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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 643406

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [x] (struck out) Direct Revision RN [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	M. J. Kupfer, LMHC, H5-49 376-6631	[] Yes [x] No	08/18/97
	6. Project Title/No./Work Order No.: Tank 241-SY-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-409, Rev. 0	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 G, Evaluation to Establish Best-Basis Inventory for Double-Shell Tank 241-SY-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 double-shell tank 241-SY-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	R. T. Winward	H5-49
File	H5-49	C. J. Benar	R2-12
T. E. Jones	H5-49		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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ID: 21

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A-7900-013-1

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

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

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

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

Document Number/Revision	Document Number/Revision	Document Number Revision
NA		

21. Approvals

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

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Double-Shell Tank 241-SY-101

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

EDT/ECN: 643406 UC: 712
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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 double-shell tank 241-SY-101 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-409	Page 1

(2) Title
Tank Characterization Report for Double-Shell Tank 241-SY-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 08/03/95 on EDT 613104.	D. L. Herting	J. G. Kristofzski
0A RS	Incorporate per ECN-643406.	M. J. Kupfer	K. M. Hodgson
		[signature] 8-20-97	[signature] 8/19/97

APPENDIX G

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-SY-101

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APPENDIX G

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-SY-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 the double-shell tank 241-SY-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.

G1.0 CHEMICAL INFORMATION SOURCES

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

- The information included in Sections 2.0, 3.0, 4.0 and 5.0 of this tank characterization report (TCR) for DST 241-SY-101 on tank history, sampling, analyses, and data evaluation.
- Internal memo on the statistical analysis of tank 241-SY-101 data (Welsh 1995).
- Inventory estimates for this tank that were generated from the Hanford Defined Waste (HDW) model (Agnew et al. 1997a).

A list of references used in this evaluation is provided in Section G5.0.

G2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Tank 241-SY-101 is one of three tanks making up the SY Tank Farm in the 200 West Area. Two of the three tanks in this farm (tanks 241-SY-101 and 241-SY-103) were filled in the 1977 to 1980 time frame with a mixture of highly concentrated double-shell slurry and complexant concentrate from B Plant cesium and strontium recovery campaigns. The B Plant processes introduced high concentrations of organic compounds to the waste. Both tanks have exhibited gas production and periodic gas release. Periodic gas releases have led to cyclic changes in the waste volume in the tanks. Safety concerns about the gas release phenomenon have led to extensive characterization of the waste materials in tank 241-SY-101 and to a lesser extent tank 241-SY-103.

The HDW model inventory estimates for tank 241-SY-101 are listed in Tables G2-1 and G2-2. Also included in Tables G2-1 and G2-2 are tank inventory estimates based on analytical data. The chemical species are reported without charge designation per the best-basis inventory convention.

Table G2-1. Hanford Defined Waste Model-Based and Sample-Based Inventory Estimates for Nonradioactive Components in Tank 241-SY-101.

Analyte	Analytical Based Inventory Estimates[b] (kg)	HDW Inventory Estimate[a] (kg)	Analyte	Analytical Based Inventory Estimates[b] (kg)	HDW Inventory Estimate[a] (kg)
Al	219,000	239,000	Ni	1,030	2,100
Bi	NR	1,580	NO_2	744,000	605,000
Ca	2,410	7,570	NO_3	850,000	1.69 E+06
Cl	56,300	47,300	OH	149,000	904,000
Cr	24,600	40,300	Pb	NR	1,160
F	NR	7,080	PO_4	44,600	80,700
Fe	2,080	3,430	Si	NR	12,300
Hg	NR	10.3	SO_4	26,600	133,000
K	22,800	14,100	TIC as CO_3	252,000	150,000
Mn	NR	1,190	TOC	104,000	77,500
Na	1.39 E+06	1.77 E+06	U_{TOTAL}	265	12,900
H_2O (Wt%)	35.0	21.3	Zr	NR	128
			Density (g/mL)	1.61	1.79

HDW = Hanford Defined Waste
NR = not reported
[a] Agnew et al. (1997a)
[b] Table 4-3 in this Tank Characterization Report.

Table G2-2. Hanford Defined Waste Model-Based and Sample-Based Inventory Estimates for Radioactive Components in Tank 241-SY-101.[a]

Analyte	Analytical Based Inventory Estimates[b] (Ci)	HDW Inventory Estimate[c] (Ci)	Analyte	Analytical Based Inventory Estimates[b] (Ci)	HDW Inventory Estimate[c] (Ci)
^{90}Sr	125,000	6.83 E+05	^{137}Cs	2.21 E+06	1.54 E+06
$^{239/240}Pu$	46.6	1,450	^{241}Am	635	345
^{99}Tc	14,600	1,450			

HDW = Hanford Defined Waste

[a] Radionuclides decayed to January 1, 1994

[b] Table 4-3 in this Tank Characterization Report

[c] Agnew et al. (1997a).

