EDMC # 47695

DOES NOT NEED TO BE SCANNED.

THIS DOCUMENT HAS BEEN SCANNED PREVIOUSLY.

PAGE COUNT 28

ACCESSION # D197246478

47386

0047695

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635512

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 []	Jim G. Field, Data Assessment and Interpretation, R2-12, 376-3753	[] Yes [X] No	07/25/97
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	Tank 241-S-109	241-S-109	N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	HNF-SD-WM-ER-627, Rev. 0-A	ECN-635482	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.

Rev. 0 pages included for duplicating purposes only.

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.

SEP 1997 RECEIVED EDMC

RELEASE STAMP

DATE: AUG 27 1997 HANFORD RELEASE STA: 4 ID: 2

ENGINEERING CHANGE NOTICE	Page 2 of 2	1. ECN (use no. from pg. 1) ECN-635512

16. Design Verification Required	17. Cost Impact ENGINEERING		CONSTRUCTION		18. Schedule Impact (days)	
[] 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			Design Agent		
Cog. Eng. J.G. Field	J G Field	8/26/97	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	8/27/97	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-S-109

Jim G. Field
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ECN-635512 UC: 2070
Org Code: 74620 Charge Code: N4G3A
B&R Code: EW 3120074 Total Pages: 176

Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-S-109, 241-S-109, S-109, S 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-S-109. This report supports the requirements of the Tri-Party Agreement Milestone M-44-10.

DATE: HANFORD RELEASE
STA: 4 ID: 2
AUG 27 1997

Kara L. Broz 8/27/97
Release Approval Date Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-627	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-S-109

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 01/22/97 on EDT-617652.	J.G. Field	K.M. Hall
0-A RS	Incorporate per ECN-635482.	J.G. Field	K.M. Hall
		J.G. Field 5/27/97	Kathleen M. Hall 5/27/97
0-B RS	Incorporate per ECN-635512.	J.G. Field	K.M. Hall
		JM Comer for JGF	Kathleen M. Hall 8/27/97

A-7320-005 (08/91) WEF168

CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TERMS

μCi/g	microcuries per gram
μCi/L	microcuries per liter
μg	microgram
μg/g	micrograms per gram
A/C	aluminum to caustic ratio
ANOVA	analysis of variance
Btu/hr	British thermal units per hour
CEO	change engineering order
CF	concentration factor
Ci	curies
Ci/L	curies per liter
CI	confidence interval
cm	centimeter
CWR	REDOX cladding waste
CWR1	REDOX cladding waste from 1952 to 1960
DOE	U.S. Department of Energy
DQO	data quality objective
DSC	differential scanning calorimetry
EB	evaporator bottoms
ECN	engineering change notice
Ecology	Washington State Department of Ecology
FIC	Food Instrument Corporation
ft	feet
g	grams
g/cc	grams per cubic centimeter
g/L	grams per liter
g/mL	grams per milliliter
GEA	gamma energy analysis
HHF	hydrostatic head fluid
HDW	Hanford defined waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
J/g	joules per gram
kg	kilogram
kg/L	kilograms per liter
kgal	kilogallon
kL	kiloliter
kW	kilowatt

LIST OF TERMS (Continued)

L	liter
LANL	Los Alamos National Laboratory
LL	lower limit
LOW	liquid observation well
m	meter
M	moles per liter
mm	millimeter
mrad/hr	millirads per hour
MT	metric ton
n/a	not applicable
NR	not reviewed
PF	partitioning factor
PHMC	Project Hanford Management Contractor
PN/S	partial neutralized inventory/analytical inventory
ppm	parts per million
R	REDOX High level waste from 1952 to 1960
RCW	REDOX Coating Waste
REDOX	Reduction Oxidation facility
RPD	relative percent difference
S	analytically determined inventory
SAP	sampling and analysis plan
SMMS1	supernate mixing model for 242-S Evaporator, 1973-1976
SST	single-shell tank
S1SltCk	242-S Evaporator saltcake waste, 1973-76
TCP	tank characterization plan
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
W	watts
WSTRS	waste status and transaction record summary
wt%	weight percent

This page intentionally left blank.

