APPENDIX B

EMISSIONS AND MATERIALS BALANCE DATA FOR THE PROPOSED ACTION AND THE VITRIFICATION AND CEMENTATION ALTERNATIVES

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Appendix B contains details and data relevant to the proposed action and alternatives. Specifically, this appendix contains information on emissions associated with the proposed action, materials balance and emissions for the vitrification process, and similar material for the cementation alternative. Floor plans for the proposed action/preferred alternative are also included.

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APPENDIX B.1

SUMMARIES OF TRU WASTE REMEDIATION

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Table B.1-1. Summary of annualized radionuclide emissions (Ci/year) for the Proposed Action

Radionuclide	Sludge emissions	Supernate emissions	Solids emissions	Total emissions
Ac-227	0.00E+00	0.00E+00	6.55E-13	6.55E-13
Ag-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ag-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241	0.00E+00	4.99E-10	4.12E-07	4.12E-07
Am-243	0.00E+00	0.00E+00	8.37E-09	8.37E-09
Au-196	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Au-198	8.10E-06	0.00E+00	0.00E+00	810E-06
Bk-249	0.00E+00	0.00E+00	2.30E-11	2.30E-11
C-14	0.00E+00	1.24E-07	1.36E-13	1.24E-07
Ce-144	2.31E-05	1.60E-08	0.00E+00	2.31E-05
Cf-249	0.00E+00	0.00E+00	1.20E-11	1.20E-11
Cf-252	8.30E-08	6.80E-10	9.69E-09	9.34E-08
Cm-240	0.00E+00	0.00E+00	1.25E-39	1.25E-39
Cm-242	0.00E+00	0.00E+00	5.27E-08	5.27E-08
Cm-243	2.24E-05	0.00E+00	0.00E+00	2.24E-05
Cm-244	7.89E-05	9.40E-07	1.74E-06	8.16E-05
Cm-245	0.00E+00	0.00E+00	2.46E-12	2.46E-12
Cm-246	0.00E+00	0.00E+00	8.00E-15	8.00E-15
Cm-248	0.00E+00	0.00E+00	2.11E-11	2.11E-11
Co-60	7.27E-05	5.47E-07	2.36E-09	7.33E-05
Cs-134	1.06E-05	1.99E-06	0.00E+00	1.26E-05
Cs-137	1.25E-03	3.16E-04	2.36E-06	1.57E-03
Es-253	0.00E+00	0.00E+00	2.79E-44	2.79E-44
Es-254m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	2.85E-04	3.94E-06	3.71E-13	2.89E-04
Eu-154	1.51E-04	1.41E-06	0.00E+00	1.53E-04
Eu-155	4.59E-05	6.29E-07	0.00E+00	4.65E-05
Fe-59	0.00E+00	0.00E+00	1.74E-25	1.74E-25
Gd-153	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H-3	7.53E-08	1.64E-07	0.00E+00	2.40E-07
I-129	0.00E+00	1.95E-10	0.00E+00	1.95E-10
I-131	0.00E+00	0.00E+00	2.28E-100	2.28E-100
Nb-95	4.98E-06	5.29E-24	0.00E+00	4.98E-06
Ni-63	0.00E+00	0.00E+00	8.49E-14	8.49E-14
Np-237	1.69E-08	0.00E+00	6.73E-10	1.75E-08
Pa-231	0.00E+00	0.00E+00	2.52E-10	2.52E-10
Pm-147	0.00E+00	0.00E+00	6.54E-10	6.54E-10
Po-209	0.00E+00	0.00E+00	1.53E-15	1.53E-15
Pu-238	1.34E-05	5.27E-09	3.03E-06	1.65E-05
Pu-239	6.58E-06	4.53E-09	8.25E-07	7.41E-06
Pu-240	2.06E-06	4.41E-09	7.70E-07	2.84E-06
Pu-241	2.32E-05	6.74E-08	4.58E-05	6.91E-05
Pu-242	4.45E-09	2.21E-10	1.91E-10	4.86E-09
Pu-244	4.12E-10	2.60E-11	0.00E+00	4.38E-10
Ra-223	0.00E+00	0.00E+00	8.83E-76	8.83E-76
Ra-226	0.00E+00	0.00E+00	1.29E-09	1.29E-09
Ru-106	3.96E-05	8.58E-08	0.00E+00	3.97E-05
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	4.01E-03	1.26E-05	1.46E-06	4.03E-03
Tc-99	8.08E-07	1.50E-06	1.37E-07	2.44E-06

Table B.1-1 (continued)

Radionuclide	Sludge Emissions	Supernate Emissions	Solids Emissions	Total Emissions
Te-123	0.00E+00	0.00E+00	2.08E-14	2.08E-14
Te-123m	0.00E+00	0.00E+00	5.71E-19	5.71E-19
Th-230	0.00E+00	0.00E+00	9.63E-15	9.63E-15
Th-232	5.61E-08	5.20E-11	1.43E-12	5.62E-08
U-232	0.00E+00	2.47E-08	2.36E-10	2.49E-08
U-233	4.64E-06	1.86E-07	8.45E-08	4.91E-06
U-234	2.06E-06	3.77E-09	1.33E-08	2.08E-06
U-235	5.39E-08	1.56E-10	5.95E-12	5.41E-08
U-236	4.49E-09	9.11E-11	7.78E-14	4.58E-09
U-238	2.05E-06	4.97E-09	3.48E-11	2.05E-06
U-239	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	0.00E+00	2.65E-286	2.65E-286
Zn-65	0.00E+00	0.00E+00	2.44E-15	2.44E-15
Zr-95	5.71E-05	1.85E-16	0.00E+00	5.71E-05
Total radionuclides	6.12E-03	3.40E-04	5.67E-05	6.52E-03

Ci = curie.

Table B.1-2. Estimated radionuclide emissions for TRU waste treatment of sludge for the Proposed Action

Radionuclide	Radionuclide composition[a] (Bq/g)	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide Emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Radionuclide emissions after control: Annualized[f] (Ci/year)
Ac-227	0		2.18E+01				0.00E+00
Ag-110	0		7.80E-07				0.00E+00
Ag-110m	0		6.84E-01				0.00E+00
Am-241			4.32E+02		0.00E+00	0.00E+00	0.00E+00
Am-243	0		7.37E+03				0.00E+00
Au-196	0		1.69E-02				0.00E+00
Au-198	3732.39	1.01E-07	7.38E-03	1.01E-07	1.01E-01	1.01E-05	8.10E-06
Bk-249	0		8.76E-01				0.00E+00
C-14	0		5.73E+03				0.00E+00
Ce-144	10647.08	2.88E-07	7.80E-01	2.88E-07	2.89E-01	2.89E-05	2.31E-05
Cf-249	0		3.51E+02				0.00E+00
Cf-252	38.27	1.03E-09	2.65E+00	1.03E-09	1.04E-03	1.04E-07	8.30E-08
Cm-240	0		7.39E-02				0.00E+00
Cm-242	0		1.63E+02				0.00E+00
Cm-243	10330.07	2.79E-07	2.91E+01	2.79E-07	2.80E-01	2.80E-05	2.24E-05
Cm-244	36370.20	9.83E-07	1.81E+01	9.83E-07	9.86E-01	9.86E-05	7.89E-05
Cm-245	0		8.50E+03				0.00E+00
Cm-246	0		4.73E+03				0.00E+00
Cm-248	0		3.40E+05				0.00E+00
Co-60	33519.35	9.06E-07	5.27E+00	9.06E-07	9.09E-01	9.09E-05	7.27E-05
Cs-134	4893.24	1.32E-07	2.06E+00	1.32E-07	1.33E-01	1.33E-05	1.06E-05
Cs-137	577076.13	1.56E-05	3.01E+01	1.56E-05	1.56E+01	1.56E-03	1.25E-03
Es-253	0		5.60E-02				0.00E+00
Es-254m	0		4.48E-03				0.00E+00
Eu-152	131531.25	3.55E-06	1.35E+01	3.55E-06	3.57E+00	3.57E-04	2.85E-04
Eu-154	69723.86	1.88E-06	8.59E+00	1.88E-06	1.89E+00	1.89E-04	1.51E-04
Eu-155	21166.34	5.72E-07	4.76E+00	5.72E-07	5.74E-01	5.74E-05	4.59E-05
Fe-59	0		1.22E-01				0.00E+00
Gd-153	0		6.61E-01				0.00E+00
H-3	34.73	9.39E-10	1.23E+01	9.39E-10	9.42E-04	9.42E-08	7.53E-08
I-129	0		1.57E+07				0.00E+00
I-131	0		2.20E-02				0.00E+00
Nb-95	2296.02	6.21E-08	9.58E-02	6.21E-08	6.23E-02	6.23E-06	4.98E-06
Ni-63	0		1.00E+02				0.00E+00
Np-237	7.77	2.10E-10	2.14E+06	2.10E-10	2.11E-04	2.11E-08	1.69E-08
Pa-231	0		3.28E+04				0.00E+00
Pm-147	0		2.62E+00				0.00E+00
Po-209	0		1.02E+02				0.00E+00
Pu-238	6198.78	1.68E-07	8.77E+01	1.68E-07	1.68E-01	1.68E-05	1.34E-05
Pu-239	3031.95	8.19E-08	2.41E+04	8.19E-08	8.22E-02	8.22E-06	6.58E-06
Pu-240	950.28	2.57E-08	6.56E+03	2.57E-08	2.58E-02	2.58E-06	2.06E-06
Pu-241	10716.94	2.90E-07	1.44E+01	2.90E-07	2.91E-01	2.91E-05	2.32E-05
Pu-242	2.05	5.54E-11	3.73E+05	5.54E-11	5.56E-05	5.56E-09	4.45E-09
Pu-244	0.19	5.14E-12	8.00E+05	5.14E-12	5.15E-06	5.15E-10	4.12E-10
Ra-223	0		3.13E-02				0.00E+00
Ra-226	0		1.60E+03				0.00E+00
Ru-106	18256.71	4.93E-07	1.02E+00	4.93E-07	4.95E-01	4.95E-05	3.96E-05
Sb-125	0		2.76E+00				0.00E+00
Sr-90	1850860.69	5.00E-05	2.88E+01	5.00E-05	5.02E+01	5.02E-03	4.01E-03
Tc-99	372.46	1.01E-08	2.11E+05	1.01E-08	1.01E-02	1.01E-06	8.08E-07
Te-123	0		1.00E+08				0.00E+00
Te-123m	0		3.28E-01				0.00E+00
Th-230	0		7.54E+04				0.00E+00
Th-232	25.88	6.99E-10	1.41E+10	6.99E-10	7.02E-04	7.02E-08	5.61E-08
U-232	0		6.89E+01				0.00E+00
U-233	2136.82	5.78E-08	1.59E+05	5.78E-08	5.79E-02	5.79E-06	4.64E-06
U-234	950.46	2.57E-08	2.46E+05	2.57E-08	2.58E-02	2.58E-06	2.06E-06

Table B.1-2 (continued)

Radionuclide	Radionuclide composition[a] (Bq/g)	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide Composition (Ci/g)	Uncontrolled[c,d] radionuclide Emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Radionuclide emissions after control: Annualized[f] (Ci/year)
U-235	24.86	6.72E-10	3.80E+06	6.72E-10	6.74E-04	6.74E-08	5.39E-08
U-236	2.07	5.59E-11	2.34E+07	5.59E-11	5.61E-05	5.61E-09	4.49E-09
U-238	943.56	2.55E-08	4.47E+09	2.55E-08	2.56E-02	2.56E-06	2.05E-06
U-239	0		4.46E-05				0.00E+00
Y-90	0		7.31E-03				0.00E+00
Zn-65	0		6.69E-01				0.00E+00
Zr-95	26302.35	7.11E-07	1.75E-01	7.11E-07	7.13E-01	7.13E-05	5.71E-05
Total							6.12E-03

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Number ORNL/TM-13351.

[b]The amount of curies present for each radionuclide is reduced by the corresponding half life to account for the species decay. The equation for estimating radionuclide decay is:

$$A = A_o \times \exp -[\ln(2) / t_{1/2} * T] .$$

The half-life of each radionuclide was obtained from the web site www.dne.bnl.gov/CoN/index.html.

T is the time between the time of sample analysis (December 1996) to the time of process startup (January 2003):

T = 6.08 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Sludge Processing Rate × Emissions Factor × Composition.

The processing rate and the operating schedule obtained from the FWEC proposal are:

Total Sludge Processing Rate = 1,003,256 kg for 15 months
Total Project Life = 15 months life

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

High-Efficiency Particulate Air (HEPA)
Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by the following equation:

Annualized Emissions = Total Emissions × 12 months/Total Project Life.

*Emissions of ^{241}Am were calculated as a decay product of ^{241}Pu by the following equation:

$$A_{Am241} = \frac{\lambda_{Am241} \times A_{Pu241} \times \left(e^{-\lambda_{Pu241}T} - e^{-\lambda_{Am241}T}\right)}{\lambda_{Am241} - \lambda_{Pu241}}$$

where $\lambda = \ln(2)/t_{1/2}$.

Bq = becquerel.
Ci = curie.
g = gram.
TRU = transuranic.

Table B.1-3. Estimated radionuclide emissions for waste treatment of supernate for the Proposed Action