G3.0 COMPONENT INVENTORY EVALUATION

The following evaluation was conducted to assess various estimates of tank contents.

G3.1 WASTE HISTORY FOR TANK 241-SY-101

The waste transfer history for tank 241-SY-101 is documented in Section 2.3.1 of this TCR. Tank 241-SY-101 began receiving double-shell slurry (DSS) waste (1,044 kL [276 kgal]) in April 1977 from the 242-S Evaporator. Between November 1977 and August 1978 the tank received complexant concentrate waste (2,112 kL [558 kgal]) from B Plant cesium and strontium recovery processes. The tank received 874 kL (231 kgal) of DSS from the 242-S Evaporator in October 1980. The tank received 30 kL (8 kgal) of water from water-lancing operations in the mid-1980's. A more detailed transfer history for this tank is available from Agnew et al. (1997b).

Shortly after the first waste was added to tank 241-SY-101, the waste began to exhibit slurry growth. The phenomenon involves the generation and retention of gases within the slurry, causing an increase in the overall waste volume with episodic gas releases. Slurry growth continued to be observed after the last waste additions in 1980. Concern over the slurry growth and episodic gas releases was heightened in 1989, when it was recognized that the gases generated and released included a mixture of hydrogen and nitrous oxide, a flammable and potentially explosive mixture. Extensive waste characterization activities were initiated in this tank to address safety issues. In 1993, a mixing pump was installed in tank 241-SY-101 which has controlled the release of gases from the waste.

G3.2 EXPECTED TYPE OF WASTE BASED ON THIS ASSESSMENT

Agnew et al. (1997a) lists the waste volume as 4,160 kL (1,100 kgal). Hanlon (1997) lists the waste volume as 4,213 kL (1,113 kgal). Prior to the installation of a mixing pump in 1993, the surface level of this tank varied as a function of time because of the gas accumulation phenomenon. Prior to pump installation, the occupied volume of the waste in this tank increased with the gas accumulation and decreased when the gas was vented. Figure 2.4 in this TCR illustrates the cyclic changes of slurry growth and gas release events in tank 241-SY-101.

Agnew et al. (1997b) identifies the waste as being 2,120 kL (560 kgal) of Supernatant Mixing Model from 242-S Evaporator (salt cake generated from 1977 to 1980 [SMMS2]) solids and 2,044 kL (540 kgal) of liquids. Hanlon (1997) identifies the waste as being 155 kL (41 kgal) of sludge, and 4,058 kL (1,072 kgal) of supernatant liquids. This TCR used data from tank sampling events in 1990 and 1991 to estimate the convective (i.e., liquid) layer to be 2,300 kL (608 kgal), the non-convective (i.e., solids) layer to be 1,670 kL (442 kgal) and the crust to be 220 kL (58 kgal) (Welsh 1995). The volumes developed in the TCR were used to develop tank inventory estimates.

Based on process history, tank 241-SY-101 would be expected to contain large quantities of organic complexing agents from the complexant concentrate. The tank would also be expected to contain large quantities of aluminum, sodium, hydroxide, nitrite, and nitrate from the DSS.

G3.3 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

The general approach of an engineering assessment is to utilize all available information to formulate the best-basis estimate of the tank's contents. The sources of information may include analytical data from samples taken from the tank of interest, analytical data from other tanks believed to contain waste types similar to those believed to be in the tank of interest, and data from models utilizing historical process records. The confidence level assigned to the best-basis inventory values then depends on the level of agreement among the various information sources.

Since 1980, the surface level in tank 241-SY-101 (and also in tank 241-SY-103) was observed to periodically rise and fall. This behavior was attributed to the accumulation of hydrogen and other gases in the non-convecting layer in the tank. When it was realized that a potentially significant safety issue was associated with the levels of reactive gases being periodically vented from the two SY tank farm tanks, a focused characterization effort was initiated. (Details of the safety issue are discussed elsewhere in this TCR.) The waste characterization efforts for tank 241-SY-101 are detailed in sections 4.0 and 5.0 of this TCR.

In order to address the very serious safety issues that had been raised by the gas venting episodes in tank 241-SY-101, the tank was sampled a number of times in 1990 and 1991. The sampling events followed separate releases of accumulated gases. In November 1990, three crust samples were obtained from the tank. In May 1991, eight crust samples and a core sample consisting of 26 segments were taken. In December 1991, a second core sample was taken from a separate riser. The analyses of these samples and the data interpretation received extensive oversight from both internal U.S. Department of Energy (DOE) and external technical reviewers. The rigor of the tank sampling efforts and the analytical characterization data generated from the samples taken from tank 241-SY-101 represent the highest quality that were available from the Hanford Site staff. For this reason these data are used as the best-basis for estimating the tank inventory.

