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# Tank Characterization Report for Double-Shell Tank 241-AP-104

L. W. Shelton

Numatec Hanford Corporation, Richland, WA 99352 U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for double-shell tank 241-AP-104 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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# (1) Document Number **RECORD OF REVISION** WHC-SD-WM-ER-596 Page 1 (2) Title Tank Characterization Report for Double-Shell Tank 241-AP-104 CHANGE CONTROL RECORD (4) Description of Change - Replace, Add, and Delete Pages Authorized for Release (3) Revision (6) Cog. Mgr. (5) Cog. Engr. Date (7) 0 Initially released 08/07/96 on W. D. Winkleman J. G. Kristofzski EDT 617503. M. J. Kupfer K. M. Hodgs MJK-m/ 8-22-97 R.M. Hodgs RS Incorporate per ECN-640362. K., M. Hodgson 0A 823-97 .

# APPENDIX D

# EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-104

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### APPENDIX D

# EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-104

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 double-shell tank 241-AP-104 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 composition information for the waste in tank 242-AP-104 is as follows:

- Appendix A of this report provides characterization results from the June 1996 grab sampling event.
- The Hanford Defined Waste (HDW) model document (Agnew et al. 1997) provides tank content estimates derived from the Los Alamos National Laboratory (LANL) model, in terms of component concentrations and inventories.

#### D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Typically, best-basis inventory documents include a comparison of sampled-based inventories derived from analytical concentration data with inventories generated by the HDW model (Agnew et al. 1997). However, the HDW model estimates for all tanks are valid as of January 1, 1994. At that time tank 241-AP-104 contained 68 kL (18 kgal) of dilute non-complexed (DN) supernatant. Since that time, tank 241-AP-104 has been filled with other DN waste and then emptied approximately down to its current level of 98.4 kL (26 kgal). Data obtained from the January 1996 sampling data are the most appropriate source of information pertaining to the waste currently in tank 241-AP-104. Therefore, the HDW model estimates are of limited value. No solids are expected to be in tank 241-AP-104.

The chemical species in this appendix are reported without charge designation per the best-basis inventory convention.

## **D3.0 COMPONENT INVENTORY EVALUATION**

When tank 241-AP-104 was sampled in January, 1996, it contained 4,258 kL (1,125 kgal) of supernatant. As explained in section 5.3, laboratory analysis indicated a concentration gradient for the supernatant. Samples taken 244 cm (96 in) from the bottom were more concentrated than samples taken closer to the waste surface. Unfortunately, samples were not taken at depths lower than 244 cm (96 in.). It may be that at depths lower than 244 cm (96 in.), the concentrations continue to increase.

Shortly after the tank was sampled, the waste level in tank 241-AP-104 was pumped down to 25 cm (9.7 in.) using a deep well turbine pump that is located near the tank bottom. The concentration gradient present before the transfer rules out using mean concentrations calculated from samples taken from all sampling locations. Since the inlet of the pump is near the tank bottom, a subset of samples taken from regions close to the waste surface are more appropriate for the waste remaining in tank 241-AP-104. Samples labeled by the laboratory as Pacific Northwest National Laboratory (PNNL) 96-3096, S96V000018, S96V000007, S96V000010, and S96V000022 were taken nearest to the waste surface at a depth 274 cm (108 in.) from the waste surface.

The best-basis inventory for the small supernatant heel remaining in tank 241-AP-104 was calculated from samples taken from the uppermost region of the waste before tank 241-AP-104 was emptied in 1996. Each analyte is represented in the data by only one sample; usually this is sample S96V000010. The sample concentrations used to generate the best-basis inventory, taken from Appendix A, are provided in Tables D3-1 and D3-2. Inventory estimates are also included in Tables D3-1 and D3-2.

Inventory estimates were developed for three elements (Ca, Cl, and K) from HDW model values reported by Agnew et al. (1997). The HDW values were corrected for volume differences (68 kL [18 kgal] in 1994 and 98 kL [26 kgal] in 1997) and normalized to the sodium ion concentration. That is, the HDW value was multiplied by the ratios of tank volumes (26/18), and sodium concentrations (4,530/12,400). The inventory estimates are reported in Table D3-1.

