 COMPONENT INVENTORY EVALUATION

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

D3.1 EXPECTED TYPE OF WASTE BASED ON THIS ASSESSMENT

The reported waste types in tank 241-BY-102 are as follows. (See Appendix A for a detailed summary of the waste transfer history.)

Agnew et al. (1997a): MW, UNK, BYSltCk
Hill et al. (1995): TBP, EB-ITS, CW, 1C

1C = First decontamination cycle waste from the bismuth phosphate process
CW = Coating waste from the bismuth phosphate process
BYSltCk = BY saltcake, a mixture of supernatant from other waste types that have been blended to create a new waste type through concentration as a salt cake
TBP = Tributyl phosphate (TBP) or uranium recovery (UR) supernatant
EB-ITS = Evaporator Bottoms (EB) from In-Tank Solidification (ITS), equivalent in this tank to BYSltCk
MW = Metal waste from the bismuth phosphate process
UNK = Unknown

As addressed in Section D2.0, Agnew et al. (1997a) provides estimated volumes for these waste types before salt well pumping, and Hanlon (1996) estimates the volumes after the pumping. The Hanlon (1996) estimate of 1,050 kL (277 kgal) is being used in the assessment.

A sludge layer may or may not exist at the bottom of tank 241-BY-102. During 1954, the tank was sluiced, and it was declared empty in June 1954 (Rodenhizer 1987). However, the HDW assumes that none of the MW solids were removed during the sluicing and attributes 68 kL (18 kgal) of the waste volume to MW sludge. There is also a possibility that TBP supernatant transferred to the tank after it was sluiced contained entrained solids, and were deposited in the tank (Agnew et al. 1997b). Because the sampling did not extend to the bottom 48 cm (19 in.) of the tank, none of these positions can be verified. This assessment does not assume a sludge layer in tank 241-BY-102.

D3.2 ASSUMPTIONS USED

The following sections provide an engineering evaluation of tank 241-BY-102 contents. For this evaluation, the following assumptions and observations were made:

- Total waste mass is calculated using the sampling-based measured density and the tank volume listed in Hanlon (1996). The different volume and density used in the HDW model will provide an intrinsic 28 percent relative percent difference, and may bias the HDW results generally higher, if the analytical concentrations from the two methods are relatively close. The waste types that contribute to the total volume are also different in each case as described in Section D2.0. As a result, the two inventory estimates are not made on the same basis.

- Only the BYSltCk waste stream contributed to solids formation.

- 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.

D3.3 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

Table D3-1 shows the engineering evaluation approaches used on tank 241-BY-102.

Table D3-1. Engineering Evaluation Approaches Used On 241-BY-102.

Type of waste	How calculated	Check method
Supernatant	No supernatant predicted	n/a
Saltcake Vol. = 1,050 kL (277 kgal)	Used the sample-based inventory, which was calculated by multiplying the average tank analyte concentration by the total mass of the waste in tank 241-BY-102. The density used was the average measured density (1.50 g/mL).	Used sample-based concentrations for three other 241-BY tanks, multiplied by saltcake total mass in tank 241-BY-102. The density used was the average density of the tanks from which the concentrations were derived (1.71).
Sludge None	No sludge predicted.	n/a

BY saltcake (BYSltCk), the abbreviation used by Agnew et al. (1997a), denotes salt waste supernatant that were evaporated and concentrated using in-tank heaters. In-tank solidification (ITS) campaigns were performed in the BY tank farm from 1964 through 1976. Waste supernatant that were evaporated originated primarily from the $BiPO_4$ process operations in B Plant. Heaters were placed in tanks 241-BY-101, 241-BY-102, and 241-BY-112. Certain BY tanks were designated as feed tanks. Concentrates from the heated tanks were transferred to other tanks in the BY tank farm and some BX tank farm tanks where they cooled and crystallized (Agnew et al. 1997a).

A defined waste comparison for BYSltCk is provided in Agnew et al. (1997a). Because of the complicated waste supernatant transfer history of feed to the ITS campaign and the lack of a flowsheet basis for the waste, it is difficult to perform an independent assessment to estimate a saltcake composition that can be compared to the model-based BYSltCk composition. Furthermore, the HDW model BYSltCk composition is the generic waste type composition (Agnew et al. 1997a, pg. B-43); not the specific set of concentrations described for each individual tank (Agnew et al. 1997a, Appendix E).