The estimated composition for each of the three layers in tank 241-SY-101 are reported in Section 4.0, Table 4-2 of this TCR. The tank inventory estimates are shown in Section 4.0, Table 4-3. Appendix A of this TCR contains the data from physical, chemical, and radiological characterization of window C and E core samples. Considerably more analytical data are included in Appendix A than is summarized in Tables 4-2 and 4-3. Tables 4-2 and 4-3 only include the analytes where sufficient data were available for calculation of a tank inventory estimate. However, many analyses were completed on selected sample splits. In such cases, there was insufficient data to develop a tank inventory estimate.

G4.0 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 assessments 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 and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage or 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 information for tank 241-SY-101 was performed. An assessment of available chemical information for tank 241-SY-101 was performed, including the following:

- The information in Sections 2.0, 3.0, 4.0 and 5.0 of this TCR for tank 241-SY-101 history, sampling, analyses, and data evaluation.
- Internal memo on the statistical analysis of tank 241-SY-101 data (Welsh 1995).
- Inventory estimates for this tank that were generated from the HDW model (Agnew et al. 1997a).

Based on this engineering assessment, a best-basis inventory was developed for tank 241-SY-101 using concentration data developed in this TCR, when available, or the HDW model tank inventory estimates reported by Agnew et al. (1997a). Because of the intense interest in understanding the composition of the wastes in this tank stemming from serious safety concerns, the characterization data are considered to be the most reliable available for any tank at Hanford.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with 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. No adjustments were required in this best-basis inventory estimate. This charge balance approach is consistent with that used by Agnew et al. (1997a).

Best-basis inventory values for tank 241-SY-101 are reported in Tables G4-1 and G4-2. The inventory values are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Table G4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-SY-101 (Effective May 31, 1997).

Analyte	Total Inventory (kg)	Basis (S, M, or C)[1]	Comment
Al	219,000	S	
Bi	1,580	M	
Ca	2,410	S	
Cl	56,300	S	
TIC as CO_3	252,000	S	
Cr	24,600	S	
F	7,080	M	
Fe	2,080	S	
Hg	10.3	M	
K	22,800	S	
La	35.6	M	
Mn	1,190	M	
Na	1.39 E+06	S	
Ni	1,030	S	
NO_2	744,000	S	
NO_3	850,000	S	
OH_{TOTAL}	702,000	C	
Pb	1,160	M	
PO_4	44,600	S	
Si	12,300	M	
SO_4	26,600	S	
Sr	0	M	
TOC	104,000	S	
U_{TOTAL}	265	S	
Zr	128	M	

[1]S = Sample-based

M = Hanford Defined Waste model-based, Agnew et al. (1997a)

C = Calculated by charge balance; includes oxides as hydroxide not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table G4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-SY-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	1,380	M	
^{14}C	204	M	
^{59}Ni	13	M	
^{60}Co	228	M	
^{63}Ni	1,280	M	
^{79}Se	20.3	M	
^{90}Sr	125,000	S	
^{90}Y	125,000	S	Referenced to ^{90}Sr.
^{93}Zr	99.5	M	
^{93m}Nb	72.1	M	
^{99}Tc	14,600	S	
^{106}Ru	0.0416	M	
^{113m}Cd	526	M	
^{125}Sb	989	M	
^{126}Sn	30.6	M	
^{129}I	2.79	M	
^{134}Cs	16.8	M	
^{137}Cs	2.21 E+06	S	
^{137m}Ba	2.09 E+06	S	Referenced to ^{137}Cs
^{151}Sm	71,400	M	
^{152}Eu	24.6	M	
^{154}Eu	3,730	M	
^{155}Eu	1,460	M	
^{226}Ra	8.54 E-04	M	
^{227}Ac	0.00542	M	
^{228}Ra	0.865	M	
^{229}Th	0.0203	M	
^{231}Pa	0.025	M	
^{232}Th	0.0584	M	
^{232}U	4.4	M	

Table G4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-SY-101 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{233}U	16.9	M	
^{234}U	4.75	M	
^{235}U	0.192	M	
^{236}U	0.149	M	
^{237}Np	5.24	M	
^{238}Pu	8.6	M	
^{238}U	5.56	M	265 kg total uranium
$^{239/240}Pu$	46.6	S	
^{241}Am	633	S	
^{241}Pu	584	M	
^{242}Cm	0.938	M	
^{242}Pu	0.00321	M	
^{243}Am	0.0123	M	
^{243}Cm	0.087	M	
^{244}Cm	0.841	M	

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

G5.0 APPENDIX G REFERENCES

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