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valence of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997). In this cases, this approach required that some anion analyte (e.g. nitrite, sulfate, phosphate or nitrate) inventories be adjusted to achieve the charge balance. The nitrate inventory estimate was reduced from 289 kg down to 275 kg to bring the total hydroxide up from a -5.22 kg up to 0 kg. The analytical data led to an inventory estimate for hydroxide of 45.5 kg. The imbalance in the hydroxide calculation strongly suggests that the selection of analyte concentration values was flawed.

Analyte	Mean concentration (µg/mL)	Inventory Estimate <sup>4</sup> (kg)		
Al	41.3	4.06		
Bi	NR	NR		
Ca	NR	11.2		
Cl	NR	3.51		
CO <sub>3</sub>	2,930	288		
Cr	17.1	1.68		
F	113	11.1		
· Fe	< 0.50	< 0.049		
Hg	NR	NR		
K	NR	0.840 <sup>b</sup>		
La	NR	NR		
Mn	<0.10	< 0.0098		
Na	4,530	446		
Ni	0.326	0.0321		
NO <sub>2</sub>	1,090	107		
NO <sub>3</sub>	2,940	289		
OH	462	45.5		
РЬ	NR	NR		
PO <sub>4</sub>	657	64.6		
Si	20.1	1.98		
SO4	560	55.1		
Sr	NR	NR		
TOC	118	11.6		
U	33.2	3.27		
Zr	NR	NR .		

Table D3-1. Supernatant Concentrations for Chemicals near the Surface Level and Inventory Estimates in Tank 241-AP-104 as of January 1996.

NR = Not reported

\*Based on a supernatant volume of 98.4 kL (26 kgal)

<sup>b</sup> Estimated from the Hanford Defined Waste model values (Agnew et al 1997); refer to text.

Analyte	Mean concentration <sup>#</sup> (µCi/mL)	Inventory estimate <sup>b</sup> (Ci)
зН	0.0139	1.36
<sup>14</sup> C	1.60 E-04	0.0157
<sup>60</sup> Co	4.10 E-04	0.0403
<sup>79</sup> Se	<3.37 E-07	<3.32 E-05
90Sr	0.082	8.07
99Tc	7.24 E-04	0.0712
106Ru	<0.1413	<13.9
129J	<6.00 E-06	<5.9 E-04
134Cs	0.00358	0.352
137Cs	3.85	379
154Eu	<0.00113	<0.111
155Eu	<0.00842	< 0.829
226Ra	< 0.0489	<4.81
<sup>237</sup> Np	<2.78 E-04	< 0.0274
238Pu	<3.97 E-05	< 0.0039
<sup>239/240</sup> Pu	<3.58 E-05	< 0.0035
<sup>241</sup> Am	<1.44 E-04	< 0.0142
<sup>243/244</sup> Cm	<1.56 E-04	< 0.0154

# Table D3-2. Supernatant Concentrations for Radionuclides near the Surface Level and Inventory Estimates in Tank 241-AP-104 as of January 1996.

<sup>a</sup> Decayed to January 1, 1994 <sup>b</sup> Based on a supernatant volume of 98.4 kL (26 kgal).

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

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-A-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.

Inventories based on a subset of samples taken during the January 1996 sampling event. should serve as the basis for the best estimate inventory to tank 241-AP-104 for the following reasons:

- 1. The January 1996, sampling event provides the most recent data for the waste.
- 2. Most of the waste in the tank when it was sampled was later removed, leaving only a small waste heel of supernatant that had been the top portion of the waste before the transfer took place.
- 3. The HDW model estimates have been invalidated due to transfers into and out of the tank subsequent to the HDW model cutoff date of January 1, 1994.

Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valence of other analytes. This charge balance approach is consistent with that used by Agnew et al. (1997). In this case, this approach required some anion analyte (e.g. nitrite, sulfate, phosphate or nitrate) inventories be adjusted to achieve the charge balance. The nitrate inventory estimate was reduced from 289 kg to 275 kg to bring the total hydroxide up from a -5.22 kg up to 0 kg. The analytical data led to an inventory estimate of 45.5 kg. The imbalance in the hydroxide calculation strongly suggests that the selection analyte concentration values was flawed.

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 <sup>90</sup>Sr, <sup>137</sup>Cs, <sup>239/240</sup>Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as <sup>60</sup>Co, <sup>99</sup>Tc, <sup>129</sup>I, <sup>154</sup>Eu, <sup>155</sup>Eu, and <sup>241</sup>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.