3.0 BEST BASIS INVENTORY ESTIMATE

Information about chemical, radiological and/or physical properties of tank waste is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as with regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank waste. Disposal activities involve designing equipment, processes, and facilities for retrieving waste and processing it into a form that is suitable for long-term storage. Chemical and radiological inventory information are generally derived using three approaches: component inventories are estimated using the results of sample analyses, component inventories are predicted using the HDW model based on process knowledge and historical information, and a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material use, and other operating data. Not surprisingly, the information derived using these different approaches is often inconsistent.

An effort is under way to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, available chemical information for 241-S-109 was evaluated. The information included the following:

- Data from 1996 partial core samples (Fritts 1996).
- An inventory estimate generated by the HDW model (Agnew et al. 1996b).
- An evaluation of the average REDOX high level waste (R) flowsheet.

The best basis inventory evaluation is included in Appendix D. Based on this evaluation, a best basis inventory was developed (Tables 3-1 and 3-2). In general, the sample-based results were preferred when they were reasonable and consistent with other results. Process estimates were added to the sample-based results for the analytes that appear on the R flowsheet. This was done to add the estimated contribution from the sludge layer, which was a minor component of this tank. Because no sample was available for this layer, the engineering assessment must be considered to have a low confidence value. The HDW model was used only where no other data were available.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-S-109 (11/9/96).

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1,2]	Comment
Al	19,000	E	This value may be as much as 4 times too high.
Bi	288	M	
Ca	245	E	
Cl	937	E	
TIC as CO_3	12,000	E	
Cr	5,370	E	
F	1,450	M	
Fe	3,410	E	
Hg	42.6	M	
K	3,350	M	
La	4.0E-03	M	
Mn	54.4	E	
Na	6.25E+05	E	
Ni	667	M	
NO_2	11,360	E	This value may be as much as 10 times too low, based on similar tanks.
NO_3	1.47E+06	E	
OH	67,700	C	
Pb	1,480	M	
P as PO_4	30,900	E	
Si	977	E	
S as SO_4	20,040	E	
Sr	8.41E-04	M	
TOC	1,510	E	
U_{TOTAL}	142	E	
Zr	87.2	M	

Notes:

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

[2]Sample data were not used because sample recovery was poor, and samples were obtained from only the upper portion of the tank (see Appendix B).

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-S-109 (11/9/96). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1,2]	Comments
^{3}H	490	M	
^{14}C	63.8	M	
^{59}Ni	4.28	M	
^{60}Co	65.2	M	
^{63}Ni	416	M	
^{79}Se	6.54	M	
^{90}Sr	2.75 E+05	E	Based on calculations from dome space temperatures
^{90}Y	2.75E+05	E	
^{93}Zr	31.9	M	
^{93m}Nb	23.6	M	
^{99}Tc	454	M	
^{106}Ru	1.02E-02	M	
^{113m}Cd	157	M	
^{125}Sb	269	M	
^{126}Sn	9.90	M	
^{129}I	0.875	M	
^{134}Cs	2.86	M	
^{137}Cs	1.06 E+05	E	Based on calculations from dome space temperatures
^{137m}Ba	1.00E+05	E	
^{151}Sm	2.31E+04	M	
^{152}Eu	5.84	M	
^{154}Eu	1.04E+03	M	
^{155}Eu	336	M	
^{226}Ra	3.01E-04	M	
^{227}Ac	1.82E-03	M	
^{228}Ra	0.111	M	
^{229}Th	2.65E-03	M	
^{231}Pa	8.07E-03	M	