Radionuclide	Radionuclide composition[a] (Bq/mL)	(Bq/g)	(Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	0			2.18E+01				0.00E+00
Ag-110	0			7.80E-07				0.00E+00
Ag-110m	0			6.84E-01				0.00E+00
Am-241				4.32E+02		6.24E-06	6.24E-10	4.99E-10
Am-243	0			7.37E+03				0.00E+00
Au-196	0			1.69E-02				0.00E+00
Au-198	0			7.38E-03				0.00E+00
Bk-249	0			8.76E-01				0.00E+00
C-14	95.45	83.00	2.24E-09	5.73E+03	2.24E-09	1.55E-03	1.55E-07	1.24E-07
Ce-144	1305.38	1135.11	3.07E-08	7.80E-01	2.89E-10	2.00E-04	2.00E-08	1.60E-08
Cf-249	0			3.51E+02				0.00E+00
Cf-252	2.07	1.80	4.86E-11	2.65E+00	1.23E-11	8.50E-06	8.50E-10	6.80E-10
Cm-240	0			7.39E-02				0.00E+00
Cm-242	0			1.63E+02				0.00E+00
Cm-243	0			2.91E+01				0.00E+00
Cm-244	883.44	768.21	2.08E-08	1.81E+01	1.70E-08	1.18E-02	1.18E-06	9.40E-07
Cm-245	0			8.50E+03				0.00E+00
Cm-246	0			4.73E+03				0.00E+00
Cm-248	0			3.40E+05				0.00E+00
Co-60	838.97	729.54	1.97E-08	5.27E+00	9.89E-09	6.84E-03	6.84E-07	5.47E-07
Cs-134	8903.12	7741.84	2.09E-07	2.06E+00	3.59E-08	2.49E-02	2.49E-06	1.99E-06
Cs-137	273946.86	238214.66	6.44E-06	3.01E+01	5.70E-06	3.95E+00	3.95E-04	3.16E-04
Es-253	0			5.60E-02				0.00E+00
Es-254m	0			4.48E-03				0.00E+00
Eu-152	3959.72	3443.23	9.31E-08	1.35E+01	7.11E-08	4.92E-02	4.92E-06	3.94E-06
Eu-154	1651.86	1436.40	3.88E-08	8.59E+00	2.54E-08	1.76E-02	1.76E-06	1.41E-06
Eu-155	1037.85	902.48	2.44E-08	4.76E+00	1.14E-08	7.86E-03	7.86E-07	6.29E-07
Fe-59	0			1.22E-01				0.00E+00
Gd-153	0			6.61E-01				0.00E+00
H-3	169.53	147.42	3.98E-09	1.23E+01	2.97E-09	2.05E-03	2.05E-07	1.64E-07
I-129	0.15	0.13	3.53E-12	1.57E+07	3.53E-12	2.44E-06	2.44E-10	1.95E-10
I-131	0			2.20E-02				0.00E+00
Nb-95	129.69	112.77	3.05E-09	9.58E-02	9.55E-26	6.61E-20	6.61E-24	5.29E-24
Ni-63	0			1.00E+02				0.00E+00
Np-237	0			2.14E+06				0.00E+00
Pa-231	0			3.28E+04				0.00E+00
Pm-147	0			2.62E+00				0.00E+00
Po-209	0			1.02E+02				0.00E+00
Pu-238	4.22	3.67	9.92E-11	8.77E+01	9.51E-11	6.58E-05	6.58E-09	5.27E-09
Pu-239	3.48	3.03	8.18E-11	2.41E+04	8.18E-11	5.66E-05	5.66E-09	4.53E-09
Pu-240	3.39	2.95	7.97E-11	6.56E+03	7.96E-11	5.51E-05	5.51E-09	4.41E-09
Pu-241	66.80	58.09	1.57E-09	1.44E+01	1.22E-09	8.43E-04	8.43E-08	6.74E-08
Pu-242	0.17	0.15	4.00E-12	3.73E+05	4.00E-12	2.76E-06	2.76E-10	2.21E-10
Pu-244	0.02	0.02	4.70E-13	8.00E+05	4.70E-13	3.25E-07	3.25E-11	2.60E-11
Ra-223	0			3.13E-02				0.00E+00
Ra-226	0			1.60E+03				0.00E+00
Ru-106	2314.29	2012.43	5.44E-08	1.02E+00	1.55E-09	1.07E-03	1.07E-07	8.58E-08
Sb-125	0			2.76E+00				0.00E+00
Sr-90	11018.92	9581.67	2.59E-07	2.88E+01	2.28E-07	1.58E-01	1.58E-05	1.26E-05
Tc-99	1149.98	999.98	2.70E-08	2.11E+05	2.70E-08	1.87E-02	1.87E-06	1.50E-06
Te-123	0			1.00E+08				0.00E+00
Te-123m	0			3.28E-01				0.00E+00
Th-230	0			7.54E+04				0.00E+00
Th-232	0.04	0.03	9.40E-13	1.41E+10	9.40E-13	6.51E-07	6.51E-11	5.20E-11
U-232	20.00	17.39	4.70E-10	6.89E+01	4.46E-10	3.09E-04	3.09E-08	2.47E-08
U-233	143.14	124.47	3.36E-09	1.59E+05	3.36E-09	2.33E-03	2.33E-07	1.86E-07
U-234	2.90	2.52	6.82E-11	2.46E+05	6.82E-11	4.72E-05	4.72E-09	3.77E-09
U-235	0.12	0.10	2.82E-12	3.80E+06	2.82E-12	1.95E-06	1.95E-10	1.56E-10
U-236	0.07	0.06	1.65E-12	2.34E+07	1.65E-12	1.14E-06	1.14E-10	9.11E-11
U-238	3.82	3.32	8.98E-11	4.47E+09	8.98E-11	6.21E-05	6.21E-09	4.97E-09
U-239	0			4.46E-05				0.00E+00
Y-90	0			7.31E-03				0.00E+00

Table B.1-3 (continued)

Radionuclide	Radionuclide composition[a] (Bq/mL)	(Bq/g)	(Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Annualized[f] (Ci/year)
Zn-65	0			6.69E-01				0.00E+00
Zr-95	147.69	128.43	3.47E-09	1.75E-01	3.34E-18	2.31E-12	2.31E-16	1.85E-16
Total								3.40E-04

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Supernatant Liquids at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Number ORNL/TM-13551, Addendum 1. An average density value for supernate was obtained from Table 4.1, p. 3, of the above report to calculate a mass faction for each metal.

Supernate Density = 1.15 g/mL.

[b]The amount of curies present for each radionuclide is reduced by the corresponding half-life to account for the species decay. The equation for estimating radionuclide decay is:

$$A = A_o \times \exp -[\ln(2) / t_{1/2} * T].$$

The half-life of each radionuclide was obtained from the web site www.dne.bnl.gov/CoN/index.html.

T is the time between the time of sample analysis (October 1997) to the time of process startup (January 2003):

T = 5.25 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Sludge Processing Rate × Emissions Factor × Composition.

The processing rate and the operating schedule obtained from the FWEC proposal are:

Total Supernate Processing Rate = 692,000 kg for 15 months
Total Project Life = 15 months life

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

High-Efficiency Particulate Air (HEPA)
Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by the following equation:

Annualized Emissions = Total Emissions × 12 months/Total Project Life.

*Emissions of ^{241}Am were calculated as a decay product of ^{241}Pu by the following equation:

$$A_{Am241} = \frac{\lambda_{Am241} \times A_{Pu241} \times \left(e^{-\lambda_{Pu241}T} - e^{-\lambda_{Am241}T}\right)}{\lambda_{Am241} - \lambda_{Pu241}}$$

where $\lambda = \ln(2)/t_{1/2}$.

Bq = becquerel.
Ci = curie.
g = gram.
mL = milliliter.

Table B.1-4. Estimated radionuclide emissions for TRU waste treatment of solids for the Proposed Action

Radionuclide	Radionuclide[a] composition (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.01E-03	2.18E+01	8.19E-04	8.19E-07	8.19E-13	6.55E-13
Ag-110	0.00E+00	7.80E-07				0.00E+00
AG-110m	0.00E+00	6.84E-01				0.00E+00
Am-241		4.32E+02		5.14E-01	5.14E-07	4.12E-07
Am-243	1.05E+01	7.37E+03	1.05E+01	1.05E-02	1.05E-08	8.37E-09
Au-196	0.00E+00	1.69E-02				0.00E+00
Au-198	0.00E+00	7.38E-03				0.00E+00
Bk-249	5.25E+00	8.76E-01	2.87E-02	2.87E-05	2.87E-11	2.30E-11
C-14	1.70E-04	5.73E+03	1.70E-04	1.70E-07	1.70E-13	1.36E-13
Ce-144	0.00E+00	7.80E-01				0.00E+00
Cf-249	1.52E-02	3.51E+02	1.50E-02	1.50E-05	1.50E-11	1.20E-11
Cf-252	6.80E+01	2.65E+00	1.21E+01	1.21E-02	1.21E-08	9.69E-09
Cm-240	1.00E-03	7.39E-02	1.56E-30	1.56E-33	1.56E-39	1.25E-39
Cm-242	6.77E+01	1.63E+02	6.59E+01	6.59E-02	6.59E-08	5.27E-08
Cm-243	0.00E+00	2.91E+01				0.00E+00
Cm-244	2.79E+03	1.81E+01	2.17E+03	2.17E+00	2.17E-06	1.74E-06
Cm-245	3.07E-03	8.50E+03	3.07E-03	3.07E-06	3.07E-12	2.46E-12
Cm-246	1.00E-05	4.73E+03	9.99E-06	9.99E-09	9.99E-15	8.00E-15
Cm-248	2.63E-02	3.40E+05	2.63E-02	2.63E-05	2.63E-11	2.11E-11
Co-60	7.01E+00	5.27E+00	2.95E+00	2.95E-03	2.95E-09	2.36E-09
Cs-134	0.00E+00	2.06E+00				0.00E+00
Cs-137	3.43E+03	3.01E+01	2.95E+03	2.95E+00	2.95E-06	2.36E-06
Es-253	8.00E+00	5.60E-02	3.49E-35	3.49E-38	3.49E-44	2.79E-44
Es-254m	1.09E+01	4.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	6.50E-04	1.35E+01	4.64E-04	4.64E-07	4.64E-13	3.71E-13
Eu-154	0.00E+00	8.59E+00				0.00E+00
Eu-155	0.00E+00	4.76E+00				0.00E+00
Fe-59	4.01E+00	1.22E-01	2.18E-16	2.18E-19	2.18E-25	1.74E-25
Gd-153	0.00E+00	6.61E-01				0.00E+00
H-3	0.00E+00	1.23E+01				0.00E+00
I-129	0.00E+00	1.57E+07				0.00E+00
I-131	5.00E-01	2.20E-02	2.84E-91	2.84E-94	2.84E-100	2.28E-100
Nb-95	0.00E+00	9.58E-02				0.00E+00
Ni-63	1.11E-04	1.00E+02	1.06E-04	1.06E-07	1.06E-13	8.49E-14
Np-237	8.41E-01	2.14E+06	8.41E-01	8.41E-04	8.41E-10	6.73E-10
Pa-231	3.15E-01	3.28E+04	3.15E-01	3.15E-04	3.15E-10	2.52E-10
Pm-147	4.65E+00	2.62E+00	8.17E-01	8.17E-04	8.17E-10	6.54E-10
Po-209	2.00E-06	1.02E+02	1.91E-06	1.91E-09	1.91E-15	1.53E-15
Pu-238	3.99E+03	8.77E+01	3.79E+03	3.79E+00	3.79E-06	3.03E-06
Pu-239	1.03E+03	2.41E+04	1.03E+03	1.03E+00	1.03E-06	8.25E-07
Pu-240	9.63E+02	6.56E+03	9.63E+02	9.63E-01	9.63E-07	7.70E-07
Pu-241	7.86E+04	1.44E+01	5.72E+04	5.72E+01	5.72E-05	4.58E-05
Pu-242	2.39E-01	3.73E+05	2.39E-01	2.39E-04	2.39E-10	1.91E-10
Pu-244	0.00E+00	8.00E+05				0.00E+00
Ra-223	2.20E-03	3.13E-02	1.10E-66	1.10E-69	1.10E-75	8.83E-76
Ra-226	1.61E+00	1.60E+03	1.61E+00	1.61E-03	1.61E-09	1.29E-09
Ru-106	0.00E+00	1.02E+00				0.00E+00
Sb-125	0.00E+00	2.76E+00				0.00E+00
Sr-90	2.13E+03	2.88E+01	1.82E+03	1.82E+00	1.82E-06	1.46E-06
Tc-99	1.71E+02	2.11E+05	1.71E+02	1.71E-01	1.71E-07	1.37E-07
Te-123	2.60E-05	1.00E+08	2.60E-05	2.60E-08	2.60E-14	2.08E-14
Te-123m	7.95E-04	3.28E-01	7.14E-10	7.14E-13	7.14E-19	5.71E-19
Th-230	1.20E-05	7.54E+04	1.20E-05	1.20E-08	1.20E-14	9.63E-15
Th-232	1.79E-03	1.41E+10	1.79E-03	1.79E-06	1.79E-12	1.43E-12
U-232	3.15E-01	6.89E+01	2.95E-01	2.95E-04	2.95E-10	2.36E-10
U-233	1.06E+02	1.59E+05	1.06E+02	1.06E-01	1.06E-07	8.45E-08
U-234	1.67E+01	2.46E+05	1.67E+01	1.67E-02	1.67E-08	1.33E-08
U-235	7.44E-03	3.80E+06	7.44E-03	7.44E-06	7.44E-12	5.95E-12
U-236	9.73E-05	2.34E+07	9.73E-05	9.73E-08	9.73E-14	7.78E-14
U-238	4.35E-02	4.47E+09	4.35E-02	4.35E-05	4.35E-11	3.48E-11
U-239	0.00E+00	4.46E-05				0.00E+00
Y-90	3.40E-06	7.31E-03	3.31E-277	3.31E-280	3.31E-286	2.65E-286

Table B.1-4 (continued)

Radionuclide	Radionuclide[a] composition (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Zn-65	2.80E-03	6.69E-01	3.05E-06	3.05E-09	3.05E-15	2.44E-15
Zr-95	0.00E+00	1.75E-01				0.00E+00
Total						5.67E-05

[a]Composition data obtained from U.S. Department of Energy Memorandum: "TRU Waste Baseline Inventory Report for Oak Ridge," June 1996.

[b]The amount of curies present for each radionuclide is reduced by the corresponding half-life to account for the species decay. The equation for estimating radionuclide decay is:

$$A = A_o \times \exp -[\ln(2) / t_{1/2} * T].$$

The half-life of each radionuclide was obtained from the web site www.dne.bnl.gov/CoN/index.html.

T is the time between the time of sample analysis (June 1996) to the time of process startup (January 2003):

T = 6.58 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor	= 0.01
Glovebox/Hot Cell Carbon Filters Adjustment Factor	= 0.10
HEPA Filters System 1 Adjustment Factor	= 0.01
HEPA Filters System 2 Adjustment Factor	= 0.01

Note that no emissions reduction credit is taken for the carbon system, since this factor only applied to iodine gas and no iodine is present in the solid waste.

[f]The annualized emissions are calculated by the following equation:

Annualized Emissions = Total Emissions × 12 months/15-month Project Life.

*Emissions of ^{241}Am were calculated as a decay product of ^{241}Pu by the following equation:

$$A_{Am241} = \frac{\lambda_{Am241} \times A_{Pu241} \times \left(e^{-\lambda_{Pu241}T} - e^{-\lambda_{Am241}T}\right)}{\lambda_{Am241} - \lambda_{Pu241}}$$

where $l = \ln(2) / t_{1/2}$.

Ci = curie.

TRU = transuranic.

Table B.1-5. CAP.88-PC Exposure modeling results summary for the Proposed Action

Radionuclide	Total emissions (Ci/year)	Effective dose equivalent (mrem/year)	Total lifetime fatal cancer risk
Ac-227	6.55E-13	8.97E-11	5.80E-16
Ag-110	0.00E+00	0.00E+00	0.00E+00
Ag-110m	0.00E+00	0.00E+00	0.00E+00
Am-241	5.58E-07	7.63E-05	3.87E-10
Am-243	8.37E-09	1.17E-06	6.24E-12
Au-196	0.00E+00		
Au-198	5.25E-254		
Bk-249	2.30E-11		
C-14	1.24E-07	4.35E-10	1.06E-14
Ce-144	1.20E-07	6.59E-08	9.17E-13
Cf-249	1.20E-11		
Cf-252	2.72E-08	8.45E-07	9.51E-12
Cm-240	1.25E-39		
Cm-242	5.27E-08	1.84E-07	1.82E-12
Cm-243	1.94E-05	1.84E-03	1.20E-08
Cm-244	6.52E-05	4.60E-03	2.76E-08
Cm-245	2.46E-12	3.56E-10	1.95E-15
Cm-246	8.00E-15	1.10E-12	5.30E-18
Cm-248	2.11E-11	1.07E-08	5.19E-14
Co-60	3.32E-05	8.37E-04	2.04E-08
Cs-134	3.37E-06	3.77E-05	9.40E-10
Cs-137	1.41E-03	4.90E-03	1.28E-07
Es-253	2.79E-44		
Es-254m	0.00E+00		
Eu-152	2.13E-04	5.34E-03	1.27E-07
Eu-154	9.40E-05	1.85E-03	4.42E-08
Eu-155	1.96E-05	1.44E-05	3.09E-10
Fe-59	1.74E-25	7.92E-26	1.78E-30
Gd-153	0.00E+00		
H-3	2.18E-07	1.31E-11	3.55E-16
I-129	1.95E-10	6.42E-09	3.74E-14
I-131	2.28E-100	0.00E+00	0.00E+00
Nb-95	5.66E-24	2.19E-24	3.61E-29
Ni-63	8.49E-14	2.56E-15	4.58E-20
Np-237	1.75E-08	2.44E-06	1.24E-11
Pa-231	2.52E-10	3.76E-08	1.31E-13
Pm-147	6.54E-10	2.21E-11	3.14E-16
Po-209	1.53E-15		
Pu-238	1.59E-05	1.74E-03	9.63E-09
Pu-239	7.41E-06	9.00E-04	4.70E-09
Pu-240	2.83E-06	3.43E-04	1.80E-09
Pu-241	6.32E-05	1.50E-04	5.68E-10
Pu-242	4.86E-09	5.62E-07	2.93E-12
Pu-244	4.38E-10	5.01E-08	2.66E-13
Ra-223	8.83E-76	0.00E+00	0.00E+00
Ra-226	1.29E-09	4.50E-08	2.49E-13
Ru-106	7.28E-07	5.19E-07	8.24E-12
Sb-125	0.00E+00	0.00E+00	0.00E+00
Sr-90-	3.48E-03	3.98E-02	6.70E-07
Tc-99	2.44E-06	5.04E-06	1.83E-10

Table B.1-5 (continued)

Radionuclide	Total emissions (Ci/year)	Effective dose equivalent (mrem/year)	Total lifetime fatal cancer risk
Te-123	2.08E-14		
Te-123m	5.71E-19		
Th-230	9.63E-15	2.46E-13	1.42E-18
Th-232	5.62E-08	1.69E-06	7.95E-12
U-232	2.49E-08	2.51E-06	1.40E-11
U-233	4.91E-06	1.74E-04	1.16E-09
U-234	2.08E-06	7.32E-05	4.86E-10
U-235	5.41E-08	2.43E-06	2.66E-11
U-236	4.58E-09	1.52E-07	1.01E-12
U-238	2.05E-06	6.47E-05	4.56E-10
U-239	0.00E+00		
Y-90	2.65E-286	0.00E+00	0.00E+00
Zn-65	2.44E-15	7.45E-15	1.93E-19
Zr-95	2.22E-15	8.36E-16	1.78E-20
Totals	5.44E-03	6.28E-02	1.05E-06

Ci = curie.
mrem = millirem.