However, samples from BY tank farm tanks other than tank 241-BY-102 that contain BYSltCk have been analyzed and the results have been reported. The analytical results for these tanks were evaluated at the core segment level and the BYSltCk was identified. Table D3-2 summarizes the compositions of saltcake from tanks 241-BY-105, 241-BY-106, and 241-BY-110, based on the segment-level analyses reported, respectively, in Simpson et al. (1996a), Bell et al. (1996), and Simpson et al. (1996b). For comparison, the waste component concentrations for tank 241-BY-102 (Appendix B) and the BYSltCk defined waste composition from Agnew et al. (1997) are also shown in Table D3-2.

The average analytical-based composition from tanks 241-BY-105, 241-BY-106, and 241-BY-110 compare more favorably with the HDW model BYSltCk composition than the tank 241-BY-102 composition does. The values in Table D3-2 were rounded to three significant figures.

Table D3-2. Concentrations of Components in BY Tank Farm Saltcake Samples.

Analyte	Component Concentration (μg/g)					
	241-BY-105	241-BY-106	241-BY-110	Average Concentration	HDW BYSltCk Concentration	241-BY-102
Al	18,400	20,400	14,100	17,600	35,800	41,600
Bi	55.6	NR	NR	55.6	116.2	< 2,030
B	NR	113	92.3	103	NR	< 1,010
Cd	6.54	8.25	21.1	12.0	NR	< 101
Ca	216	308	400	308	1,820	< 2,100
Chloride	897	2,060	2,250	1,740	2,780	1,220
Cr	321	855	2,900	1,360	1,630	1,870
Co	8.75	NR	NR	8.75	NR	< 406
Cu	7.57	NR	NR	7.57	NR	< 210
Fluoride	4,100	5,130	5,420	4,880	700	18,000
Fe	476	215	924	538	554	1,860
Pb	50.3	64.5	130	82	726	< 2,030
Mn	54.8	9.57	52.8	39.1	110	372
Ni	75.9	47.9	193	106	490	4,820
Nitrate	4.91E+05	3.29E+05	1.84E+05	3.35E+05	2.46E+05	95,000
Nitrite	9,410	32,100	30,600	24,000	49,500	13,900
Oxalate	11,300	8,990	13,600	11,300	0.15	19,300
Phosphate	4,890	5,270	14,200	8,120	4,020	27,000
P	1,010	1,032	4,650	2,230	NR	< 9,500
K	712	2,470	1,930	1,700	911	NR
Si	180	184	451	272	1,359	4,350
Na	1.98E+05	2.03E+05	2.37E+05	2.13E+05	1.76E+05	2.67E+05
Sr	88.3	44.4	58.1	64	0.19	< 203
Sulfate	10,600	11,300	18,400	13,400	11,400	57,700
S	3,140	3,280	5,950	4,120	NR	17,300
TIC	NR	7,360	31,800	19,580	3,720	27,800
TOC	3,250	2,500	5,920	3,890	NR	4,360

Table D3-2. Concentrations of Components in BY Tank Farm Saltcake Samples.

Analyte	Component Concentration (μg/g)					
	241-BY-105	241-BY-106	241-BY-110	Average Concentration	HDW BYSltCk Concentration	241-BY-102
U	261	164	697	374	3,790	<10,100
Zn	36.8	164.	32.8	77.9	NR	< 396
Zr	5.23	6.28	14.4	8.64	16.7	< 203
Density (g/mL)	NR	1.71	NR	1.71	1.62	1.50
Wt% H_2O	16.1	25.5	23.2	21.6	37.4	26.5
	Component Concentration (μg/g)					
Analyte	241-BY-105	241-BY-106	241-BY-110	Average Concentration	HDW BYSltCk Concentration	241-BY-102
Radionuclides						
^{137}Cs	NR	106	60	83.0	133.2	NR
^{90}Sr	NR	<4.26	22.5	22.5	80.3	NR
$^{239/240}Pu$	NR	NR	0.0192	0.0192	0.107	NR
Total Alpha	0.0168	<0.00945	0.0434	0.0301	NR	0.0889
Total Beta	NR	<80.2	NR	NR	NR	NR

As indicated in Table D3-2, the concentrations of major waste components such as sodium, aluminum, nitrate, fluoride, and sulfate vary among the three comparison tanks (tanks 241-BY-105, 241-BY-106, 241-BY-110) by no more than a factor of about three. However, the variation among tanks for minor components is much higher.