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-S-109 (11/9/96). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1,2]	Comments
^{232}Th	7.51E-03	M	
^{232}U	0.676	M	
^{233}U	2.59	M	
^{234}U	2.30	M	
^{235}U	9.60E-02	M	
^{236}U	6.11E-02	M	
^{237}Np	1.78	M	
^{238}Pu	3.46	M	
^{238}U	2.35	M	
^{239}Pu	161	M	
^{240}Pu	24.7	M	
^{241}Am	106	M	
^{241}Pu	2.16	M	
^{242}Cm	0.210	M	
^{242}Pu	1.09E-03	M	
^{243}Am	3.05E-03	M	
^{243}Cm	1.89E-02	M	
^{244}Cm	0.208	M	

Notes:

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

[2]Sample data were not used because sample recovery was poor and samples were obtained from only the upper portion of the tank (see Appendix B). Model estimates taken from Agnew (1997).

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-S-109

D1.0 BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-S-109

The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-S-109.

D1.1 EXPECTED TYPE OF WASTE BASED ON THIS ASSESSMENT

Agnew et al. (1996b)	SMMS1, CWR1
Hill et al. (1995)	B, R

It is not known whether the sludge layer in the tank is R cladding waste (CWR1) or R waste. Based on tank transfer history (Agnew et al. 1996a) and radioactivity estimates determined from tank headspace temperatures (see Appendix E), it is assumed that the small sludge layer is R waste and not CWR1 as reported in Agnew et al. (1996b).

D1.2 TANK INVENTORY ESTIMATES

Two inventories have been developed for Tank 241-S-109. A sampling inventory, based on core sampling results (Fritts 1996) and the HDW inventory (Agnew et al. 1996b). The sampling and HDW inventories can not be compared directly, because they are calculated differently. The sample inventory was based on partial core samples taken from two risers. None of the sludge expected at the bottom of the tank was recovered during this sampling event. Consequently, the sample inventory is only for the saltcake portion of the tank or 1,870 kL (494 kgal) and is calculated based on a mean sample density of 1.3 g/mL. Further, the sample inventory in Table D1-1 assumes that the small portion of saltcake recovered is representative of the entire saltcake volume. This is not necessarily true, as discussed in section D3.0. The HDW inventory (Agnew et al. 1996b) includes both the saltcake and sludge volumes for a total volume of 1,920 kL (507 kgal). The HDW inventory is calculated using an estimated average density of 1.5 g/mL for the tank.

The sampling and HDW inventories (Tables D1-1 and D1-2) provide a starting point for calculating a best-basis inventory for the tank that combines the best information from the sampling data, modeling estimates, and process information. The chemical species are reported without charge designation according to the best-basis inventory convention.

Table D1-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-S-109. (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	4,215	97,000	Ni	NR	667
Ag	43.1	NR	NO_2	11,360	2.29E+5
As	NR	NR	NO_3	1.46E+6	5.55E+5
Ba	NR	NR	OH	NR	2.56E+5
Be	NR	NR	oxalate	NR	2.17E-3
Bi	NR	288	Pb	NR	1,480
Ca	245	2,570	Pd	NR	NR
Ce	NR	NR	P as PO_4	30,900	11,300
Cd	NR	NR	Pt	NR	NR
Cl	937	11,900	Rh	NR	NR
Co	NR	NR	Ru	NR	NR
Cr	3,790	NR	Sb	NR	NR
Cr^{+3}	NR	6,810	Se	NR	NR
Cr^{+6}	NR	NR	Si	977	3,700 (as SiO_3)
Cs	NR	NR	S as SO_4	19,950	33,000
Cu	NR	NR	Sr	NR	8.41E-4
F	NR	1,450	Te	NR	NR
Fe	3,190	1,170	TIC	12,000	32,600
FeCN/CN	NR	NR	Th	NR	NR
formate	NR	NR	Tl	NR	NR
Hg	NR	42.6	TOC	1,510	0.358 (wt% C)
K	NR	3,350	U_{total}	142	7,440
La	NR	4.0E-3	V	NR	NR
Mg	NR	NR	W	NR	NR