Table B.1-6. Summary of TRU waste treatment hourly particulate emissions (lbs/h) for the Proposed Action

Particulate contaminant	Classification	Average hourly emissions (lbs/h)				Maximum[a] hourly emissions (lbs/h)	Average[b] annual emissions (tons/year)
		Sludge	Supernate	Solids	Total		
TSP		3.43E-01	3.43E-01	3.43E-03	6.89E-01	8.61E-01	2.07E+00
Total HAP		3.81E-04	4.83E-06	2.23E-08	3.86E-04	4.82E-04	1.16E-03
Antimony (Sb)	HAP	9.36E-06	2.95E-07	0.00E+00	9.66E-06	1.21E-05	2.90E-05
Arsenic (As)	HAP	5.89E-06	5.99E-07	0.00E+00	6.49E-06	8.11E-06	1.95E-05
Beryllium (Be)	HAP	6.27E-07	2.98E-09	0.00E+00	6.30E-07	7.88E-07	1.89E-06
Cadmium (Cd)	HAP	3.15E-06	1.16E-07	2.02E-09	3.27E-06	4.09E-06	9.82E-06
Chromium (Cr)	HAP	1.16E-04	2.03E-06	0.00E+00	1.18E-04	1.47E-04	3.53E-04
Cobalt (Co)	HAP	1.25E-06	4.77E-08	0.00E+00	1.30E-06	1.62E-06	3.89E-06
Lead (Pb)	HAP	1.58E-04	7.54E-07	1.82E-08	1.59E-04	1.99E-04	4.78E-04
Manganese (Mn)	HAP	3.57E-05	9.84E-08	0.00E+00	3.58E-05	4.48E-05	1.07E-04
Mercury (Hg)	HAP	2.25E-05	2.36E-07	2.02E-09	2.27E-05	2.84E-05	6.82E-05
Nickel (Ni)	HAP	2.17E-05	3.67E-07	0.00E+00	2.21E-05	2.76E-05	6.63E-05
Selenium (Se)	HAP	6.42E-06	2.80E-07	0.00E+00	6.70E-06	8.38E-06	2.01E-05
Aluminum (Al)		2.75E-03	4.20E-06	0.00E+00	2.75E-03	3.44E-03	8.25E-03
Barium (Ba)		3.21E-05	5.46E-07	0.00E+00	3.27E-05	4.08E-05	9.80E-05
Bismuth (Bi)		0.00E+00	8.05E-07	0.00E+00	8.05E-07	1.01E-06	2.41E-06
Boron (B)		4.29E-06	3.76E-07	0.00E+00	4.66E-06	5.83E-06	1.40E-05
Calcium (Ca)		8.26E-03	4.07E-04	0.00E+00	8.67E-03	1.08E-02	2.60E-02
Cerium (Ce)		0.00E+00	1.10E-07	0.00E+00	1.10E-07	1.38E-07	3.31E-07
Cesium (Cs)		1.36E-06	5.37E-07	0.00E+00	1.89E-06	2.37E-06	5.68E-06
Copper (Cu)		1.83E-05	2.56E-07	0.00E+00	1.86E-05	2.33E-05	5.58E-05
Gallium (Ga)		0.00E+00	9.84E-08	0.00E+00	9.84E-08	1.23E-07	2.95E-07
Iodine (I)		0.00E+00	4.41E-06	0.00E+00	4.41E-06	5.51E-06	1.32E-05
Iron (Fe)		1.48E-03	3.25E-06	0.00E+00	1.48E-03	1.86E-03	4.45E-03
Lanthanum (La)		0.00E+00	1.19E-08	0.00E+00	1.19E-08	1.49E-08	3.58E-08
Lithium (Li)		0.00E+00	7.96E-06	0.00E+00	7.96E-06	9.95E-06	2.39E-05
Magnesium (Mg)		1.39E-03	5.32E-05	0.00E+00	1.44E-03	1.80E-03	4.33E-03
Molybdenum (Mo)		0.00E+00	3.70E-07	0.00E+00	3.70E-07	4.62E-07	1.11E-06
Niobium (Nb)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphorus (P)		4.51E-03	2.08E-05	0.00E+00	4.53E-03	5.67E-03	1.36E-02
Potassium (K)		2.19E-03	3.38E-03	0.00E+00	5.57E-03	6.96E-03	1.67E-02
Rubidium (Rb)		0.00E+00	3.52E-07	0.00E+00	3.52E-07	4.40E-07	1.06E-06
Silicon (Si)		7.79E-04	1.64E-05	0.00E+00	7.96E-04	9.95E-04	2.39E-03
Silver (Ag)		2.70E-06	5.96E-08	4.77E-10	2.76E-06	3.45E-06	8.29E-06
Sodium (Na)		1.50E-02	1.63E-02	0.00E+00	3.14E-02	3.92E-02	9.42E-02
Strontium (Sr)		3.04E-05	3.84E-06	0.00E+00	3.43E-05	4.28E-05	1.03E-04
Thallium (Th)		2.01E-03	3.28E-06	0.00E+00	2.02E-03	2.52E-03	6.05E-03
Thallium (Tl)		4.13E-06	5.28E-07	0.00E+00	4.66E-06	5.82E-06	1.40E-05
Tin (Sn)		0.00E+00	1.13E-07	0.00E+00	1.13E-07	1.42E-07	3.40E-07
Titanium (Ti)		0.00E+00	1.52E-07	0.00E+00	1.52E-07	1.90E-07	4.56E-07
Tungsten (W)		0.00E+00	1.37E-07	0.00E+00	1.37E-07	1.71E-07	4.11E-07
Uranium (U)		1.65E-02	1.30E-04	0.00E+00	1.66E-02	2.08E-02	4.99E-02
Vanadium (V)		9.87E-07	2.68E-08	0.00E+00	1.01E-06	1.27E-06	3.04E-06
Zinc (Zn)		4.57E-05	4.14E-06	0.00E+00	4.98E-05	6.23E-05	1.49E-04
Zirconium (Zr)		0.00E+00	8.94E-09	0.00E+00	8.94E-09	1.12E-08	2.68E-08

[a]Maximum hourly is estimated by multiplying the average hourly by 1.25.
[b]Average annual emissions are the average hourly emissions multiplied by 6000 h/year.
h = hour.
HAP = hazardous air pollutant.
lb = pound.
TRU = transuranic.

Table B.1-7. Estimated metals emissions for TRU/sludge waste treatment for the Proposed Action

Metals	Metals[a] composition (mg/kg)	Metals mass fraction (g/total g)	Metals[b] concentration (g/dscf)	Uncontrolled metal[c] emissions for the project		Emissions after[d] control for the project		Average[e] hourly emissions (lbs/h)
				(g)	(lbs)	(g)	(lbs)	
TSP			1.30E-01	1.12E+09	2.47E+06	1,120,731	2468.57	3.43E-01
Silver (Ag)	7.88	7.88E-06	1.02E-06	8.83E+03	1.95E+01	8.83E+00	1.95E-02	2.70E-06
Aluminum (Al)	8012.46	8.01E-03	1.04E-03	8.98E+06	1.98E+04	8.98E+03	1.98E+01	2.75E-03
Arsenic (As)	17.18	1.72E-05	2.23E-06	1.93E+04	4.24E+01	1.93E+01	4.24E-02	5.89E-06
Boron (B)	12.51	1.25E-05	1.62E-06	1.40E+04	3.09E+01	1.40E+01	3.09E-02	4.29E-06
Barium (Ba)	93.65	9.37E-05	1.21E-05	1.05E+05	2.31E+02	1.05E+02	2.31E-01	3.21E-05
Beryllium (Be)	1.83	1.83E-06	2.37E-07	2.05E+03	4.52E+00	2.05E+00	4.52E-03	6.27E-07
Bismuth (Bi)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Calcium (Ca)	24100.46	2.41E-02	3.13E-03	2.70E+07	5.95E+04	2.70E+04	5.95E+01	8.26E-03
Cadmium (Cd)	9.20	9.20E-06	1.19E-06	1.03E+04	2.27E+01	1.03E+01	2.27E-02	3.15E-06
Cerium (Ce)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt (Co)	3.64	3.64E-06	4.72E-07	4.08E+03	8.99E+00	4.08E+00	8.99E-03	1.25E-06
Chromium (Cr)	337.40	3.37E-04	4.38E-05	3.78E+05	8.33E+02	3.78E+02	8.33E-01	1.16E-04
Cesium (Cs)	3.96	3.96E-06	5.14E-07	4.44E+03	9.78E+00	4.44E+00	9.78E-03	1.36E-06
Copper (Cu)	53.51	5.35E-05	6.94E-06	6.00E+04	1.32E+02	6.00E+01	1.32E-01	1.83E-05
Iron (Fe)	4319.89	4.32E-03	5.60E-04	4.84E+06	1.07E+04	4.84E+03	1.07E+01	1.48E-03
Gallium (Ga)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury (Hg)	65.61	6.56E-05	8.51E-06	7.35E+04	1.62E+02	7.35E+01	1.62E-01	2.25E-05
Iodine (I)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium (K)	6381.12	6.38E-03	8.28E-04	7.15E+06	1.58E+04	7.15E+03	1.58E+01	2.19E-03
Lanthanum (La)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lithium (Li)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Magnesium (Mg)	4052.20	4.05E-03	5.26E-04	4.54E+06	1.00E+04	4.54E+03	1.00E+01	1.39E-03
Manganese (Mn)	104.16	1.04E-04	1.35E-05	1.17E+05	2.57E+02	1.17E+02	2.57E-01	3.57E-05
Molybdenum (Mo)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium (Na)	43892.46	4.39E-02	5.69E-03	4.92E+07	1.08E+05	4.92E+04	1.08E+02	1.50E-02
Niobium (Nb)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	63.42	6.34E-05	8.23E-06	7.11E+04	1.57E+02	7.11E+01	1.57E-01	2.17E-05
Phosphorus (P)	13158.71	1.32E-02	1.71E-03	1.47E+07	3.25E+04	1.47E+04	3.25E+01	4.51E-03
Lead (Pb)	462.24	4.62E-04	6.00E-05	5.18E+05	1.14E+03	5.18E+02	1.14E+00	1.58E-04
Rubidium (Rb)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony (Sb)	27.30	2.73E-05	3.54E-06	3.06E+04	6.74E+01	3.06E+01	6.74E-02	9.36E-06
Selenium (Se)	18.73	1.87E-05	2.43E-06	2.10E+04	4.62E+01	2.10E+01	4.62E-02	6.42E-06
Silicon (Si)	2272.82	2.27E-03	2.95E-04	2.55E+06	5.61E+03	2.55E+03	5.61E+00	7.79E-04
Tin (Sn)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium (Sr)	88.75	8.88E-05	1.15E-05	9.95E+04	2.19E+02	9.95E+01	2.19E-01	3.04E-05
Thallium (Th)	5867.64	5.87E-03	7.61E-04	6.58E+06	1.45E+04	6.58E+03	1.45E+01	2.01E-03
Titanium (Ti)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium (Tl)	12.05	1.21E-05	1.56E-06	1.35E+04	2.97E+01	1.35E+01	2.97E-02	4.13E-06
Uranium (U)	48161.88	4.82E-02	6.25E-03	5.40E+07	1.19E+05	5.40E+04	1.19E+02	1.65E-02
Vanadium (V)	2.88	2.88E-06	3.74E-07	3.23E+03	7.11E+00	3.23E+00	7.11E-03	9.87E-07
Tungsten (W)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc (Zn)	133.22	1.33E-04	1.73E-05	1.49E+05	3.29E+02	1.49E+02	3.29E-01	4.57E-05
Zirconium (Zr)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* Document Number ORNL/TM-13351.

[2]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Conc. = 2.0 gr/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

Operating schedule data were obtained from the FWENC proposal:

Air Flow Rate	=	20,000 dscfm assumed rate from sludge process
Project Operating Schedule	=	15 months life
		4 weeks/month
		5 d/week
		24 h/d
Calculated Operating Hours	=	7,200 h for the 15 months

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 90%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

d = day.
dscf = dry standard cubic foot.
dscfm = dry standard cubic feet per minute.
g = gram.
gr/dscf = grains per dry standard cubic foot.
h = hour.
lb = pound.
kg = kilogram.
mg = milligram.
TRU = transuranic.

