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Subject: Saltstone Disposal Facility Case K Inventory Determination

Summary

The Saltstone Disposal Facility (SDF) Case K inventory determination was performed to address the known conservatisms in the *Inventory Determination of PODD/SA Radionuclides in Saltstone Disposal Valults 1 and 4 as of 9/30/10* related to the use of material balance calculations and thus the disposal inventories modeled in the SDF Performance Assessment (PA). [X-CLC-Z-00034, SRR-CWDA-2009-00017] The SDF Case K inventory determination evaluated seven radionuclides resulting in changes to the inventories modeled for four radionuclides that influence calculated Ra-226 doses. The SDF Case K inventory changes are presented in Table 1. No changes are recommended to the modeled Ni-59, Tc-99 and I-129 inventories.

Table 1: Case K Modified Inventory

Radionuclide	Vault 4 (Ci)	FDC (Ci)
Pu-238	1.0E+03	NC
U-234	1.0E+01	NC
Th-230	1.0E-02	1.3E-04
Ra-226	1.0E-03	1.3E-05

NC no change
FDC future disposal cells

Methodology

The SDF Case K inventory was developed using historical sample analyses for Tank 50. [SRNL-L3100-2011-00011, SRNL-STI-2010-00713, SRNL-STI-2010-00598, SRNL-STI-2010-00437, SRNL-STI-2010-00210, SRNL-STI-2009-00828, SRNS-TR-2008-00328, WSRC-TR-2008-00184, WSRC-TR-2008-00080, WSRC-TR-2007-00253, WSRC-TR-2007-00133, X-CLC-Z-00038, X-CLC-Z-0032, SRR-WSE-2010-00162, SRR-WSE-2010-00076, SRR-WSE-2010-00011, SRR-WSE-2009-00090, SRR-WSE-2009-00019, LWO-WSE-2009-00095, LWO-WSE-

2008-00135, LWO-WSE-2008-00067, LWO-WSE-2008-00012, SWD-SWE-99-0056] The SDF radionuclides were Ni-59, Tc-99, I-129, Ra-226, Th-230, U-234 and Pu-238. For Ni-59, Tc-99 and I-129, the objective was to confirm that the PA inventory estimate was still appropriate. [SRNS-J2100-2008-00004] For Ra-226, Th-230, U-234 and Pu-238, the purpose was to remove the conservatism from the PA inventory estimate associated with the radionuclides with an impact to the modeled Ra-226 dose. Radionuclide concentrations of salt solution feed to the Saltstone Production Facility from Tank 50 and the volume of salt solution disposed of in the SDF for each calendar year quarter are presented in Table 2.

Table 2: Tank 50 Historical Sample Analyses

Radionuclide	1Q11 pCi/ml	4Q10 pCi/ml	3Q10 pCi/ml	2Q10 pCi/ml	1Q10 pCi/ml	4Q09 pCi/ml	3Q09 pCi/ml
Ni-59	<2.4E+01	<2.5E-01	<3.3E-01	<1.1E-01	<1.0E+01	<1.5E+01	<7.0E+00
Tc-99	3.2E+04	2.8E+04	3.0E+04	3.3E+04	3.1E+04	2.9E+04	2.4E+04
I-129	6.1E+00	5.7E+00	8.0E+00	4.5E+00	5.4E+00	5.7E+00	5.2E+00
Ra-226	<3.3E+01	<2.0E+01	<1.6E+01	<3.7E+01	<2.6E+01	<2.2E+01	<1.8E+01
Th-230	<8.2E+03	<6.6E+02	<1.3E+03	<4.1E+02	<1.5E+02	<2.3E+02	<9.5E+02
U-234	<1.1E+03	<9.7E+01	<2.0E+02	1.5E+02	1.4E+02	2.1E+02	1.9E+02
Pu-238	1.5E+04	3.0E+04	2.0E+04	2.2E+04	2.8E+03	8.5E+03	3.6E+03
Total Volume (gal)	4.2E+05	1.9E+05	1.4E+05	2.7E+05	9.5E+04	5.1E+05	3.5E+05