Table D1-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-S-109. (2 sheets)

Analyte	Sampling[1] Inventory Estimate (kg)	HDW[2] Inventory Estimate (kg)	Analyte	Sampling[1] Inventory Estimate (kg)	HDW[2] Inventory Estimate (kg)
Mn	54.4	318	Zn	47.8	NR
Mo	NR	NR	Zr	NR	87.2 (as $ZrO(OH)_2$)
Na	6.2E+5	4.67E+5	H_2O (Wt%)	NR	40.1
Nd	NR	NR	density (kg/L)	1.3	1.52
NH_4	NR	1,800			

Notes:

[1]Fritts (1996)

[2]Agnew et al. (1996b)

Table D1-2. Sampling and Predicted Inventory Estimates for Radioactive Components in Tank 241-S-109.

Analyte	Sampling[1] Inventory Estimate (Ci)	HDW[2] Inventory Estimate (Ci)	Analyte	Sampling[1] Inventory Estimate (Ci)	HDW[2] Inventory Estimate (Ci)
^{14}C	NR	NR	^{237}Np	NR	NR
^{90}Sr	2.76E+5	2.14E+5	$^{239/240}Pu$	NR	255
^{99}Tc	NR	NR	^{241}Am	NR	NR
^{129}I	NR	NR	Total α	18.7	NR
^{137}Cs	1.06E+5	4.82E+5	Total β	NR	NR
^{154}Eu	NR	NR			

Notes:

[1]Fritts (1996)

[2]Agnew et al. (1996b).

D2.0 INVENTORY EVALUATION

The following evaluation provides an engineering assessment of tank 241-S-109 contents. For this evaluation, the following assumptions and observations are made:

- Tank waste mass is calculated using the measured density of the saltcake (1.3 g/mL) and the tank volume listed by Agnew et al. (1996b), which is 494 kgal of saltcake, and 13 kgal of sludge.

- Only the SMMS1 and R waste streams contributed to solids formation.

- Bulk component information for the sludge layer is sufficient for comparing analytical and predicted data sets. This information can be obtained from technical flowsheets (refer to Table D2-1). Note in this case there is no analytical data so only the technical flowsheet information is available.

- 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.

- All Bi and Al precipitate.

- No Si from blowsand is factored into this evaluation.

- All NO_3, Na and SO_4, remain dissolved in the interstitial liquid.

- Interstitial liquid is a composite of all wastes. Contributions of dissolved components are weighted by volume.

- Concentration of components in interstitial liquid is based on a void fraction of 0.686 the average of (R1 and R2) as reported by Agnew et al. (1996b). This factor is higher than the present void fraction but is assumed to better represent the original void fraction.

- Cr and Fe partition between the liquid and solid phases.

Technical flowsheet information for the average R streams is provided in Table D2-1. The comparative LANL defined waste streams also are provided in this table. Note that the REDOX coating waste average flowsheet is also included for comparison purposes.

Table D3-1. Comparison of Selected Component Inventory Estimates for Tank 241-S-109 Waste.

Component	This evaluation (kg)	Sample-based (kg)	HDW estimated (kg)
Bi	>3	NR	288
K	NR	NR	3350
La	NR	NR	4E-03
NO_3	1.47E+06	1.46E+06	2.29E+05
Mn	NR	54.4	318
SO_4	20,040	19,950	33,000
Cr	5370	3,790	6,810
PO_4	NR	30,900	11,300
F	NR	NR	1450
Al	19,000	4,215	97,000
Fe	3,410	3,190	1,170
Na	6.25E+05	6.2E+05	4.67E+05
H_2O (percent)		NR	40.1

Note:
HDW = Hanford Defined Waste
NR = Not reported.