Table B.1-8. Estimated metals emissions for supernate waste treatment for the Proposed Action

Metals	Metals[a] composition (mg/L)	Metals[b] composition (g/total g)	Metalsc concentration (g/dscf)	Uncontrolled metal[d] for the project		Emissions after[e] control for the project		Average[f] hourly emissions (lbs/h)
				(g)	(lbs)	(g)	(lbs)	
TSP			1.30E-01	1.12E+09	2.47E+06	1,120,731	2468.57	3.43E-01
Silver (Ag)	0.20	1.74E-07	2.26E-08	1.95E+02	4.29E-01	1.95E-01	4.29E-04	5.96E-08
Aluminum (Al)	14.08	1.22E-05	1.59E-06	1.37E+04	3.02E+01	1.37E+01	3.02E-02	4.20E-06
Arsenic (As)	2.01	1.75E-06	2.27E-07	1.96E+03	4.31E+00	1.96E+00	4.31E-03	5.99E-07
Boron (B)	1.26	1.10E-06	1.42E-07	1.23E+03	2.70E+00	1.23E+00	2.70E-03	3.76E-07
Barium (Ba)	1.83	1.59E-06	2.06E-07	1.78E+03	3.93E+00	1.78E+00	3.93E-03	5.46E-07
Beryllium (Be)	0.01	8.70E-09	1.13E-09	9.75E+00	2.15E-02	9.75E-03	2.15E-05	2.98E-09
Bismuth (Bi)	2.70	2.35E-06	3.05E-07	2.63E+03	5.80E+00	2.63E+00	5.80E-03	8.05E-07
Calcium (Ca)	1363.88	1.19E-03	1.54E-04	1.33E+06	2.93E+03	1.33E+03	2.93E+00	4.07E-04
Cadmium (Cd)	0.39	3.39E-07	4.40E-08	3.80E+02	8.37E-01	3.80E-01	8.37E-04	1.16E-07
Cerium (Ce)	0.37	3.22E-07	4.17E-08	3.61E+02	7.94E-01	3.61E-01	7.94E-04	1.10E-07
Cobalt (Co)	0.16	1.39E-07	1.80E-08	1.56E+02	3.43E-01	1.56E-01	3.43E-04	4.77E-08
Chromium (Cr)	6.82	5.93E-06	7.69E-07	6.65E+03	1.46E+01	6.65E+00	1.46E-02	2.03E-06
Cesium (Cs)	1.80	1.57E-06	2.03E-07	1.75E+03	3.86E+00	1.75E+00	3.86E-03	5.37E-07
Copper (Cu)	0.86	7.48E-07	9.70E-08	8.38E+02	1.85E+00	8.38E-01	1.85E-03	2.56E-07
Iron (Fe)	10.89	9.47E-06	1.23E-06	1.06E+04	2.34E+01	1.06E+01	2.34E-02	3.25E-06
Gallium (Ga)	0.33	2.87E-07	3.72E-08	3.22E+02	7.08E-01	3.22E-01	7.08E-04	9.84E-08
Mercury (Hg)	0.79	6.87E-07	8.91E-08	7.70E+02	1.70E+00	7.70E-01	1.70E-03	2.36E-07
Iodine (I)	14.79	1.29E-05	1.67E-06	1.44E+04	3.17E+01	1.44E+01	3.17E-02	4.41E-06
Potassium (K)	11335.07	9.86E-03	1.28E-03	1.10E+07	2.43E+04	1.10E+04	2.43E+01	3.38E-03
Lanthanum (La)	0.04	3.48E-08	4.51E-09	3.90E+01	8.59E-02	3.90E-02	8.59E-05	1.19E-08
Lithium (Li)	26.69	2.32E-05	3.01E-06	2.60E+04	5.73E+01	2.60E+01	5.73E-02	7.96E-06
Magnesium (Mg)	178.49	1.55E-04	2.01E-05	1.74E+05	3.83E+02	1.74E+02	3.83E-01	5.32E-05
Manganese (Mn)	0.33	2.87E-07	3.72E-08	3.22E+02	7.08E-01	3.22E-01	7.08E-04	9.84E-08
Molybdenum (Mo)	1.24	1.08E-06	1.40E-07	1.21E+03	2.66E+00	1.21E+00	2.66E-03	3.70E-07
Sodium (Na)	54828.38	4.77E-02	6.18E-03	5.34E+07	1.18E+05	5.34E+04	1.18E+02	1.63E-02
Niobium (Nb)	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	1.23	1.07E-06	1.39E-07	1.20E+03	2.64E+00	1.20E+00	2.64E-03	3.67E-07
Phosphorus (P)	69.88	6.08E-05	7.88E-06	6.81E+04	1.50E+02	6.81E+01	1.50E-01	2.08E-05
Lead (Pb)	2.53	2.20E-06	2.85E-07	2.47E+03	5.43E+00	2.47E+00	5.43E-03	7.54E-07
Rubidium (Rb)	1.18	1.03E-06	1.33E-07	1.15E+03	2.53E+00	1.15E+00	2.53E-03	3.52E-07
Antimony (Sb)	0.99	8.61E-07	1.12E-07	9.65E+02	2.13E+00	9.65E-01	2.13E-03	2.95E-07
Selenium (Se)	0.94	8.17E-07	1.06E-07	9.16E+02	2.02E+00	9.16E-01	2.02E-03	2.80E-07
Silicon (Si)	55.11	4.79E-05	6.22E-06	5.37E+04	1.18E+02	5.37E+01	1.18E-01	1.64E-05
Tin (Sn)	0.38	3.30E-07	4.29E-08	3.70E+02	8.16E-01	3.70E-01	8.16E-04	1.13E-07
Strontium (Sr)	12.87	1.12E-05	1.45E-06	1.25E+04	2.76E+01	1.25E+01	2.76E-02	3.84E-06
Thallium (Th)	11.01	9.57E-06	1.24E-06	1.07E+04	2.36E+01	1.07E+01	2.36E-02	3.28E-06
Titanium (Ti)	0.51	4.43E-07	5.75E-08	4.97E+02	1.09E+00	4.97E-01	1.09E-03	1.52E-07
Thallium (Tl)	1.77	1.54E-06	2.00E-07	1.72E+03	3.80E+00	1.72E+00	3.80E-03	5.28E-07
Uranium (U)	434.76	3.78E-04	4.90E-05	4.24E+05	9.33E+02	4.24E+02	9.33E-01	1.30E-04
Vanadium (V)	0.09	7.83E-08	1.02E-08	8.77E+01	1.93E-01	8.77E-02	1.93E-04	2.68E-08
Tungsten (W)	0.46	4.00E-07	5.19E-08	4.48E+02	9.87E-01	4.48E-01	9.87E-04	1.37E-07
Zinc (Zn)	13.89	1.21E-05	1.57E-06	1.35E+04	2.98E+01	1.35E+01	2.98E-02	4.14E-06
Zirconium (Zr)	0.03	2.61E-08	3.38E-09	2.92E+01	6.44E-02	2.92E-02	6.44E-05	8.94E-09

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Supernate Liquids at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Number ORNL/TM-13551, Addendum 1.

[b]An average density value was obtained from Table 4.1, p. 3, of the above report to calculate a mass faction for each metal.

Supernate Density = 1.15 g/mL.

[c]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Conc. = 2.0 gr/dscf.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

Operating schedule data were obtained from the FWENC proposal:

Air Flow Rate	=	20,000 dscfm assumed rate from supernate process
Project Operating Schedule	=	15 months life
		4 weeks/month
		5 d/week
		24 h/d
Calculated Operating Hours	=	7,200 h for the 15 months

[e]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 99%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly	=	Pounds Emitted for Project/Project Operating Hours
Airborne Particulate Conc.	=	2.0 gr/dscf
Project Operating Schedule	=	15 months life 4 weeks/month 5 d/week 24 h/d

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

L = liter.

lb = pound.

mg = milligram.

Table B.1-9. Metal emissions for TRU/RH solid wastes tretment for the Proposed Action using 40 *CFR* 61 Appendix D calculation procedures

Metal	Mass of[a] metals in waste (kg)	Uncontrolled[b,c] metals emissions (g)	Uncontrolled[b,c] metals emissions (lbs)	Metals emissions[d] after control (g)	Metals emissions[d] after control (lbs)	Average[e] hourly emissions (lbs/h)
Silver (Ag)	20	2.00E+01	4.41E-02	2.00E-04	4.41E-07	1.10E-10
Cadmium (Cd)	100	1.00E+02	2.20E-01	1.00E-03	2.20E-06	5.51E-10
Mercury (Hg)	100	1.00E+02	2.20E-01	1.00E-03	2.20E-06	5.51E-10
Lead (Pb)	980	9.80E+02	2.16E+00	9.80E-03	2.16E-05	5.40E-09
Total	1200					

	Concentration[f] (g/dscf)	Uncontrolled TSP emissions (g)	Uncontrolled TSP emissions (lbs)	TSP emissions after control (g)	TSP emissions after control (lbs)	Average hourly (lbs/h)
TSP Hot Cell	0.13	3.11E+08	6.86E+05	3.11E+03	6.86E+00	1.71E-03

[a]Quantities are based on U.S. Department of Energy analysis and knowledge of process for the Resource Conservation and Recovery Act metals in the solid wastes.

[b]An emissions factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metals Mass in Waste × Emissions Factor.

The operating schedule was obtained from the FWENC proposal:

Project Operating Schedule = 80 h/week
50 weeks/year
Calculated Operating Hours = 4000 h total

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor = 0.01
Glovebox/Hot Cell Carbon Filters Adjustment Factor = 0.10
HEPA Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.10

Note that no emissions reduction credit is taken for the carbon system, since this factor only applied to iodine gas and no iodine is present in the solid waste.

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project / Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system.

Exhaust Flowrate = 10,000 dscf assumed for hot cell.

dscf = dry standard cubic foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

RH = remote handled.

TRU = transuranic.

Table B.1-10. Metal emissions for TRU/CH solid wastes treatment for the Proposed Action using 40 *CFR* 61 Appendix D of NESHAP calculation procedures

Metal	Mass of[a] metals in waste (kg)	Uncontrolled[b,c] metals emissions (g)	Uncontrolled[b,c] metals emissions (lbs)	Metals emissions[d] after control (g)	Metals emissions[d] after control (lbs)	Average[e] hourly emissions (lbs/h)
Silver (Ag)	100	1.00E+02	2.20E-01	1.00E-03	2.20E-06	3.67E-10
Cadmium (Cd)	400	4.00E+02	8.81E-01	4.00E-03	8.81E-06	1.47E-09
Mercury (Hg)	400	4.00E+02	8.81E-01	4.00E-03	8.81E-06	1.47E-09
Lead (Pb)	3500	3.50E+03	7.71E+00	3.50E-02	7.71E-05	1.28E-08
Total	4400					

	Concentration[f] (g/dscf)	Uncontrolled TSP emissions (g)	Uncontrolled TSP emissions (lbs)	TSP emissions after control (g)	TSP emissions after control (lbs)	Average hourly (lbs/h)
TSP Glove Box	0.13	4.67E+08	1.03E+06	4.67E+03	1.03E+01	1.71E-03

[a]Quantities are based on U.S. Department of Energy analysis and knowledge of process for the Resource Conservation Recovery Act metals in the solid wastes.

[b]An emissions factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metals Mass in Waste × Emissions Factor.

The operating schedule was obtained from the FWENC proposal:

Project Operating Schedule = 120 h/week
50 weeks/year
Calculated Operating Hours = 6000 h total

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor = 0.01
Glovebox/Hot Cell Carbon Filters Adjustment Factor = 0.10
HEPA Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.10

Note that no emissions reduction credit is taken for the carbon system, since this factor only applied to iodine gas and no iodine is present in the solid waste.

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system.

Exhaust Flowrate = 10,000 dscf assumed for hot cell.

CH = contact handled.

dscf = dry standard cubic foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

NESHAP = National Emission Standards for Hazardous Air Pollutants.

TRU = transuranic.

Table B.1-11. Particulate emissions from TRU solid wastes treatment (lbs/h) for the Proposed Action

Metal	RH waste emissions	CH waste emissions	Particulate emissions from solid waste
TSP	1.71E-03	1.71E-03	3.43E-03
Silver (Ag)	1.10E-10	3.67E-10	4.77E-10
Cadmium (Cd)	5.51E-10	1.47E-09	2.02E-09
Mercury (Hg)	5.51E-10	1.47E-09	2.02E-09
Lead (Pb)	5.40E-09	1.28E-08	1.82E-08

CH = contact handled.
h = hour.
lb = pound.
RH = remote handled.
TRU = transuranic.
TSP = total suspended particulate.

Table B.1-12. Summary of volatile organic emissions for the Proposed Action

	Sludge organic emissions		Supernate organic emissions		Total hourly organic emissions	
Tank farm	**(lbs)**	**(lbs/h)**	**(lbs)**	**(lbs/h)**	**(lbs)**	**(lbs/h)**
Bethel Valley	89.10	0.062	0.15	1.06E-04	89.25	0.062
GAAT	21.86	0.013	6.71	7.14E-04	28.57	0.014
Melton Valley	150.18	0.039	7.01	4.36E-04	157.30	0.039
OHF	1.48	0.007	1.40	6.61E-05	2.88	0.007
Total	**262.62**		**15.28**		**277.89**	

GAAT = Gunite and Associate Tanks.
h = hour.
lb = pound.
OHF = Old Hydrofracture Facility.

Table B.1-13. Estimated total organic emissions for the Proposed Action

Air contaminant	Classified as: VOC	Classified as: HAP	Maximum[a] hourly emissions (lbs/h)	Average[b] hourly emissions (lbs/h)	Average[c] annual emissions (tons/year)
Total VOC			6.21E-02	5.18E-02	0.11
Total HAP			1.33E-03	1.11E-03	0.01
2-Butanone (MEK)	Yes	Yes	1.22E-06	1.02E-06	1.80E-04
Benzene	Yes	Yes	0.00E+00	0.00E+00	1.33E-06
Bis-(2-ethylhexyl)phthalate	Yes	Yes	0.00E+00	0.00E+00	7.80E-03
Bromomethane	Yes	Yes	5.07E-04	4.23E-04	2.90E-04
Carbon tetrachloride	Yes	Yes	0.00E+00	0.00E+00	1.47E-04
Chlorobenzene	Yes	Yes	0.00E+00	0.00E+00	8.60E-07
Chloroform	Yes	Yes	0.00E+00	0.00E+00	4.88E-06
Chloromethane	Yes	Yes	6.73E-06	5.61E-06	1.55E-06
Di-n-butylphthalate	Yes	Yes	7.02E-04	5.85E-04	2.17E-03
Ethylbenzene	Yes	Yes	0.00E+00	0.00E+00	1.42E-07
Hexachlorobenzene	Yes	Yes	0.00E+00	0.00E+00	2.97E-04
Methyl alcohol	Yes	Yes	0.00E+00	0.00E+00	1.95E-03
Methylene chloride	No	Yes	0.00E+00	0.00E+00	9.22E-06
Naphthalene	Yes	Yes	0.00E+00	0.00E+00	2.88E-04
Polychlorinated biphenyls	Yes	Yes	1.10E-04	9.13E-05	6.31E-05
Tetrachloroethene	Yes	Yes	0.00E+00	0.00E+00	6.84E-06
Toluene	Yes	Yes	0.00E+00	0.00E+00	3.71E-06
Trichloroethane	Yes	Yes	0.00E+00	0.00E+00	6.71E-08
Trichloroethene	Yes	Yes	0.00E+00	0.00E+00	2.94E-06
1,2-Dichoroethene	Yes	No	0.00E+00	0.00E+00	9.84E-07
1-Decanol	Yes	No	2.63E-04	2.19E-04	1.52E-04
1-Docosene	Yes	No	0.00E+00	0.00E+00	1.76E-04
1-Dotriacontanol	Yes	No	0.00E+00	0.00E+00	1.76E-04
1-Hexanol, 2-ethyl	Yes	No	2.37E-03	1.97E-03	1.50E-03
1-Methyldecyl-benzene	Yes	No	9.43E-04	7.86E-04	5.43E-04
1-Methylundecyl-benzene	Yes	No	7.23E-04	6.03E-04	4.17E-04
1-Nonadecanol	Yes	No	2.15E-04	1.79E-04	4.13E-04
1-Octanamine, N-nitroso-*n*-octyl-	Yes	No	0.00E+00	0.00E+00	1.88E-04
1-Propyl alcohol	Yes	No	0.00E+00	0.00E+00	1.89E-04
2,4,5-Trichlorophenol	Yes	No	0.00E+00	0.00E+00	7.71E-07
2,4-Dichlorophenol	Yes	No	0.00E+00	0.00E+00	1.61E-06
2-Butanamine	Yes	No	0.00E+00	0.00E+00	1.16E-06
2-Ethyl-1-hexanol	Yes	No	4.28E-06	3.57E-06	9.87E-07
2-Hexanone	Yes	No	0.00E+00	0.00E+00	1.14E-06
2-Methylnaphalene	Yes	No	0.00E+00	0.00E+00	6.72E-05
2-Nitrophenol	Yes	No	0.00E+00	0.00E+00	2.74E-05
4-Methyl-2-pentanone	Yes	No	0.00E+00	0.00E+00	6.18E-05
Benzene, 1,3-*bis*(1-methylethyl)-	Yes	No	0.00E+00	0.00E+00	8.05E-04
Benzene, diethyl-	Yes	No	0.00E+00	0.00E+00	1.78E-03
Benzenesulfonamide, *N*-butyl	Yes	No	0.00E+00	0.00E+00	1.73E-05
Benzo(*a*)anthrecene	Yes	No	0.00E+00	0.00E+00	5.72E-05
Benzo(*a*)pyrene	Yes	No	0.00E+00	0.00E+00	7.66E-05
Benzo(*b*)fluoroanthene	Yes	No	0.00E+00	0.00E+00	8.13E-05
Benzo(*g,h,i*)perylene	Yes	No	0.00E+00	0.00E+00	6.05E-05
Benzoic Acid	Yes	No	0.00E+00	0.00E+00	2.94E-04
Benzophenone	Yes	No	0.00E+00	0.00E+00	4.11E-04
Bromodichloromethane	Yes	No	0.00E+00	0.00E+00	7.52E-08
Chrysene	Yes	No	0.00E+00	0.00E+00	5.21E-05