Radionuclide	2Q09[a] pCi/ml	1Q09[a] pCi/ml	2Q08[a] pCi/ml	1Q08 pCi/ml	4Q07 pCi/ml	2Q07[a] pCi/ml	4Q06[a] pCi/ml
Ni-59	<1.8E+01	<1.4E+02	<6.7E+01	<6.7E+01	<3.6E+01	<1.5E+01	<3.3E+00
Tc-99	2.8E+04	2.7E+04	2.6E+04	2.6E+04	4.4E+02	<2.6E+02	<2.5E+02
I-129	<2.0E+00	<4.2E+00	<7.2E+00	<7.2E+00	3.2E+00	<3.2E+00	<6.4E+00
Ra-226	<6.1E+02	<4.5E+02	<4.8E+02	<4.8E+02	<8.0E+02	<3.5E+02	<9.8E+02
Th-230	<2.0E+02	<4.9E+02	<7.1E+02	<7.1E+02	<3.6E+02	<1.1E+02	<3.1E+02
U-234	<1.1E+02	1.5E+02	<2.1E+02	<2.1E+02	<1.1E+02	<5.9E+01	<9.3E+01
Pu-238	1.7E+04	3.4E+04	3.2E+04	3.2E+04	1.3E+04	4.1E+02	8.7E+02
Total Volume (gal)	8.1E+05	3.6E+05	1.5E+05	4.0E+05	7.9E+05	1.8E+05	6.5E+04

[SRNL-L3100-2011-00011, SRNL-STI-2010-00713, SRNL-STI-2010-00598, SRNL-STI-2010-00437, SRNL-STI-2010-00210, SRNL-STI-2009-00828, SRNS-TR-2008-00328, WSRC-TR-2008-00184, WSRC-TR-2008-00080, WSRC-TR-2007-00253, WSRC-TR-2007-00133, X-CLC-Z-00038, X-CLC-Z-0032, SRR-WSE-2010-00162, SRR-WSE-2010-00076, SRR-WSE-2010-00011, SRR-WSE-2009-00090, SRR-WSE-2009-00019, LWO-WSE-2009-00095, LWO-WSE-2008-00135, LWO-WSE-2008-00067, LWO-WSE-2008-00012, SWD-SWE-99-0056]

[a] Sample data used was not taken during this quarter but was chosen from the quarter before or after to best represent the material disposed.

NOTE: A less than sign (<) indicated the analytical result was less than the detection limit.

It should be noted that no processing occurred during 3Q08, 4Q08, 1Q07 and 3Q07.

Alternate Methods for Ni-59 and Ra-226

Because the sample results for Ni-59 and Ra-226 were below analytical detection limit, the methodology used in *Nickel-59, Cerium-144/Praseodymium-144 and Radium-226 in Salt Feed*, was utilized. In the case of Ni-59, the approach is to utilize a Ni-59/Ni-63 activity ratio of 0.020 to a known Ni-63 concentration. [SRNL-L3100-2009-00189] Therefore, for all sampling quarters presented in Table 2, the Ni-63 sample results were used to calculate an alternate Ni-59 concentration as presented in Table 3.

Table 3: Alternate Ni-59 Concentrations

Radionuclide	1Q11 pCi/ml	4Q10 pCi/ml	3Q10 pCi/ml	2Q10 pCi/ml	1Q10 pCi/ml	4Q09 pCi/ml	3Q09 pCi/ml
Ni-63	6.9E+01	3.8E+02	2.8E+02	1.4E+02	1.8E+02	4.2E+01	6.5E+01
Ni-59	1.4E+00	7.5E+00	5.6E+00	2.8E+00	3.6E+00	8.4E-01	1.3E+00

Radionuclide	2Q09 pCi/ml	1Q09 pCi/ml	2Q08 pCi/ml	1Q08 pCi/ml	4Q07 pCi/ml	2Q07 pCi/ml	4Q06 pCi/ml
Ni-63	1.1E+02	8.2E+01	8.2E+01	2.0E+02	3.5E+02	2.6E+00	8.9E+02
Ni-59	2.1E+00	1.6E+00	1.6E+00	4.0E+00	6.9E+00	5.3E-02	1.8E+01

NOTE: Ni-63 come from same references as Table 2.