Bismuth. Because the sample-based value was not reported, no meaningful comparison is available to the HDW model. The inventory from the sludge layer was 3.1 kg but no saltcake value is given. The Bi is therefore >3 but probably less than 288, the HDW model estimate.

Nitrate. The HDW estimated inventory is smaller than the sample-based inventory by about six times and the inventory estimated in this evaluation adds less than 1 percent to the sampling results. It is not known why this difference is occurring, but it most likely is because of incorrect feed in information to the model. When no reason for differences is given for other analytes, a model associated problem will be the assumed most likely reason.

Sulfate. The engineering evaluation added the flowsheet sludge prediction to that portion of the sample-based calculations that represents the expected sludge volume. The engineering evaluation was used as the best basis because this portion of the tank was not sampled. It is essentially the same value as the sample predicted. The HDW model predicts about 50 percent more than the other values.

Chromium. The HDW estimated inventory is over 80 percent higher than the sample-based inventory. The estimate from this evaluation is about half way between the other two estimates. The additional amount from the engineering estimate is from flowsheet estimates for Cr in the sludge, which is a much higher molarity than that of the saltcake. The sample-based inventory did not measure the sludge layers of the tank. The engineering estimate was used for the best basis.

Phosphate. The sample-based estimate was used as the best basis because a good prediction of the sludge molarity could not be made from flowsheet information. This estimate is about three times higher than that predicted by the HDW model.

Fluoride. The sample-based estimate was not reported and because a good prediction of the sludge molarity could not be made from flowsheet information, the best basis is that predicted by the HDW model.

Sodium. The engineering estimate is about 1 percent higher than the sample-based estimate because sludge is much lower than saltcake in Na, so little Na was added by the sludge. This engineering estimate was used as the best basis and it is about 35 percent higher than that predicted by the HDW model.

Potassium. There is no sample-based estimate and because a good prediction of the sludge molarity could not be made from flowsheet information, the HDW model estimate becomes the best-basis estimate.

Lanthanum. There is no sample-based estimate and because a good prediction of the sludge molarity could not be made from flowsheet information, the best basis is that predicted by the HDW model.

Manganese. The sample-based estimate was used as the best basis because a good prediction of the sludge molarity could not be made from flowsheet information. This best basis is about six times lower than that predicted by the HDW model.

Aluminum. Like Cr, Al engineering calculations based on the R sludge add significant amounts of analyte to the inventory. The engineering based inventory was used as the best basis and is over five times the sample-based estimate. Because only the upper half of the saltcake was analyzed and similar tanks (241-U-102, 241-S101 and 241-S-102) show twice the Al in the bottom half of the saltcake, the analytical saltcake number was multiplied by 1.5, and was added to the sludge value to give the best basis calculation. The HDW model predicted a value about four and a half times that of this estimate. Although no quality control problems were identified in the sample data, based on Agnew et al. (1996b) and process data from tanks containing similar waste types, the sample-based numbers for Al appear to be low. This is being investigated. The engineering estimate is used as the best basis with a caution that it may be up to four times too high.

Iron. Using the R flowsheet information to estimate Fe in the sludge adds less than 10 percent to the saltcake values from the sample-based value. The HDW model predicts about one third of this value.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach required that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures was not increased. This charge balance approach is consistent with that used by Agnew et al. (1977).

D4.0 BEST-BASIS INVENTORY ESTIMATE

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. Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the HDW model based on process knowledge and historical information, or (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage and other operating data. Not surprisingly, the information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1995). As part of this effort, an evaluation of available chemical information for 241-S-109 was performed, including:

- Data from 1996 partial core samples (Fritts 1996).
- An inventory estimate generated by the HDW model (Agnew et al. 1996b).
- Evaluation of the average R flowsheet

Based on this evaluation, a best-basis inventory was developed (see Tables D4-1 and D4-2). In general, the sample-based TCR results were preferred when they were reasonable and consistent with other results. Process estimates were added to the sample-based results for those analytes that appear on the R flowsheet. This was done to add the estimated contribution from the sludge layer, which was a minor component of this tank. Because no sample was available for this layer the engineering assessment must be considered to have a low confidence value. The HDW model was used only where no other data were available.