Table B.1-13 (continued)

Air contaminant	Classified as: VOC	Classified as: HAP	Maximum[a] hourly emissions (lbs/h)	Average[b] hourly emissions (lbs/h)	Average[c] annual emissions (tons/year)
Dibromonitrophenol	Yes	No	0.00E+00	0.00E+00	1.39E-04
Diethyl benzene	Yes	No	1.67E-03	1.39E-03	1.66E-03
Diethylphthalate	Yes	No	0.00E+00	0.00E+00	1.22E-04
dimethyl sulfone	Yes	No	0.00E+00	0.00E+00	1.51E-06
Di-n-octylphthalate	Yes	No	0.00E+00	0.00E+00	2.13E-03
Dodecane	Yes	No	4.49E-03	3.74E-03	3.69E-03
Ethanone, 1-(2,3,4-trimethylphenyl)-	Yes	No	1.15E-03	9.59E-04	6.63E-04
Ethanone, 1-(4-ethylphenyl)-	Yes	No	2.50E-04	2.08E-04	3.26E-04
Ethyl alcohol	Yes	No	0.00E+00	0.00E+00	3.82E-04
Ethylphenylethanone	Yes	No	8.55E-04	7.12E-04	4.92E-04
Fluoroanthene	Yes	No	0.00E+00	0.00E+00	2.19E-04
Hepatanone	Yes	No	7.15E-05	5.96E-05	4.22E-05
Heptadecane	Yes	No	0.00E+00	0.00E+00	1.58E-04
Heptanal	Yes	No	0.00E+00	0.00E+00	1.63E-06
Heptane, 4-ethyl-2,2,6,6-tetrameethyl	Yes	No	0.00E+00	0.00E+00	6.21E-04
Hexadecanoic acid	Yes	No	0.00E+00	0.00E+00	2.12E-04
n-Butyl alcohol	Yes	No	0.00E+00	0.00E+00	2.40E-04
Nonadecane	Yes	No	0.00E+00	0.00E+00	1.70E-04
Octadecane	Yes	No	0.00E+00	0.00E+00	2.11E-04
Pentadecane	Yes	No	2.32E-04	1.94E-04	3.04E-04
Phenanthrene	Yes	No	0.00E+00	0.00E+00	3.16E-04
Phosphoric acid, *tris*-(2-ethylhexyl)-	Yes	No	2.71E-03	2.26E-03	1.56E-03
Pyrene	Yes	No	0.00E+00	0.00E+00	2.11E-04
Tetradecane	Yes	No	6.15E-03	5.12E-03	5.33E-03
Tetrahydrofuran	Yes	No	0.00E+00	0.00E+00	9.30E-07
Tributyl phosphate	Yes	No	5.16E-03	4.30E-03	5.05E-03
Tridecane	Yes	No	1.04E-02	8.70E-03	8.17E-03
Trimethyl decane	Yes	No	5.48E-04	4.57E-04	3.16E-04
Tris(ethylhexyl)phosphate	Yes	No	9.67E-04	8.06E-04	5.57E-04
Undecane	Yes	No	1.62E-03	1.35E-03	2.00E-03
Total unknowns	Yes	No	2.00E-02	1.66E-02	5.27E-02

[a]The maximum hourly emissions are those for the Bethel Valley tank farm, which had the highest calculated hourly emissions for sludge and supernate.

[b]The average hourly emissions are estimated by scaling down the maximum hourly emissions by the ratio of 6000 annual operating hours over the 7200-h project life.

h = hour.

HAP = hazardous air pollutant.

lb = pound.

VOC = volatile organic compound.

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APPENDIX B.2

SUMMARIES OF MATERIAL BALANCE FOR VITRIFICATION PROCESS

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Table B.2-1. Material balance for vitrification process in the Vitrification Alternative

Stream No.	Units	1 Sludge/ supernate in MVSTs	2 Mobilized sludge/ supernate	3 Mixed sludge/ supernate	4 To melter feed preparation	5 Melter feed	6 Glass from melter	7 Contain-erized glass	8 Glass to certifi-cation	9 Load into 72B cask	10 Ship to WIPP	11 Non-debris solid waste	12 Glass former blend	13 Melter off-gas	14 Air leakage into melter	15 Film cooler air	16 To quencher/ scrubber	17 Off-gas from CH/RH special wastes	18 Off-gas to mist eliminator	19 Off-gas from mist eliminator
									Metals/oxides											
Ag/Ag2O	kg	10	10	10	10	10	10	10	10	10	10	0	0	0			0	0	0	0
Al/Al2O3	kg	17,756	17,755	17,755	17,755	17,755	17,578	17,578	17,578	17,578	17,578	0	0	178			178	0	36	4
As/As2O3	kg	31	31	31	31	31	30	30	30	30	30	0	0	0			0	0	0	0
B/B2O3	kg	54	54	54	54	54	53	53	53	53	53	0	0	1			1	0	0	0
Ba/BaO	kg	126	126	126	126	126	124	124	124	124	124	0	0	1			1	0	0	0
Be/BeO	kg	6	6	6	6	6	6	6	6	6	6	0	0	0			0	0	0	0
Bi/Bi2O3	kg	5	5	5	5	5	5	5	5	5	5	0	0	0			0	0	0	0
Ca/CaO	kg	42,507	42,507	42,507	42,507	320,409	314,001	314,001	314,001	314,001	314,001	0	277,902	6,408			6,408	0	1,282	128
Cd/CdO	kg	13	13	13	13	13	13	13	13	13	13	0	0	0			0	0	0	0
Ce/Ce2O3	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Co/CoO	kg	6	6	6	6	6	6	6	6	6	6	0	0	0			0	0	0	0
Cr/Cr2O3	kg	593	593	593	593	593	587	587	587	587	587	0	0	6			6	0	1	0
Cs/Cs2O	kg	11	11	11	11	11	10	10	10	10	10	0	0	1			1	0	0	0
Cu/CuO	kg	80	80	80	80	80	79	79	79	79	79	0	0	1			1	0	0	0
Fe/Fe2O3	kg	7,251	7,251	7,251	7,251	7,251	7,179	7,179	7,179	7,179	7,179	0	0	73			73	0	15	1
Ga/Ga2O3	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Hg/HgO	kg	84	84	84	84	84	0	0	0	0	0	0	0	84			84	0	17	2
I/I2O5	kg	31	31	31	31	31	0	0	0	0	0	0	0	31			31	0	6	1
K/K2O	kg	30,840	30,840	30,840	30,840	30,840	30,531	30,531	30,531	30,531	30,531	0	0	308			308	0	62	6
La/La2O3	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Li/Li2O	kg	92	92	92	92	92	91	91	91	91	91	0	0	1			1	0	0	0
Mg/MgO	kg	8,335	8,335	8,335	8,335	8,335	8,251	8,251	8,251	8,251	8,251	0	0	83			83	0	17	2
Mn/MnO	kg	280	280	280	280	280	278	278	278	278	278	0	0	3			3	0	1	0
Mo/MoO3	kg	3	3	3	3	3	3	3	3	3	3	0	0	0			0	0	0	0
Na/Na2O	kg	187,475	187,475	187,475	187,475	187,475	185,600	185,600	185,600	185,600	185,600	0	0	1,875			1,875	0	375	37
Nb/NbO	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Ni/NiO	kg	97	97	97	97	97	96	96	96	96	96	0	0	1			1	0	0	0
P/P2O5	kg	35,533	35,533	35,533	35,533	35,533	35,178	35,178	35,178	35,178	35,178	0	0	355			355	0	71	7
Pb/PbO	kg	587	587	587	587	587	581	581	581	581	581	0	0	6			6	0	1	0
Rb/Rb2O	kg	2	2	2	2	2	2	2	2	2	2	0	0	0			0	0	0	0
Sb/Sb2O3	kg	40	40	40	40	40	40	40	40	40	40	0	0	0			0	0	0	0
Se/SeO	kg	28	28	28	28	28	28	28	28	28	28	0	0	0			0	0	0	0
Si/SiO2	kg	5,878	5,877	5,877	5,877	874,564	857,072	857,072	857,072	857,072	857,072	0	868,686	17,491			17,491	0	3,498	350
Sn/SnO2	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Sr/SrO	kg	147	147	147	147	147	146	146	146	146	146	0	0	1			1	0	0	0
Th/ThO2	kg	7,832	7,832	7,832	7,832	7,832	7,754	7,754	7,754	7,754	7,754	0	0	78			78	0	16	2
Ti/TiO2	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Tl/Tl2O5	kg	20	20	20	20	20	20	20	20	20	20	0	0	0			0	0	0	0
U/U2O5	kg	66,631	66,631	66,631	66,631	66,631	65,964	65,964	65,964	65,964	65,964	0	0	666			666	0	133	13
V/VO	kg	5	5	5	5	5	5	5	5	5	5	0	0	0			0	0	0	0
W/WO3	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Zn/ZnO	kg	222	222	222	222	222	219	219	219	219	219	0	0	2			2	0	0	0
Zr/ZrO2	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Grout binder	kg																			

Table B.2-1 (continued)

Stream No.	Units	1 Sludge/ supernate in MVSTs	2 Mobilized sludge/ supernate	3 Mixed sludge/ supernate	4 To melter feed preparation	5 Melter feed	6 Glass from melter	7 Contain-erized glass	8 Glass to certifi-cation	9 Load into 72B cask	10 Ship to WIPP	11 Non-debris solid waste	12 Glass former blend	13 Melter off-gas	14 Air leakage into melter	15 Film cooler air	16 To quencher/ scrubber	17 Off-gas from CH/RH special wastes	18 Off-gas to mist eliminator	19 Off-gas from mist eliminator
Anions																				
CO3-	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Br-	kg	5,400	5,400	5,400	5,400	5,400	0	0	0	0	0	0	0	0			0	0	0	0
CO3--	kg	188	188	188	188	188	0	0	0	0	0	0	0	0			0	0	0	0
Cl-	kg	10,610	10,610	10,610	10,610	10,610	5,305	5,305	5,305	5,305	5,305	0	0	0			0	0	0	0
CrO4--	kg	3,857	3,857	3,857	3,857	3,857	2,314	2,314	2,314	2,314	2,314	0	0	1,543			1,543	0	309	31
F-	kg	1,674	1,674	1,674	1,674	1,674	1,172	1,172	1,172	1,172	1,172	0	0	0			0	0	0	0
OH-	kg	515	515	515	515	515	0	0	0	0	0	0	0	0			0	0	0	0
NO3-	kg	27,781	27,781	27,781	27,781	27,781	5,556	5,556	5,556	5,556	5,556	0	0	0			0	0	0	0
NO2-	kg	300,200	300,199	300,199	300,199	300,199	60,040	60,040	60,040	60,040	60,040	0	0	0			0	0	0	0
PO4-	kg	8,047	8,047	8,047	8,047	8,047	4,828	4,828	4,828	4,828	4,828	0	0	3,219			3,219	0	644	322
SO4--	kg	6,682	6,682	6,682	6,682	6,682	4,009	4,009	4,009	4,009	4,009	0	0	0			0	0	0	0
CN-	kg	4,106	4,106	4,106	4,106	4,106	0	0	0	0	0	0	0	0			0	0	0	0
C2H3O2-	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
C6H5O7---	kg	397	397	397	397	397	0	0	0	0	0	0	0	0			0	0	0	0
HCO2-	kg	142	142	142	142	142	0	0	0	0	0	0	0	0			0	0	0	0
C2O4--	kg	301	301	301	301	301	0	0	0	0	0	0	0	0			0	0	0	0
Phthalates	kg	390	390	390	390	390	0	0	0	0	0	0	0	0			0	0	0	0
Water and gases																				
H2O	kg	2,212,350	2,212,350	2,212,350	2,212,350	2,287,080	0	0	0	0	0	74,730	0	2,938,108	650,514	334,446	3,272,554	0	6,340,079	6,340,079
Ar	kg		0	0	0	0	0	0	0	0	0	0	0	48,221	48,221	24,791	73,012	0	73,012	73,012
CO2	kg		0	0	0	0	0	0	0	0	0	0	0	61,251	1,704	876	62,127	0	62,127	62,127
N2	kg		0	0	0	0	0	0	0	0	0	0	0	4,097,532	4,031,327	2,072,607	6,170,140	0	6,170,140	6,170,140
NH3	kg		0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
O2	kg		0	0	0	0	0	0	0	0	0	0	0	1,142,094	1,081,402	555,976	1,698,070	0	1,679,338	1,675,069
HBr (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	5,467			5,467	0	1,093	1,093
HCl (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	5,455			5,455	0	545	273
HF (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	529			529	0	53	26
NOx (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	95,991			95,991	0	67,194	60,474
SO2 (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	1,782			1,782	0	178	89
Totals																				
Carbon	kg	13,879	13,879	13,879	13,879	13,879	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metal oxides	kg	412,613	412,613	412,613	412,613	1,559,201	1,531,544	1,531,544	1,531,544	1,531,544	1,531,544	0	1,146,588	27,657	0	0	27,657	0	5,531	553
Anions	kg	370,290	370,289	370,289	370,289	370,289	83,225	83,225	83,225	83,225	83,225	0	0	4,762	0	0	4,762	0	952	353
Dry gases	kg	0	0	0	0	0	0	0	0	0	0	0	0	5,458,321	5,162,654	2,654,251	8,112,572	0	8,053,681	8,042,304
H20	kg	2,212,350	2,212,350	2,212,350	2,212,350	2,287,080	0	0	0	0	0	74,730	0	2,938,108	650,514	334,446	3,272,554	0	6,340,079	6,340,079
Mass	kg	3,009,132	3,009,131	3,009,131	3,009,131	4,230,449	1,614,769	1,614,769	1,614,769	1,614,769	1,614,769	74,730	1,146,588	8,428,848	5,813,167	2,988,696	11,417,544	0	14,400,244	14,383,289
Miscellaneous																				
Flowrate	kg/h	155.29	155.29	155.29	155.29	218.32	83.33	83	83	83	83		59.17	434.99	300.00	154.24	589.22	0.00	743.15	742.28
Flowrate	gpm	0.568	0.568	0.568	0.568	0.598	0.131	0	0	0	0	0.000	0.098	478.298	1,115.294	573.401	1,051.699		2,000.234	2,000.234
Flowrate	scfm																			
Flowrate	acfm																			
Temperature	°C	25	25	25	25	25	25	25	25	25	25	25	25	529	25	25	350		25	25
Specific gravity		1.20	1.20	1.20	1.20	1.61	2.80	3	3	3	3	1.00	2.67	0.0040	0.0012	0.0012	0.0025		0.0016	0.0016
Density	lb/ft^3	75.14	75.16	75.16	75.16	100.33	174.80	175	175	175	175	1.00	166.37	0.2500	0.0739	0.0739	0.1540	0.0000	0.1021	0.1020