In the case of Ra-226, the approach is to calculate the Ra-226 concentration as a function of year for the Deliquification, Dissolution and Adjustment (DDA) stream using the equation 4.2E-20*exp(0.0188Y), where Y=year. [SRNL-L3100-2009-00189] The resulting alternate Ra-226 concentrations are presented in Table 4.

Table 4: Alternate Ra-226 Concentrations

Period	Ra-226 (pCi/ml)	Period	Ra-226 (pCi/ml)
1Q11	1.1E-03	**2Q09**	1.1E-03
4Q10	1.1E-03	**1Q09**	1.1E-03
3Q10	1.1E-03	**2Q08**	1.0E-03
2Q10	1.1E-03	**1Q08**	1.0E-03
1Q10	1.1E-03	**4Q07**	1.0E-03
4Q09	1.1E-03	**2Q07**	1.0E-03
3Q09	1.1E-03	**4Q06**	1.0E-03

[SRNL-L3100-2009-00189]

Using the radionuclide concentrations and volumes from Table 2, the curies of each radionuclide are determined as presented in Table 5. In addition, the alternate Ni-59 and Ra-226 are also shown. The last column in Table 5 shows the total estimated inventory of each radionuclide in SDF Vault 4.

Table 5: Radionuclide Total Curies

Radionuclide	1Q11	4Q10	3Q10	2Q10	1Q10	4Q09	3Q09	2Q09
	Ci	Ci	Ci	Ci	Ci	Ci	Ci	Ci
Ni-59	3.7E-02	1.8E-04	1.7E-04	1.1E-04	3.6E-03	2.9E-02	9.3E-03	5.5E-02
Ni-59[a]	2.2E-03	5.5E-03	2.9E-03	2.9E-03	1.3E-03	1.6E-03	1.7E-03	6.6E-03
Tc-99	5.0E+01	2.0E+01	1.6E+01	3.4E+01	1.1E+01	5.6E+01	3.2E+01	8.5E+01
I-129	9.7E-03	4.2E-03	4.2E-03	4.6E-03	2.0E-03	1.1E-02	6.8E-03	6.0E-03
Ra-226	5.2E-02	1.4E-02	8.1E-03	3.7E-02	9.3E-03	4.3E-02	2.4E-02	1.9E+00
Ra-226[a]	1.7E-06	7.9E-07	5.7E-07	1.1E-06	3.9E-07	2.1E-06	1.4E-06	3.3E-06
Th-230	1.3E+01	4.8E-01	6.8E-01	4.2E-01	5.5E-02	4.4E-01	1.3E+00	6.2E-01
U-234	1.7E+00	7.1E-02	1.0E-01	1.5E-01	5.1E-02	4.1E-01	2.5E-01	3.2E-01
Pu-238	2.4E+01	2.2E+01	1.1E+01	2.2E+01	1.0E+00	1.6E+01	4.7E+00	5.1E+01

Radionuclide	1Q09	2Q08	1Q08	4Q07	2Q07	4Q06	Vault 4 Before 3Q06	Totals
	Ci	Ci	Ci	Ci	Ci	Ci	Ci	Ci
Ni-59	1.9E-01	3.9E-02	1.0E-01	1.1E-01	1.0E-02	8.2E-04	9.1E-03	5.9E-01
Ni-59[a]	2.3E-03	9.6E-04	6.1E-03	2.1E-02	3.6E-05	4.4E-03	-	5.9E-02
Tc-99	3.7E+01	1.5E+01	3.9E+01	1.3E+00	1.8E-01	6.2E-02	2.4E+01	4.2E+02
I-129	5.7E-03	4.2E-03	1.1E-02	9.6E-03	2.2E-03	1.6E-03	8.2E-02	1.6E-01
Ra-226	6.2E-01	2.8E-01	7.2E-01	2.4E+00	2.4E-01	2.4E-01	-	6.6E+00
Ra-226[a]	1.5E-06	6.1E-07	1.6E-06	3.1E-06	7.0E-07	2.5E-07	-	1.9E-05
Th-230	6.7E-01	4.1E-01	1.1E+00	1.1E+00	7.4E-02	7.7E-02	-	2.0E+01
U-234	2.0E-01	1.2E-01	3.2E-01	3.2E-01	4.0E-02	2.3E-02	3.5E+00	7.6E+00
Pu-238	4.7E+01	1.9E+01	4.8E+01	4.0E+01	2.8E-01	2.1E-01	6.6E-01	3.1E+02

[SRNL-L3100-2009-00189, WSRC-RP-2008-00390]
[a] calculated by alternate method
\- data not available

Final Estimate

Using the current estimates for Vault 4 in Table 5, final estimates were developed. Given that the values listed in Table 5 are an estimate of the material currently present, additional material is expected. Since the goal is to develop inventories that are only to be used for one modeling case, approximations were used for the material expected to be added.