The best-basis inventory for tank 241-S-109 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 for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am etc., were infrequently reported. For this reason, it was 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 the 177 tanks were reported in Agnew et al. (1997). The best-basis value for any one analyte may be a model result, a sample, or an engineering assessment-based result, if available. (No attempt was 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).

Best-basis tables for chemicals and only four radionuclides (^{90}Sr, ^{137}Cs, Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the Hanford Defined Waste model. When values for all 46 radionuclides became available in Rev. 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-S-109 (11/9/96).

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1,2]	Comment
Al	19,000	E	This value may be as much as 4 times too high.
Bi	288	M	
Ca	245	E	
Cl	937	E	
TIC as CO_3	12,000	E	
Cr	5,370	E	
F	1,450	M	
Fe	3,410	E	
Hg	42.6	M	
K	3,350	M	
La	4.0E-03	M	
Mn	54.4	E	
Na	6.25E+05	E	
Ni	667	M	
NO_2	11,360	E	This value may be as much as 10 times too low, based on similar tanks.
NO_3	1.47E+06	E	
OH	67,700	C	
Pb	1,480	M	
P as PO_4	30,900	E	
Si	977	E	
S as SO_4	20,040	E	
Sr	8.41E-04	M	
TOC	1,510	E	
U_{TOTAL}	142	E	
Zr	87.2	M	

Notes:

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

[2]Sample data were not used because sample recovery was poor, and samples were obtained from only the upper portion of the tank (see Appendix B).

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-S-109 (11/9/96). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1,2]	Comments
^{3}H	490	M	
^{14}C	63.8	M	
^{59}Ni	4.28	M	
^{60}Co	65.2	M	
^{63}Ni	416	M	
^{79}Se	6.54	M	
^{90}Sr	2.75 E+05	E	Based on calculations from dome space temperatures
^{90}Y	2.75E+05	E	
^{93}Zr	31.9	M	
^{93m}Nb	23.6	M	
^{99}Tc	454	M	
^{106}Ru	1.02E-02	M	
^{113m}Cd	157	M	
^{125}Sb	269	M	
^{126}Sn	9.90	M	
^{129}I	0.875	M	
^{134}Cs	2.86	M	
^{137}Cs	1.06 E+05	E	Based on calculations from dome space temperatures
^{137m}Ba	1.00E+05	E	
^{151}Sm	2.31E+04	M	
^{152}Eu	5.84	M	
^{154}Eu	1.04E+03	M	
^{155}Eu	336	M	
^{226}Ra	3.01E-04	M	
^{227}Ac	1.82E-03	M	
^{228}Ra	0.111	M	
^{229}Th	2.65E-03	M	
^{231}Pa	8.07E-03	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-S-109 (11/9/96). (2 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1,2]	Comments
^{232}Th	7.51E-03	M	
^{232}U	0.676	M	
^{233}U	2.59	M	
^{234}U	2.30	M	
^{235}U	9.60E-02	M	
^{236}U	6.11E-02	M	
^{237}Np	1.78	M	
^{238}Pu	3.46	M	
^{238}U	2.35	M	
^{239}Pu	161	M	
^{240}Pu	24.7	M	
^{241}Am	106	M	
^{241}Pu	2.16	M	
^{242}Cm	0.210	M	
^{242}Pu	1.09E-03	M	
^{243}Am	3.05E-03	M	
^{243}Cm	1.89E-02	M	
^{244}Cm	0.208	M	

Notes:

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

[2]Sample data were not used because sample recovery was poor and samples were obtained from only the upper portion of the tank (see Appendix B). Model estimates taken from Agnew (1997).