Table B.2-1 (continued)

Stream No.	Units	1 Sludge/ supernate in MVSTs	2 Mobilized sludge/ supernate	3 Mixed sludge/ supernate	4 To melter feed preparation	5 Melter feed	6 Glass from melter	7 Contain-erized glass	8 Glass to certifi-cation	9 Load into 72B cask	10 Ship to WIPP	11 Non-debris solid waste	12 Glass former blend	13 Melter off-gas	14 Air leakage into melter	15 Film cooler air	16 To quencher/ scrubber	17 Off-gas from CH/RH special wastes	18 Off-gas to mist eliminator	19 Off-gas from mist eliminator
Radiochemical constituents (in Ci)																				
Au-198		7.43E-257	7.43E-257	7.43E-257	7.43E-257	7.43E-257	7.35E-257	7.35E-257	7.35E-257	7.35E-257	7.35E-257		0.00E+00	7.43E-259	0.00E+00	0.00E+00	7.43E-259		1.49E-259	1.49E-260
Bk-249			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00
C-14		4.12E+00	4.12E+00	4.12E+00	4.12E+00	4.12E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00		0.00E+00	4.12E-02	0.00E+00	0.00E+00	4.12E-02		8.24E-03	4.12E-03
Ce-144		1.42E+00	1.42E+00	1.42E+00	1.42E+00	1.42E+00	1.40E+00	1.40E+00	1.40E+00	1.40E+00	1.40E+00		0.00E+00	1.42E-02	0.00E+00	0.00E+00	1.42E-02		2.83E-03	2.83E-04
Cf-252		2.48E-01	2.48E-01	2.48E-01	2.48E-01	2.48E-01	2.45E-01	2.45E-01	2.45E-01	2.45E-01	2.45E-01		0.00E+00	2.48E-03	0.00E+00	0.00E+00	2.48E-03		4.96E-04	4.96E-05
Cm-243		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00
Cm-244		9.32E+02	9.31E+02	9.31E+02	9.31E+02	9.31E+02	9.22E+02	9.22E+02	9.22E+02	9.22E+02	9.22E+02		0.00E+00	9.31E+00	0.00E+00	0.00E+00	9.31E+00		1.86E+00	1.86E-01
Co-60		4.76E+02	4.76E+02	4.76E+02	4.76E+02	4.76E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	4.76E+02	0.00E+00	0.00E+00	4.76E+02		9.52E+01	9.52E+00
Cs-134		6.41E+01	6.40E+01	6.40E+01	6.40E+01	6.40E+01	5.76E+01	5.76E+01	5.76E+01	5.76E+01	5.76E+01		0.00E+00	6.40E+00	0.00E+00	0.00E+00	6.40E+00		1.28E+00	6.40E-01
Cs-137		2.60E+04	2.60E+04	2.60E+04	2.60E+04	2.60E+04	2.34E+04	2.34E+04	2.34E+04	2.34E+04	2.34E+04		0.00E+00	2.60E+03	0.00E+00	0.00E+00	2.60E+03		5.19E+02	2.60E+02
Eu-152		1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02		0.00E+00	1.24E+00	0.00E+00	0.00E+00	1.24E+00		2.47E-01	1.24E-02
Eu-154		4.28E+01	4.28E+01	4.28E+01	4.28E+01	4.28E+01	4.24E+01	4.24E+01	4.24E+01	4.24E+01	4.24E+01		0.00E+00	4.28E-01	0.00E+00	0.00E+00	4.28E-01		8.56E-02	4.28E-03
Eu-155		1.78E+01	1.78E+01	1.78E+01	1.78E+01	1.78E+01	1.76E+01	1.76E+01	1.76E+01	1.76E+01	1.76E+01		0.00E+00	1.78E-01	0.00E+00	0.00E+00	1.78E-01		3.56E-02	1.78E-03
H-3		5.13E+00	5.12E+00	5.12E+00	5.12E+00	5.12E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	5.12E+00	0.00E+00	0.00E+00	5.12E+00		2.56E+00	2.56E+00
I-129		6.48E-03	6.48E-03	6.48E-03	6.48E-03	6.48E-03	6.41E-03	6.41E-03	6.41E-03	6.41E-03	6.41E-03		0.00E+00	6.48E-05	0.00E+00	0.00E+00	6.48E-05		1.30E-05	1.30E-06
Nb-95		7.21E-20	7.20E-20	7.20E-20	7.20E-20	7.20E-20	7.13E-20	7.13E-20	7.13E-20	7.13E-20	7.13E-20		0.00E+00	7.20E-22	0.00E+00	0.00E+00	7.20E-22		1.44E-22	1.44E-23
Pu-238		1.73E-01	1.73E-01	1.73E-01	1.73E-01	1.73E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01		0.00E+00	1.73E-03	0.00E+00	0.00E+00	1.73E-03		3.47E-04	3.47E-05
Pu-239		1.50E-01	1.50E-01	1.50E-01	1.50E-01	1.50E-01	1.49E-01	1.49E-01	1.49E-01	1.49E-01	1.49E-01		0.00E+00	1.50E-03	0.00E+00	0.00E+00	1.50E-03		3.00E-04	3.00E-05
Pu-240		1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01		0.00E+00	1.46E-03	0.00E+00	0.00E+00	1.46E-03		2.93E-04	2.93E-05
Pu-241		2.13E+00	2.13E+00	2.13E+00	2.13E+00	2.13E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00		0.00E+00	2.13E-02	0.00E+00	0.00E+00	2.13E-02		4.25E-03	4.25E-04
Pu-242		7.35E-03	7.34E-03	7.34E-03	7.34E-03	7.34E-03	7.27E-03	7.27E-03	7.27E-03	7.27E-03	7.27E-03		0.00E+00	7.34E-05	0.00E+00	0.00E+00	7.34E-05		1.47E-05	1.47E-06
Pu-244		8.64E-04	8.63E-04	8.63E-04	8.63E-04	8.63E-04	8.55E-04	8.55E-04	8.55E-04	8.55E-04	8.55E-04		0.00E+00	8.63E-06	0.00E+00	0.00E+00	8.63E-06		1.73E-06	1.73E-07
Ru-106		1.35E+00	1.35E+00	1.35E+00	1.35E+00	1.35E+00	1.34E+00	1.34E+00	1.34E+00	1.34E+00	1.34E+00		0.00E+00	1.35E-02	0.00E+00	0.00E+00	1.35E-02		2.71E-03	2.71E-04
Sr-90		4.09E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.04E+02	4.04E+02	4.04E+02	4.04E+02	4.04E+02		0.00E+00	4.08E+00	0.00E+00	0.00E+00	4.08E+00		8.17E-01	4.08E-02
Tc-99		4.97E+01	4.96E+01	4.96E+01	4.96E+01	4.96E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01		0.00E+00	2.48E+01	0.00E+00	0.00E+00	2.48E+01		4.96E+00	4.96E-02
Th-232		1.73E-03	1.73E-03	1.73E-03	1.73E-03	1.73E-03	1.71E-03	1.71E-03	1.71E-03	1.71E-03	1.71E-03		0.00E+00	1.73E-05	0.00E+00	0.00E+00	1.73E-05		3.45E-06	3.45E-07
U-233		6.19E+00	6.18E+00	6.18E+00	6.18E+00	6.18E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00		0.00E+00	6.18E-02	0.00E+00	0.00E+00	6.18E-02		1.24E-02	1.24E-03
U-234		1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01		0.00E+00	1.25E-03	0.00E+00	0.00E+00	1.25E-03		2.50E-04	2.50E-05
U-235		5.19E-03	5.18E-03	5.18E-03	5.18E-03	5.18E-03	5.13E-03	5.13E-03	5.13E-03	5.13E-03	5.13E-03		0.00E+00	5.18E-05	0.00E+00	0.00E+00	5.18E-05		1.04E-05	1.04E-06
U-236		3.03E-03	3.02E-03	3.02E-03	3.02E-03	3.02E-03	2.99E-03	2.99E-03	2.99E-03	2.99E-03	2.99E-03		0.00E+00	3.02E-05	0.00E+00	0.00E+00	3.02E-05		6.04E-06	6.04E-07
U-238		1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.63E-01	1.63E-01	1.63E-01	1.63E-01	1.63E-01		0.00E+00	1.65E-03	0.00E+00	0.00E+00	1.65E-03		3.30E-04	3.30E-05
Zr-95		8.25E-11	8.24E-11	8.24E-11	8.24E-11	8.24E-11	8.16E-11	8.16E-11	8.16E-11	8.16E-11	8.16E-11		0.00E+00	8.24E-13	0.00E+00	0.00E+00	8.24E-13		1.65E-13	1.65E-14
TRU activity		7.26E-01	2.60E+00	2.60E+00	2.60E+00	2.60E+00	2.58E+00	2.58E+00	2.58E+00	2.58E+00	2.58E+00	0.00E+00	0.00E+00	2.60E-02	0.00E+00	0.00E+00	2.60E-02	0.00E+00	5.21E-03	5.21E-04

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
Metals/oxides																			
Ag/Ag2O	kg	0.002	0.000	0	0	0	0	0	0	0	0.000	0.100	0.000	0.100	0.100		0.002		0.000
Al/Al2O3	kg	3.569	0.000	0	0	0	142	0	32	174	0.000	174.004	0.000	174.004	174.004		3.568		0.018
As/As2O3	kg	0.006	0.000	0	0	0	0	0	0	0	0.000	0.302	0.000	0.302	0.302		0.006		0.000
B/B2O3	kg	0.011	0.000	0	0	0	0	0	0	1	0.000	0.525	0.000	0.525	0.525		0.011		0.000
Ba/BaO	kg	0.025	0.000	0	0	0	1	0	0	1	0.000	1.231	0.000	1.231	1.231		0.025		0.000
Be/BeO	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.059	0.000	0.059	0.059		0.001		0.000

Table B.2-1 (continued)

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
Bi/Bi2O3	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.047	0.000	0.047	0.047		0.001		0.000
Ca/CaO	kg	128.206	0.013	0	0	0	5,127	0	1,153	6,280	0.000	6280.011	0.000	6280.011	6,280.011		128.193		0.043
Cd/CdO	kg	0.003	0.000	0	0	0	0	0	0	0	0.000	0.127	0.000	0.127	0.127		0.003		0.000
Ce/Ce2O3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.007	0.000	0.007	0.007		0.000		0.000
Co/CoO	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.056	0.000	0.056	0.056		0.001		0.000
Cr/Cr2O3	kg	0.119	0.000	0	0	0	5	0	1	6	0.000	5.811	0.000	5.811	5.811		0.119		0.001
Cs/Cs2O	kg	0.022	0.000	0	0	0	1	0	0	1	0.000	1.080	0.000	1.080	1.080		0.022		0.000
Cu/CuO	kg	0.016	0.000	0	0	0	1	0	0	1	0.000	0.785	0.000	0.785	0.785		0.016		0.000
Fe/Fe2O3	kg	1.457	0.000	0	0	0	58	0	13	71	0.000	71.061	0.000	71.061	71.061		1.457		0.007
Ga/Ga2O3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.007	0.000	0.007	0.007		0.000		0.000
Hg/HgO	kg	1.685	0.000	0	0	0	67	0	8	76	0.000	75.826	0.000	75.826	75.826		1.685		0.000
I/I2O5	kg	0.622	0.000	0	0	0	25	0	0	25	0.000	24.898	0.000	24.898	24.898		0.622		0.000
K/K2O	kg	6.199	0.001	0	0	0	247	0	56	302	0.000	302.230	0.000	302.230	302.230		6.198		0.031
La/La2O3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.001	0.000	0.001	0.001		0.000		0.000
Li/Li2O	kg	0.018	0.000	0	0	0	1	0	0	1	0.000	0.901	0.000	0.901	0.901		0.018		0.000
Mg/MgO	kg	1.675	0.000	0	0	0	67	0	15	82	0.000	81.679	0.000	81.679	81.679		1.675		0.008
Mn/MnO	kg	0.056	0.000	0	0	0	2	0	1	3	0.000	2.748	0.000	2.748	2.748		0.056		0.000
Mo/MoO3	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.029	0.000	0.029	0.029		0.001		0.000
Na/Na2O	kg	37.682	0.004	0	0	0	1,500	0	337	1,837	0.000	1837.251	0.000	1837.251	1,837.251		37.679		0.187
Nb/NbO	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000		0.000		0.000
Ni/NiO	kg	0.019	0.000	0	0	0	1	0	0	1	0.000	0.950	0.000	0.950	0.950		0.019		0.000
P/P2O5	kg	7.142	0.001	0	0	0	284	0	64	348	0.000	348.226	0.000	348.226	348.226		7.141		0.036
Pb/PbO	kg	0.118	0.000	0	0	0	5	0	1	6	0.000	5.752	0.000	5.752	5.752		0.118		0.001
Rb/Rb2O	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.020	0.000	0.020	0.020		0.000		0.000
Sb/Sb2O3	kg	0.008	0.000	0	0	0	0	0	0	0	0.000	0.393	0.000	0.393	0.393		0.008		0.000
Se/SeO	kg	0.006	0.000	0	0	0	0	0	0	0	0.000	0.276	0.000	0.276	0.276		0.006		0.000
Si/SiO2	kg	349.831	0.035	0	0	0	13,993	0	3,148	17,141	0.000	17,141	0.000	17141.448	17,141		349.796		0.006
Sn/SnO2	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.008	0.000	0.008	0.008		0.000		0.000
Sr/SrO	kg	0.030	0.000	0	0	0	1	0	0	1	0.000	1.442	0.000	1.442	1.442		0.030		0.000
Th/ThO2	kg	1.574	0.000	0	0	0	63	0	14	77	0.000	76.753	0.000	76.753	76.753		1.574		0.008
Ti/TiO2	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.013	0.000	0.013	0.013		0.000		0.000
Tl/Tl2O5	kg	0.004	0.000	0	0	0	0	0	0	0	0.000	0.198	0.000	0.198	0.198		0.004		0.000
U/U2O5	kg	13.393	0.001	0	0	0	533	0	120	653	0.000	652.982	0.000	652.982	652.982		13.391		0.067
V/VO	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.045	0.000	0.045	0.045		0.001		0.000
W/WO3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.009	0.000	0.009	0.009		0.000		0.000
Zn/ZnO	kg	0.045	0.000	0	0	0	2	0	0	2	0.000	2.172	0.000	2.172	2.172		0.045		0.000
Zr/ZrO2	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.001	0.000	0.001	0.001		0.000		0.000
Grout binder	kg														268,030	268,030			
									Anions										
CO3-	kg	0.000	0.000	0	0	0	0	0	0	0	0	0	0.000	0	0		0.000		0.000
Br-	kg	0.005	0.000	0	0	0	4,320	0	0	4,320	0	4,320	0.000	4,320	4,320		0.005		0.005
CO3--	kg	0.000	0.000	0	0	0	0	0	0	0	0	0	0.000	0	0		0.000		0.000
Cl-	kg	0.011	0.000	0	0	0	4,775	0	265	5,040	0	5,040	0.000	5,040	5,040		0.011		0.011
CrO4--	kg	30.858	0.003	0	0	0	1,234	0	278	1,512	0	1,512	0.000	1,512	1,512		30.855		0.004
F-	kg	0.002	0.000	0	0	0	452	0	25	477	0	477	0.000	477	477		0.002		0.002
OH-	kg	0.001	0.000	0	0	0	0	0	0	0	0	0	0.000	0	0		0.001		0.001
NO3-	kg	0.028	0.000	0	0	0	46,705	0	10,898	57,603	0	57,603	0.000	57,603	57,603		0.028		0.028
NO2-	kg	0.300	0.000	0	0	0	235	0	55	289	0	289	0.000	289	289		0.300		0.300
PO4-	kg	321.899	0.032	0	0	0	2,575	0	322	2,897	0	2,897	0.000	2,897	2,897		321.866		0.008