Note that the iron, chromium, nickel, silicon, fluoride, phosphate, and sulfate concentrations in the tank 241-BY-102 samples are significantly higher than the corresponding average concentrations of those components in the three BY farm comparison tanks. The high sulfate and phosphate concentrations in tank 241-BY-102 are apparently compensated by lower nitrate concentrations. Some of the apparent anomalies for tank 241-BY-102 likely result from the use of tank 241-BY-102 as the ITS unit 1 (ITS-1). This tank contained the heater itself, whereas several of the other BY farm tanks received evaporated supernatant from tank 241-BY-102. In particular, components with slightly lower solubilities would likely concentrate and precipitate from solution and collect on or near the caked surface of the ITS unit in tank 241-BY-102.

D3.4 ESTIMATED COMPONENT INVENTORIES

Estimated chemical inventories from tank 241-BY-102 are summarized in Table D3-3. Shown are the sample-based inventory, and the inventory estimate by the HDW model. Also shown is the predicted (engineering evaluation) inventory based on the average analytical values for the three BY farm comparison tanks. Comments and observations are provided in the following text.

Tank 241-BY-112 and tank 241-BY-102 were the designated tanks in the BY tank farm for the ITS systems. Tank 241-BY-101 had an ITS unit for a short time; this was upgraded and transferred to tank 241-BY-102. Because of its configuration (i.e. a heater in one tank and subsequent tanks connected in series for cooling the concentrated supernatant), the ITS system caused a different mix of analytes to settle in tank 241-BY-102. For example, there is significantly less nitrate and nitrite in tank 241-BY-102 than in the other BY tanks. There is also more calcium, manganese, nickel, silicon, sulfate, phosphate, fluoride, and iron than in the BY saltcake in the three comparison tanks (see Section D3.3). At this time, there is no way to accurately predict the saltcake analytical values through an engineering assessment, other than by using analytical data from other tanks containing BY saltcake. However, because tank 241-BY-102 was the evaporator tank for the ITS system, prediction as to what is in tank 241-BY-102 by using other BY tanks as a basis is less accurate.

Table D3-3. Comparison of Selected Component Inventory Estimates for Tank 241-BY-102 Waste. (2 Sheets)

Component	Engineering assessment (kg)	Sample-based (kg)	HDW[1] estimate (kg)
Bi	100	<3,190	229
Ca	552	<3,320	3,720
Cl	3,120	1,920	5,500
K	3,050	NR	1,800
La	NR	<1,590	0.55
NO_3	601,000	149,000	475,000
NO_2	43,000	21,900	97,000
Mn	70	<585	218
Ni	190	<7,580	942
Oxalate	20,300	30,400	0.3
Pb	147	<3,190	1,400
Si	488	6,840	2,640
SO_4	24,000	90,800	23,000

Table D3-3. Comparison of Selected Component Inventory Estimates for Tank 241-BY-102 Waste. (2 Sheets)

Component	Engineering assessment (kg)	Sample-based (kg)	HDW[1] estimate (kg)
Sr	115	<319	0.38
Cr	2,440	2,940	3,170
PO_4	14,600	42,400	10,500
F	8,750	28,300	1,380
Al	31,600	65,400	69,600
Fe	965	<2,920	1,520
TIC	35,100	43,800	8,800
TOC	6,970	6,860	9,200
U	671	<15,900	39,500
Zr	15.6	<319	32.9
Na	382,000	420,000	351,000
H_2O (percent)	21.6	26.5	38.3

HDW = Hanford Defined Waste
NR = Not reported.
[1]Agnew et al. 1997a

The HDW model does not properly represent the decreased solubilities for components in tank 241-BY-102 (e.g., phosphate, sulfate, and fluoride) that are normally quite soluble in other tanks containing BYSltCk. The increased temperatures and rapid boil-off in tank 241-BY-102 likely resulted in a concentration and precipitation of these components. The concentrated supernatant were transferred to other BY farm tanks for cooling and further precipitation of the more soluble components.

Because of the unique history of tank 241-BY-102 as an ITS evaporator tank, it is judged that the analytical data from the 1996 core sample best represents the component concentrations for this tank. With the exception of tank 241-BY-112, other tanks in the BY farm received concentrated supernatant from the ITS evaporator tanks. The waste in these receiver tanks exhibit markedly different concentrations of certain components.