Best-basis inventory estimates for tank 241-AP-104 are 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.	<b>Best-Basis</b>	Inventory	Estimates	for	Nonradi	oactive Comp	oonents in
Ta	ank 241-AP	-104 (Effe	ctive April	30	, 1997).	(2 Sheets)	1.1

Analyte	Supernatant inventory (kg)	Basis (S, M, E or C) <sup>1</sup>	Comment
Al	4.06	S	
Bi	0	М	
Ca	11.2	M/E	
Cl ·	3.51	M/E	
TIC as CO <sub>3</sub>	288	S	
Cr	1.68	S	
F	11.1	S	-
Fe	< 0.049	S	
Hg	0	М	
K	0.840	M/E	
La	0	М	
Mn	< 0.0098	S	
Na	446	S	
Ni	• 0.0321	S	
NO <sub>2</sub>	107	S	
NO <sub>3</sub>	275	S/C	Nitrate value reduced from 289 kg to 275 kg in order to raise total hydroxide value to 0.
OHTOTAL	0	С	
Pb	0	М	
PO <sub>4</sub>	64.6	S	
Si	1.98	S	
SO4	55.1	S	
Sr	0	М	
TOC	11.6	S	
UTOTAL	3.27	S	

Table D4-1.	<b>Best-Basis</b>	Inventory	Estimates	for	Nonradio	pactive Compone	ents in
Ta	nk 241-AP	-104 (Effe	ctive April	30,	, 1997).	(2 Sheets)	

Analyte	Supernatant inventory (kg)	Basis (S, M, E or C) <sup>7</sup>	Comment
Zr	0	М	

 $^{1}S = Sample-based$ 

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

E = Engineering assessment-based

C = Calculated by charge balance; includes oxides as hydroxides, not including CO<sub>3</sub>, NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>, SO<sub>4</sub>, and SiO<sub>3</sub>.

Table D4-2.	Best-Basis Inventory Estimates for Radioactive Components in	
Tank 241-AP-104	Decayed to January 1, 1994 (Effective April 30, 1997). (2 Shee	ts)

Analyte	Total inventory (Ci)	Basis (S, M, or E) <sup>1</sup>	Comment
<sup>3</sup> H	1.36	S	
14C	0.0157	S	
<sup>59</sup> Ni	0	M	
60Co	0.0403	S	
<sup>63</sup> Ni	0	М	
<sup>79</sup> Se	<3.32 E-05	S	
90Sr	8.07	S	
90Y	8.07	S	Referenced to <sup>90</sup> Sr.
<sup>93</sup> Zr	0	M	
93mNb	0	М	
99Tc	0.0712	S	
106Ru	<13.9	S	
113mCd	0	М	
125Sb	0	М	
126Sn	0	М	
<sup>129</sup> I	<5.90 E-04	S	
134Cs	0.352	S	
137Cs	372	S	
<sup>137m</sup> Ba	359.	S ·	Referenced to <sup>137</sup> Cs
<sup>151</sup> Sm	0	М	
<sup>152</sup> Eu	0	М	
154Eu	<0.111	S	
<sup>155</sup> Eu	< 0.829	S	
<sup>226</sup> Ra	<4.81	S	
<sup>227</sup> Ac	0	М	
<sup>228</sup> Ra	0	Μ.	
229Th	0	М	

Analyte	Total inventory (Ci)	Basis (S, M, or E) <sup>1</sup>	Comment
<sup>231</sup> Pa	0	М	
<sup>232</sup> Th	0	М	•
232U	0	М	
<sup>233</sup> U	0	М	
<sup>234</sup> U	0	М	
<sup>235</sup> U	0	М	
236U	0	М	
<sup>237</sup> Np	< 0.0274	S	
<sup>238</sup> Pu	< 0.0039	S	
<sup>238</sup> U	0	М	
239/240Pu	< 0.0035	S	
<sup>241</sup> Am	< 0.0142	S	
<sup>241</sup> Pu	. 0	М	
<sup>242</sup> Cm	0	М	
<sup>242</sup> Pu	0	М	
<sup>24,3</sup> Am	0	М	
<sup>243</sup> Cm	<6.16 E-04	S	4 percent of <sup>243/244</sup> Cm
244Cm	< 0.0147	S	96 percent of <sup>243/244</sup> Cm

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-104 Decayed to January 1, 1994 (Effective April 30, 1997). (2 Sheets)

 $^{1}S = Composite sample-based, no segment data$ 

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

E = Engineering assessment-based.

#### **D5.0 APPENDIX D REFERENCES**

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