Table B.2-1 (continued)

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
SO4--	kg	0.007	0.000	0	0	0	2,406	0	134	2,539	0	2,539	0.000	2,539	2,539		0.007		0.007
CN-	kg	0.004	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.004		0.004
C2H3O2-	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
C6H5O7---	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
HCO2-	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
C2O4--	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
Phthalates	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
Water and gases																			
H2O	kg	7,586,847	7,586,847	0	0	3,334,267	266,741	152,797	152,797	419,539	0.000	419,539	209,769	209,769	209,769		0.000		1,246,768
Ar	kg	165,431	165,431	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		92,419
CO2	kg	65,392	65,392	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		3,265
N2	kg	13,896,536	13,896,536	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		7,726,396
NH3	kg		0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
O2	kg	3,747,672	3,747,672	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		2,072,603
HBr (gas)	kg	1,093	1,093	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
HCl (gas)	kg	273	273	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
HF (gas)	kg	26	26	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
NOx (gas)	kg	60,474	60,474	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
SO2 (gas)	kg	89	89	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
Totals																			
Carbon	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Metal oxides	kg	554	0	0	0	0	22,126	0	4,966	27,091	0	27,091	0	27,091	295,122		553		0
Anions	kg	353	0	0	0	0	62,701	0	11,976	74,677	0	74,677	0	74,677	74,677		353		0
Dry gases	kg	17,936,987	17,936,987	0	0	0	0	0	0	0	0	0	0	0	0		0	0	9,894,684
H20	kg	7,586,847	7,586,847	0	0	3,334,267	266,741	152,797	152,797	419,539	0	419,539	209,769	209,769	209,769		0	0	1,246,768
Mass	kg	25,524,741	25,523,835	0	0	3,334,267	351,568	152,797	169,740	521,307	0	521,307	209,769	311,538	579,568		907	0	11,141,452
Miscellaneous																			
Flowrate	kg/hr	1,317.25	1,317.21			172.07	18.14	7.89	8.76	26.90	0.00	26.90	10.83	16.08	29.91		0.05		402
Flowrate	gpm	4,137.794	4,137.794			0.758	0.208	0.035	0.035	0.095	0.000	0.095	0.048	0.047	0.069				1,496
Flowrate	scfm																		200
Flowrate	acfm																		
Temperature	°C	25	25			25	80	25	25	25	25	25					25		25
Specific gravity		0.0014	0.0014			1.00	1.32	1.00	1.11	1.25	1.25	1.25	1.00	1.50	1.90		1.50		0.0012
Density	lb/ft^3	0.0875	0.0875			62.43	82.28	62.43	69.35	78.07	78.07	78.07	62.43	93.92	118.61		93.64		0.0739
Radiochemical constituents (in Ci)																			
Au-198		8.92E-260	1.49E-264			0.00E+00	5.94E-259	0.00E+00	1.34E-259	7.28E-259	0.00E+00	7.28E-259	0.00E+00	0.000	7.28E-259		1.48E-260		7.43E-260
Bk-249		0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	0.00E+00		0.00E+00		0.00E+00
C-14		8.24E-03	4.12E-07			0.00E+00	3.29E-02	0.00E+00	4.12E-03	3.71E-02	0.00E+00	3.71E-02	0.00E+00	0.037	3.71E-02		4.12E-03		4.12E-03
Ce-144		1.70E-03	2.83E-08			0.00E+00	1.13E-02	0.00E+00	2.55E-03	1.39E-02	0.00E+00	1.39E-02	0.00E+00	0.014	1.39E-02		2.83E-04		1.42E-03
Cf-252		2.98E-04	4.96E-09			0.00E+00	1.98E-03	0.00E+00	4.46E-04	2.43E-03	0.00E+00	2.43E-03	0.00E+00	0.002	2.43E-03		4.96E-05		2.48E-04
Cm-243		0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	0.00E+00		0.00E+00		0.00E+00
Cm-244		1.12E+00	1.86E-05			0.00E+00	7.45E+00	0.00E+00	1.68E+00	9.12E+00	0.00E+00	9.12E+00	0.00E+00	9.123	9.12E+00		1.86E-01		9.32E-01
Co-60		1.00E+01	9.52E-04			0.00E+00	3.81E+02	0.00E+00	8.57E+01	4.66E+02	0.00E+00	4.66E+02	0.00E+00	466.479	4.66E+02		9.52E+00		4.76E-01
Cs-134		7.05E-01	6.40E-05			0.00E+00	5.12E+00	0.00E+00	6.40E-01	5.76E+00	0.00E+00	5.76E+00	0.00E+00	5.764	5.76E+00		6.40E-01		6.41E-02
Cs-137		2.86E+02	2.60E-02			0.00E+00	2.08E+03	0.00E+00	2.60E+02	2.34E+03	0.00E+00	2.34E+03	0.00E+00	2337.282	2.34E+03		2.60E+02		2.60E+01
Eu-152		1.36E-01	1.24E-06			0.00E+00	9.88E-01	0.00E+00	2.35E-01	1.22E+00	0.00E+00	1.22E+00	0.00E+00	1.223	1.22E+00		1.24E-02		1.24E-01
Eu-154		4.71E-02	4.28E-07			0.00E+00	3.42E-01	0.00E+00	8.13E-02	4.24E-01	0.00E+00	4.24E-01	0.00E+00	0.424	4.24E-01		4.28E-03		4.28E-02
Eu-155		1.96E-02	1.78E-07			0.00E+00	1.43E-01	0.00E+00	3.39E-02	1.76E-01	0.00E+00	1.76E-01	0.00E+00	0.176	1.76E-01		1.78E-03		1.78E-02

Table B.2-1 (continued)

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
H-3		2.57E+00	2.56E-04			0.00E+00	2.56E+00	0.00E+00	0.00E+00	2.56E+00	0.00E+00	2.56E+00	0.00E+00	2.562	2.56E+00		2.56E+00		5.13E-03
I-129		7.78E-06	1.30E-10			0.00E+00	5.18E-05	0.00E+00	1.17E-05	6.35E-05	0.00E+00	6.35E-05	0.00E+00	0.000	6.35E-05		1.30E-06		6.48E-06
Nb-95		8.65E-23	1.44E-27			0.00E+00	5.76E-22	0.00E+00	1.30E-22	7.06E-22	0.00E+00	7.06E-22	0.00E+00	0.000	7.06E-22		1.44E-23		7.21E-23
Pu-238		2.08E-04	3.47E-09			0.00E+00	1.39E-03	0.00E+00	3.12E-04	1.70E-03	0.00E+00	1.70E-03	0.00E+00	0.002	1.70E-03		3.47E-05		1.73E-04
Pu-239		1.80E-04	3.00E-09			0.00E+00	1.20E-03	0.00E+00	2.70E-04	1.47E-03	0.00E+00	1.47E-03	0.00E+00	0.001	1.47E-03		3.00E-05		1.50E-04
Pu-240		1.76E-04	2.93E-09			0.00E+00	1.17E-03	0.00E+00	2.63E-04	1.43E-03	0.00E+00	1.43E-03	0.00E+00	0.001	1.43E-03		2.92E-05		1.46E-04
Pu-241		2.55E-03	4.25E-08			0.00E+00	1.70E-02	0.00E+00	3.83E-03	2.08E-02	0.00E+00	2.08E-02	0.00E+00	0.021	2.08E-02		4.25E-04		2.13E-03
Pu-242		8.81E-06	1.47E-10			0.00E+00	5.87E-05	0.00E+00	1.32E-05	7.19E-05	0.00E+00	7.19E-05	0.00E+00	0.000	7.19E-05		1.47E-06		7.35E-06
Pu-244		1.04E-06	1.73E-11			0.00E+00	6.91E-06	0.00E+00	1.55E-06	8.46E-06	0.00E+00	8.46E-06	0.00E+00	0.000	8.46E-06		1.73E-07		8.64E-07
Ru-106		1.63E-03	2.71E-08			0.00E+00	1.08E-02	0.00E+00	2.44E-03	1.33E-02	0.00E+00	1.33E-02	0.00E+00	0.013	1.33E-02		2.71E-04		1.35E-03
Sr-90		4.50E-01	4.08E-06			0.00E+00	3.27E+00	0.00E+00	7.76E-01	4.04E+00	0.00E+00	4.04E+00	0.00E+00	4.044	4.04E+00		4.08E-02		4.09E-01
Tc-99		9.93E-02	4.96E-06			0.00E+00	1.99E+01	0.00E+00	4.91E+00	2.48E+01	0.00E+00	2.48E+01	0.00E+00	24.774	2.48E+01		4.96E-02		4.97E-02
Th-232		2.07E-06	3.45E-11			0.00E+00	1.38E-05	0.00E+00	3.11E-06	1.69E-05	0.00E+00	1.69E-05	0.00E+00	0.000	1.69E-05		3.45E-07		1.73E-06
U-233		7.42E-03	1.24E-07			0.00E+00	4.94E-02	0.00E+00	1.11E-02	6.06E-02	0.00E+00	6.06E-02	0.00E+00	0.061	6.06E-02		1.24E-03		6.19E-03
U-234		1.50E-04	2.50E-09			0.00E+00	1.00E-03	0.00E+00	2.25E-04	1.23E-03	0.00E+00	1.23E-03	0.00E+00	0.001	1.23E-03		2.50E-05		1.25E-04
U-235		6.22E-06	1.04E-10			0.00E+00	4.14E-05	0.00E+00	9.33E-06	5.08E-05	0.00E+00	5.08E-05	0.00E+00	0.000	5.08E-05		1.04E-06		5.19E-06
U-236		3.63E-06	6.04E-11			0.00E+00	2.42E-05	0.00E+00	5.44E-06	2.96E-05	0.00E+00	2.96E-05	0.00E+00	0.000	2.96E-05		6.04E-07		3.03E-06
U-238		1.98E-04	3.30E-09			0.00E+00	1.32E-03	0.00E+00	2.97E-04	1.62E-03	0.00E+00	1.62E-03	0.00E+00	0.002	1.62E-03		3.30E-05		1.65E-04
Zr-95		9.90E-14	1.65E-18			0.00E+00	6.59E-13	0.00E+00	1.48E-13	8.07E-13	0.00E+00	8.07E-13	0.00E+00	0.000	8.07E-13		1.65E-14		8.25E-14
TRU activity		3.13E-03	5.21E-08	0.00E+00	0.00E+00	0.00E+00	2.08E-02	0.00E+00	4.69E-03	2.55E-02	0.00E+00	2.55E-02	0.00E+00	2.55E-02	2.55E-02		5.21E-04	0.00E+00	2.61E-03

CH = contact handled.
Ci = curie.
gpm = gallons per minute.
h = hour.
HEPA = high-efficiency particulate air.
kg = kilogram.
lb = pound.
MVST = Melton Valley Storage Tank.
RH = remote handled.
scfm = standard cubic feet per minute.
TRU = transuranic.
WIPP = Waste Isolation Pilot Plant (New Mexico).

Table B.2-2. ORNL RH solid waste stream, OR-W106, volume/mass balance

Stream No.	301	302	303	306	307	308	309	310	311	312	314	315	316	317	319
Source	Feed	Removed waste	Debris	After size reduce	45-gal drums	To com-paction	To buffer storage	Pucks to 55-gal drums	55-gal drums	Grouted drums	To certifi-cation	Pack to ship	Grout feed	Grout wash	Process waste water
Component volume (m^3)															
Grout						0.0	0.0	0.0	0.0	14.9	14.9	14.9	16.4	1.5	1.5
Liquid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	9.9
Solids (i.e., misc.)	369.0	369.0	369.0	369.0	0.0	295.2	157.5	157.5	0.0	157.5	157.5	157.5	0.0	0.0	0.0
Metal debris	0.0	0.0	0.0	0.0	4.1	4.1	4.1	4.1	0.0	4.1	4.1	4.1	0.0	0.0	0.0
Glass debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plastic/rubber debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paper/cloth debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electronic equipment	9.5	9.5	9.5	9.5	0.0	7.6	5.0	5.0	0.0	5.0	5.0	5.0	0.0	0.0	0.0
Total volume (m^3)	378.5	378.5	378.5	378.5	4.1	306.9	166.6	166.6	0.0	181.6	181.6	181.6	16.4	11.4	11.4
Density (kg/m^3)	619	619	619	619	7,800	868	1,599	1,599	0	1,615	1,615	1,615	1,800	1,105	1,105
Net mass (kg)	234,150	234,150	234,150	234,150	32,278	266,428	266,428	266,428	0	293,266	293,266	293,266	29,521	12,585	12,585
Activities															
Total activity (Ci)	283	283	283	283	0	283	283	283	0	283	283	283	0	0	0
Total TRU activity (Ci)	19.4	19.4	19.4	19.4	0.0	19.4	19.4	19.4	0.0	19.4	19.4	19.4	0	0	0
TRU Concentration(nCi/g)	82.9	82.9	82.9	82.9	0.0	72.8	72.8	72.8		66.2	66.2	66.2			

Notes per Stream No:

Defer to Notes in Table B.2-3 unless otherwise specified.

301: The remote-handled (RH) Solids are contained in 91 C4 casks, 87 C6 casks, 19 C12 casks, 13 wood boxes, and three 55-gal drums per the Transuranic Waste Baseline Inventory Report (TWBIR).

306: No size reduction was assumed since the specific gravity was at 0.6.

311: Due to inconsistencies in puck sizes and no requirement for grout (non-Resource Conservation and Recovery Act), there will be ~15% more 55-gal drums than needed by volume.

ORNL = Oak Ridge National Laboratory.

TRU = transuranic.