Tank 241-BY-112, which also contained an ITS unit, was sampled in 1996. When the analytical results become available, these will be examined to determine if similar differences in component concentrations exist between tank 241-BY-112 and the concentrated supernatant receiver tanks.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

An evaluation of available chemical information for tank 241-BY-102 was performed that included:

- Data from push mode 1996 core samples (Appendix B)
- An inventory estimate generated by the HDW model (Agnew et al. 1997)
- Evaluation of the BYSltCk data from other BY Tank Farm Tanks.

Based on this evaluation, a best-basis inventory was developed for tank 241-BY-102. For the following reasons, the sampling-based inventory was chosen as the best-basis for those analytes for which sampling-based analytical values were available:

- The sample-based inventory analytical concentrations compared favorably to those of other BY tanks. There were, however, the noted exceptions because this tank was the evaporator tank for the ITS-1 unit.
- No methodology is available to fully predict BYSltCk from process flowsheet or historical records
- Waste transfer records are not complete and not always accurate

For those few analytes for which no values could be calculated from the sample-based data, the engineering evaluation data or the HDW model values were used. These values are less reliable than the values for which sample data are available.

Based on this evaluation, a best-basis inventory was developed for tank 241-BY-102. When the sample-based inventory had a high less-than value or was not measured, the engineering assessment-based values were used (if available). The HDW model was used only where no other data were available.

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, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997a).

The best-basis inventory for tank 241-BY-102 is presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	67,500	S	
Bi	100	E	Used ave. conc. from other tanks in BY Farm. Note if an unexpected sludge layer of 1C/CW waste is present this value may be over 2,600 kg
Ca	552	E	
Cl	1,920	S	
CO_3	219,000	S	TIC = 43,800
Cr	2,940	S	
F	28,300	S	
Fe	965	E	
Hg	8.6	M	
K	3,050	E	Used ave. conc. from other tanks in BY Farm
La	0.353	M	
Mn	70	E	
Na	420,000	S	
Ni	190	E	
NO_2	21,900	S	
NO_3	149,000	S	
OH	175,000	C	Derived from charge balance
Pb	147	E	Used ave. conc. from other tanks in BY Farm
P as PO_4	42,400	S	
Si	6,840	S	
S as SO_4	90,800	S	
Sr	115	E	Used ave. conc. from other tanks in BY Farm

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, or E)[1]	Comment
TOC	6,860	S	
U_{TOTAL}	671	E	Used ave. conc. from other tanks in BY Farm. May be low. Sample < 15,900.
Zr	15.6	E	Used ave. conc. from other tanks in BY Farm

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based
C = Derived from charge balance
NR = Not reported.

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 Hanford Defined Waste 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.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	159	M	
^{14}C	41.2	M	
^{59}Ni	4.31	M	
^{60}Co	38.9	M	
^{63}Ni	428	M	
^{79}Se	3.45	M	
^{90}Sr	38,000	E	HDW = 1.52E+05 Ci
^{90}Y	38,000	E	Referenced to ^{90}Sr
^{93}Zr	16.7	M	
^{93m}Nb	12.0	M	
^{99}Tc	231	M	
^{106}Ru	7.69E-03	M	
^{113m}Cd	88.4	M	
^{125}Sb	174	M	
^{126}Sn	5.16	M	
^{129}I	0.448	M	
^{134}Cs	1.92	M	
^{137}Cs	1.40E+05	E	HDW = 1.83E+05 Ci
^{137m}Ba	1.33E+05	E	Referenced to ^{137}Cs
^{151}Sm	1.19E+04	M	
^{152}Eu	5.39	M	
^{154}Eu	652	M	
^{155}Eu	327	M	
^{226}Ra	1.74E-04	M	
^{227}Ac	2.33E-03	M	
^{228}Ra	2.03	M	
^{229}Th	4.68E-02	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-102 (January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{231}Pa	1.19E-02	M	
^{232}Th	7.63E-02	M	
^{232}U	11.2	M	
^{233}U	43.0	M	
^{234}U	12.4	M	
^{235}U	0.534	M	
^{236}U	0.161	M	
^{237}Np	0.776	M	
^{238}Pu	3.02	M	
^{238}U	15.9	M	
^{239}Pu	140	S	Based on total alpha measurement
^{240}Pu	18.9	M	
^{241}Am	53.8	M	
^{241}Pu	217	M	
^{242}Cm	2.88E-03	M	
^{242}Pu	1.05E-03	M	
^{243}Am	1.86E-03	M	
^{243}Cm	2.12E-04	M	
^{244}Cm	1.68E-03	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based
NR = Not reported.

D5.0 APPENDIX D REFERENCES

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