U-234 - Table 5 shows 7.6E+00 curies through 1Q11. Vault 4 is over half full although current treatment methods in the Actinide Removal Process (ARP) are expected to limit the amount of additional uranium material. Therefore a conservative value of 1.0E+01 curie was chosen for the Vault 4 inventory. There was no change to the U-234 inventory estimate for the FDCs. Since the FDCs' estimate is generally based on sample results and not a theoretical relationship, there is no new information to necessitate an adjustment.

Th-230 - Table 5 shows 2.0E+01 curies through 1Q11. This estimate is based on sample analysis that returned detection limits or has estimates that were based on detection limit values. Based on this, the inventory estimate in Table 5 is considered to be conservative. A realistic estimate was developed using in-growth of Th-230 from the delay of U-234. Based on in-growth rates, a Th-230 inventory reaches slightly greater than 1/1000 of the U-234 initial inventory after 100 years, assuming a negligible initial inventory of Th-230. [CBU-PIT-2005-00040] Since the U-234 Vault 4 inventory in this case is 7.6E+00 curies, the Th-230 inventory in Vault 4 is estimated to be 7.6E-03 curies. The U-234 inventory estimate in FDCs is 1.3E-01 curie. [SRNS-J2100-2008-00004] Based on this inventory estimate, the Th-230 inventory estimate for FDCs is 1.3E-04 curie.

Ra-226 - Table 5 shows 6.6E+00 curies and 1.9E-05 curies through 1Q11 using different methodologies. The first estimate is based on sample analysis that returned detection limits or has estimates that were based on detection limit values. Based on this, the first inventory estimate in Table 5 is considered to be conservative. The second estimate was based on in-growth of Ra-226 from the decay of U-234 and in-growth and decay of Th-230 in the salt solution feed stream. [SRNL-L3100-2009-00189] This estimate matches well with the in-growth curve of Ra-226 which estimates slightly less than 1/10000 of the U-234 initial inventory. [CBU-PIT-2005-00040] Based on in-growth rates, and the estimate from the salt solution feed stream, a nominal rate of 1/10000 of the U-234 initial inventory was used to provide a realistic estimate. Since the U-234 Vault 4 inventory in this case is 7.6E+00 curie, the Ra-226 inventory in Vault 4 is estimated to be 7.6E-04 curies. The U-234 inventory estimate in FDCs is 1.3E-01 curies. [SRNS-J2100-2008-00004] Based on this inventory estimate, the Th-230 inventory estimate for FDCs is 1.3E-05 curies.

Pu-238 - Table 5 shows 3.1E+02 curies through 1Q11. Since Vault 4 is over 50% full, the additional inventory from additions to fill the vault is expected to add less than the current inventory. To be conservative, 1.0E+03 curies was estimated for a final Vault 4 inventory estimate. There was no change to the Pu-238 inventory estimate for the FDCs. Since the FDCs' estimate is generally based on sample results and not a theoretical relationship, there is no new information to necessitate an adjustment.

Ni-59 - Table 5 shows 5.9E-02 curies through 1Q11 calculated by alternate method. Comparison of this value to the SDF PA (Table 3.3-3) value of 0.4 curies (SRR-CDWA-2009-00017) shows that the PA value is reasonably conservative; therefore, no change is justified.

Tc-99 - Table 5 shows4.2E+02 curies through 1Q11. Comparison of this value to the SDF PA (Table 3.3-3) value of 580 curies shows that the PA value is reasonably conservative; therefore, no change is justified.

I-129 - Table 5 shows 1.6E-01 curies through 1Q11. Comparison of this value to the SDF PA (Table 3.3-3) value of 0.28 curies shows that the PA value is reasonably conservation; therefore, no change is justified.

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