D5.0 APPENDIX D REFERENCES

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996a, *Waste Status and Transaction Record Summary for the Southwest Quadrant of the Hanford 200 East Area*, WHC-SD-WM-TI-614, 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, 1996b, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Rev. 0, 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. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Fritts, L. L., 1996, *Tank 241-S-109, Cores 158 and 160, Analytical Results for the Final Report,* WHC-SD-WM-DP-194, Rev. 0, Westinghouse Hanford Company, Richland Washington.

Heasler, P. G., K. M. Remund, J. M. Tingey, D. B. Baird, F. M. Ryan, and J. M. Conner, 1996, *Tank Characterization Report for Single-Shell Tank B-201*, WHC-SD-WM-ER-550, Rev. 0, Westinghouse Hanford Company, 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, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., A. L. Boldt, G. L. Borsheim, N. G. Colton, B. A. Higley, K. M. Hodgson, S. L. Lambert, M. D. LeClair, R. M. Orme, D. E. Place, W. W. Schulz, L. W. Shelton, R. A. Watrous, and R. T. Winward, 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.

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.

DISTRIBUTION SHEET

To	From	Page 1 of 2
Distribution	Data Assessment and Interpretation	Date 07/25/97
Project Title/Work Order		EDT No. N/A
Tank Characterization Report for Single-Shell Tank 241-S-109, HNF-SD-WM-ER-627, Rev. 0-B		ECN No. ECN-635512

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
OFFSITE					
Sandia National Laboratory P.O. Box 5800 MS-0744, Dept. 6404 Albuquerque, NM 87815					
D. Powers		X			
Nuclear Consulting Services Inc. P. O. Box 29151 Columbus, OH 43229-01051					
J. L. Kovach		X			
Chemical Reaction Sub-TAP P.O. Box 271 Lindsborg, KS 67456					
B. C. Hudson		X			
SAIC 555 Quince Orchard Rd., Suite 500 Gaithersburg, MD 20878-1437					
H. Sutter		X			
Los Alamos Laboratory CST-14 MS-J586 P. O. Box 1663 Los Alamos, NM 87545					
S. F. Agnew		X			
Tank Advisory Panel 102 Windham Road Oak Ridge, TN 37830					
D. O. Campbell		X			

DISTRIBUTION SHEET

To	From	Page 2 of 2
Distribution	Data Assessment and Interpretation	Date 07/25/97
Project Title/Work Order		EDT No. N/A
Tank Characterization Report for Single-Shell Tank 241-S-109, HNF-SD-WM-ER-627, Rev. 0-B		ECN No. ECN-635512

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
ONSITE					
Department of Energy - Richland Operations					
J. F. Thompson	S7-54	X			
W. S. Liou	S7-54	X			
J. A. Poppiti	S7-54	X			
DE&S Hanford, Inc.					
R. J. Cash	S7-14	X			
W. L. Cowley	R2-54	X			
G. L. Dunford	A2-34	X			
G. D. Johnson	S7-14	X			
J. E. Meacham	S7-14	X			
Fluor Daniel Northwest					
E. D. Johnson	E6-08	X			
Lockheed Martin Hanford, Corp.					
J. G. Field	R2-12	X			
K. M. Hodgson	H0-34	X			
T. J. Kelley	S7-21	X			
L. M. Sasaki	R2-12	X			
B. C. Simpson	R2-12	X			
L. R. Webb	R2-12	X			
ERC (Environmental Resource Center)	R1-51	X			
T.C.S.R.C.	R1-10	5			
Lockheed Martin Services, Inc.					
B. G. Lauzon	R1-08	X			
Central Files	A3-88	X			
EDMC	H6-08	X			
Numatec Hanford Corporation					
J. S. Garfield	H5-49	X			
D. L. Herting	T6-07	X			
J. S. Hertzel	H5-61	X			
D. L. Lamberd	H5-61	X			
Pacific Northwest National Laboratory					
A. F. Noonan	K9-91	X			