Table B.2-3. ORNL RH solid waste (excluding OR-W106) volume/mass balance

Stream No.	301	302	303	306	307	308	309	310	311	312	314	315	316	317	319
Source	Feed	Removed waste	Debris	After size reduce	45-gal drums	To com-paction	To buffer storage	Pucks to 55-gal drums	55-gal drums	Grouted drums	To certifica-tion	Pack to ship	Grout feed	Grout wash	Process waste water
						Component volume (m^3)									
Grout						0.0	0.0	0.0	0.0	5.6	5.6	5.6	6.2	0.6	0.6
Liquid	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5
Solids (i.e., misc.)	137.9	137.9	137.9	137.9	0.0	69.0	33.4	33.4	0.0	33.4	33.4	33.4	0.0	0.0	0.0
Metal debris	4.1	4.1	4.1	3.0	1.2	2.7	1.8	1.8	0.0	1.8	1.8	1.8	0.0	0.0	0.0
Glass debris	3.1	3.1	3.1	3.1	0.0	1.6	0.6	0.6	0.0	0.6	0.6	0.6	0.0	0.0	0.0
Plastic/rubber debris	9.7	9.7	9.7	9.7	0.0	4.9	1.2	1.2	0.0	1.2	1.2	1.2	0.0	0.0	0.0
Paper/cloth debris	9.3	9.3	9.3	9.3	0.0	4.7	1.2	1.2	0.0	1.2	1.2	1.2	0.0	0.0	0.0
Electronic equipment	6.4	6.4	6.4	6.4	0.0	3.2	1.6	1.6	0.0	1.6	1.6	1.6	0.0	0.0	0.0
Total volume (m^3)	171.5	171.5	170.5	169.5	1.2	85.9	39.8	39.8	0.0	45.4	45.4	45.4	6.2	3.0	3.0
Density (kg/m^3)	311	311	313	315	7,800	726	1,569	1,569	0	1,598	1,598	1,598	1,800	1,148	1,148
Net mass (kg)	53,366	53,366	53,366	53,366	9,036	62,402	62,402	62,402	0	72,518	72,518	72,518	11,128	3,487	3,487
						Activities									
Total activity (Ci)	425	425	425	425	0	425	425	425	0	425	425	425	0	0	0.00E+0
TRU activity (Ci)	56	56	56	56	0	56	56	56	0	56	56	56	0	0	0.00E+0
TRU conc. (nCi/g)	1,040	1,040	1,040	1,040	0	889	889	889		765	765	765			

Notes per Stream No.:

Defer to notes for worksheet "RH" unless otherwise specified in worksheet "RH 106" or in this worksheet.
ORNL = Oak Ridge National Laboratory.
RH = remote handled.
TRU = transuranic.

Table B.2-4. Summary of annualized radionuclide emissions for the Vitrification Alternative (Ci/year)

Radionuclide	Sludge/ supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Ac-227	0.00E+00	7.16E-18	5.80E-16	3.19E-16	3.19E-16
AG-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241	4.56E-06	4.74E-10	2.65E-11	2.30E-10	4.56E-06
Am-243	0.00E+00	9.26E-12	6.66E-17	4.21E-12	4.21E-12
Au-196	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Au-198	2.76E-264	0.00E+00	0.00E+00	0.00E+00	2.76E-264
Bk-249	0.00E+00	2.53E-14	2.72E-19	1.15E-14	1.15E-14
C-14	1.65E-07	1.50E-16	0.00E+00	6.82E-17	1.65E-07
Ce-144	5.26E-08	0.00E+00	0.00E+00	0.00E+00	5.26E-08
Cf-249	1.80E-10	1.32E-14	9.89E-15	1.14E-14	1.80E-10
Cf-252	9.02E-09	2.98E-12	4.47E-12	3.80E-12	9.03E-09
Cm-240	6.76E-07	1.39E-42	0.00E+00	6.31E-43	6.76E-07
Cm-242	3.46E-05	5.80E-11	0.00E+00	2.64E-11	3.46E-05
Cm-243	2.33E-06	0.00E+00	0.00E+00	0.00E+00	2.33E-06
Cm-244	9.79E-04	1.60E-09	2.47E-10	8.61E-10	9.79E-04
Cm-245	4.51E-08	2.71E-15	0.00E+00	1.23E-15	4.51E-08
Cm-246	1.56E-08	8.82E-18	0.00E+00	4.01E-18	1.56E-08
Cm-248	6.47E-09	2.32E-14	0.00E+00	1.06E-14	6.47E-09
Co-60	2.66E-05	1.45E-15	1.86E-12	1.01E-12	2.66E-05
Cs-134	2.33E-06	0.00E+00	0.00E+00	0.00E+00	2.33E-06
Cs-137	9.46E-04	2.28E-09	7.43E-11	1.08E-09	9.46E-04
Es-253	1.26E-10	3.01E-47	0.00E+00	1.37E-47	1.26E-10
Es-254m	1.09E-10	0.00E+00	0.00E+00	0.00E+00	1.09E-10
Eu-152	1.14E-04	4.09E-16	0.00E+00	1.86E-16	1.14E-04
Eu-154	4.97E-05	0.00E+00	0.00E+00	0.00E+00	4.97E-05
Eu-155	1.03E-05	0.00E+00	0.00E+00	0.00E+00	1.03E-05
Fe-59	6.29E-13	2.06E-28	0.00E+00	9.35E-29	6.29E-13
Gd-153	9.85E-10	0.00E+00	0.00E+00	0.00E+00	9.85E-10
H-3	3.63E-07	0.00E+00	0.00E+00	0.00E+00	3.63E-07
I-129	1.81E-07	0.00E+00	0.00E+00	0.00E+00	1.81E-07
I-131	1.25E-12	0.00E+00	2.42E-120	1.32E-120	1.25E-12
Nb-95	4.51E-09	0.00E+00	0.00E+00	0.00E+00	4.51E-09
Ni-63	9.09E-11	9.36E-17	0.00E+00	4.26E-17	9.09E-11
Np-237	8.94E-09	5.65E-13	1.33E-13	3.29E-13	8.94E-09
Pa-231	2.20E-12	2.78E-13	0.00E+00	1.26E-13	2.32E-12
Pm-147	1.20E-10	7.20E-13	0.00E+00	3.27E-13	1.20E-10
Po-209	6.00E-20	1.69E-18	0.00E+00	7.67E-19	8.27E-19
Pu-238	6.79E-06	3.23E-09	1.85E-11	1.48E-09	6.79E-06
Pu-239	3.49E-06	9.00E-10	4.87E-12	4.12E-10	3.49E-06
Pu-240	1.10E-06	8.50E-10	6.05E-18	3.86E-10	1.10E-06
Pu-241	9.16E-06	1.86E-09	4.24E-12	8.47E-10	9.16E-06
Pu-242	2.63E-09	2.11E-13	0.00E+00	9.59E-14	2.63E-09
Pu-244	2.50E-10	0.00E+00	0.00E+00	0.00E+00	2.50E-10
Ra-223	0.00E+00	5.51E-79	3.68E-91	2.51E-79	2.51E-79
Ra-226	0.00E+00	1.42E-12	0.00E+00	6.44E-13	6.44E-13

Table B.2-4 (continued)

Radionuclide	Sludge/ supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Ru-106	3.35E-07	0.00E+00	0.00E+00	0.00E+00	3.35E-07
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	1.84E-03	1.36E-09	2.67E-11	6.31E-10	1.84E-03
Tc-99	2.42E-06	1.57E-11	0.00E+00	7.14E-12	2.42E-06
Te-123	0.00E+00	2.30E-17	0.00E+00	1.04E-17	1.04E-17
Te-123m	0.00E+00	6.42E-22	0.00E+00	2.92E-22	2.92E-22
Th-230	0.00E+00	1.06E-17	0.00E+00	4.81E-18	4.81E-18
Th-232	2.98E-08	6.98E-16	7.43E-16	7.23E-16	2.98E-08
U-232	3.01E-08	2.60E-13	0.00E+00	1.18E-13	3.01E-08
U-233	2.69E-06	8.92E-11	3.01E-12	4.22E-11	2.69E-06
U-234	1.10E-06	1.47E-11	0.00E+00	6.70E-12	1.10E-06
U-235	2.88E-08	6.29E-15	2.87E-16	3.02E-15	2.88E-08
U-236	2.49E-09	8.57E-17	0.00E+00	3.90E-17	2.49E-09
U-238	1.09E-06	3.83E-14	6.66E-17	1.75E-14	1.09E-06
U-239	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	1.71E-280	0.00E+00	7.77E-281	7.77E-281
Zn-65	0.00E+00	2.71E-18	0.00E+00	1.23E-18	1.23E-18
Zr-95	3.94E-16	0.00E+00	0.00E+00	0.00E+00	3.94E-16

Ci = curie.
CH = contact handled.
RH = remote handled.

Table B.2-5. Estimated radionuclide emissions for remediation of sludge and supernate by the Vitrification Alternative[a]

Radionuclide	Sludge (Bq/g)	Supernate (Bq/g)	Sludge and supernate (Ci/g)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled radionuclide emissions[c,d] (Ci)	Process radionuclide emissions[e] (Ci)	Radionuclide emissions after control: Project life[f] (Ci)	Radionuclide emissions after control: Annualized[g] (Ci/year)[g]
Ac-227	0.00E+00	0.00E+00	0.00E+00	2.18E+01				0.00E+00	0.00E+00
AG-110	0.00E+00	0.00E+00	0.00E+00	7.80E-07				0.00E+00	0.00E+00
AG-110m	0.00E+00	0.00E+00	0.00E+00	6.84E-01				0.00E+00	0.00E+00
Am-241[h]	0.00E+00	0.00E+00	0.00E+00	4.32E+02		1.25E-01	1.49E-260	1.25E-05	4.56E-06
Am-243	0.00E+00	0.00E+00	0.00E+00	7.37E+03				0.00E+00	0.00E+00
Au-196	0.00E+00	0.00E+00	0.00E+00	1.69E-02				0.00E+00	0.00E+00
Au-198	3.73E+03	0.00E+00	3.92E-08	7.38E-03	2.47E-266	7.44E-260	1.49E-260	7.58E-264	2.76E-264
Bk-249	0	0	0	8.76E-01		0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	0.00E+00	8.30E+01	1.37E-09	5.73E+03	1.37E-09	4.12E-03	4.12E-03	4.54E-07	1.65E-07
Ce-144	1.06E+04	1.14E+03	1.31E-07	7.80E-01	4.71E-10	1.42E-03	2.83E-04	1.45E-07	5.26E-08
Cf-249	0.00E+00	0.00E+00	0.00E+00	3.51E+02		0.00E+00	4.96E-05	4.96E-10	1.80E-10
Cf-252	3.83E+01	1.80E+00	4.32E-10	2.65E+00	8.25E-11	2.48E-04	0.00E+00	2.48E-08	9.02E-09
Cm-240	0.00E+00	0.00E+00	0.00E+00	7.39E-02		0.00E+00	1.86E-01	1.86E-06	6.76E-07
Cm-242	0.00E+00	0.00E+00	0.00E+00	1.63E+02		0.00E+00	9.52E+00	9.52E-05	3.46E-05
Cm-243	1.03E+04	0.00E+00	1.09E-07	2.91E+01		0.00E+00	6.40E-01	6.40E-06	2.33E-06
Cm-244	3.64E+04	7.68E+02	3.95E-07	1.81E+01	3.10E-07	9.32E-01	2.60E+02	2.69E-03	9.79E-04
Cm-245	0.00E+00	0.00E+00	0.00E+00	8.50E+03		0.00E+00	1.24E-02	1.24E-07	4.51E-08
Cm-246	0.00E+00	0.00E+00	0.00E+00	4.73E+03		0.00E+00	4.28E-03	4.28E-08	1.56E-08
Cm-248	0.00E+00	0.00E+00	0.00E+00	3.40E+05		0.00E+00	1.78E-03	1.78E-08	6.47E-09
Co-60	3.35E+04	7.30E+02	3.64E-07	5.27E+00	1.58E-07	4.77E-01	2.56E+00	7.33E-05	2.66E-05
Cs-134	4.89E+03	7.74E+03	1.79E-07	2.06E+00	2.13E-08	6.41E-02	1.30E-06	6.41E-06	2.33E-06
Cs-137	5.77E+05	2.38E+05	1.00E-05	3.01E+01	8.64E-06	2.60E+01	1.44E-23	2.60E-03	9.46E-04
Es-253	0.00E+00	0.00E+00		5.60E-02		0.00E+00	3.47E-05	3.47E-10	1.26E-10
Es-254m	0.00E+00	0.00E+00		4.48E-03		0.00E+00	3.00E-05	3.00E-10	1.09E-10
Eu-152	1.32E+05	3.44E+03	1.44E-06	1.35E+01	1.04E-06	3.13E+00	2.93E-05	3.13E-04	1.14E-04
Eu-154	6.97E+04	1.44E+03	7.56E-07	8.59E+00	4.54E-07	1.37E+00	4.25E-04	1.37E-04	4.97E-05
Eu-155	2.12E+04	9.02E+02	2.37E-07	4.76E+00	9.44E-08	2.84E-01	1.47E-06	2.84E-05	1.03E-05
Fe-59	0.00E+00	0.00E+00	0.00E+00	1.22E-01	0.00E+00	0.00E+00	1.73E-07	1.73E-12	6.29E-13
Gd-153	0.00E+00	0.00E+00	0.00E+00	6.61E-01	0.00E+00	0.00E+00	2.71E-04	2.71E-09	9.85E-10
H-3	3.47E+01	1.47E+02	2.80E-09	1.23E+01	1.96E-09	5.90E-03	4.08E-02	9.98E-07	3.63E-07
I-129	0.00E+00	1.30E-01	2.15E-12	1.57E+07	2.15E-12	6.48E-06	4.96E-02	4.97E-07	1.81E-07
I-131	0.00E+00	0.00E+00	0.00E+00	2.20E-02	0.00E+00	0.00E+00	3.45E-07	3.45E-12	1.25E-12
Nb-95	2.30E+03	1.13E+02	2.60E-08	9.58E-02	3.34E-28	1.01E-21	1.24E-03	1.24E-08	4.51E-09
Ni-63	0.00E+00	0.00E+00	0.00E+00	1.00E+02	0.00E+00	0.00E+00	2.50E-05	2.50E-10	9.09E-11
Np-237	7.77E+00	0.00E+00	8.16E-11	2.14E+06	8.16E-11	2.46E-04	1.04E-06	2.46E-08	8.94E-09
Pa-231	0.00E+00	0.00E+00	0.00E+00	3.28E+04	0.00E+00	0.00E+00	6.04E-07	6.04E-12	2.20E-12
Pm-147	0.00E+00	0.00E+00	0.00E+00	2.62E+00	0.00E+00	0.00E+00	3.30E-05	3.30E-10	1.20E-10
Po-209	0.00E+00	0.00E+00	0.00E+00	1.02E+02	0.00E+00	0.00E+00	1.65E-14	1.65E-19	6.00E-20
Pu-238	6.20E+03	3.67E+00	6.52E-08	8.77E+01	6.20E-08	1.87E-01	5.21E-04	1.87E-05	6.79E-06
Pu-239	3.03E+03	3.03E+00	3.19E-08	2.41E+04	3.19E-08	9.60E-02	3.00E-05	9.60E-06	3.49E-06
Pu-240	9.50E+02	2.95E+00	1.00E-08	6.56E+03	1.00E-08	3.02E-02	2.93E-05	3.02E-06	1.10E-06
Pu-241	1.07E+04	5.81E+01	1.14E-07	1.44E+01	8.37E-08	2.52E-01	4.25E-04	2.52E-05	9.16E-06
Pu-242	2.05E+00	1.48E-01	2.40E-11	3.73E+05	2.40E-11	7.22E-05	1.47E-06	7.23E-09	2.63E-09
Pu-244	1.90E-01	1.74E-02	2.28E-12	8.00E+05	2.28E-12	6.87E-06	1.73E-07	6.89E-10	2.50E-10

Table B.2-5 (continued)

Radionuclide	Sludge (Bq/g)	Supernate (Bq/g)	Sludge and supernate (Ci/g)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled radionuclide emissions[c,d] (Ci)	Process radionuclide emissions[e] (Ci)	Radionuclide emissions after control: Project life[f] (Ci)	Radionuclide emissions after control: Annualized[g] (Ci/year)[g]
Ra-223	0.00E+00	0.00E+00	0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-226	0.00E+00	0.00E+00	0.00E+00	1.60E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	1.83E+04	2.01E+03	2.25E-07	1.02E+00	3.05E-09	9.17E-03	2.71E-04	9.20E-07	3.35E-07
Sb-125	0.00E+00	0.00E+00	0.00E+00	2.76E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	1.85E+06	9.58E+03	1.96E-05	2.88E+01	1.68E-05	5.07E+01	4.08E-02	5.07E-03	1.84E-03
Tc-99	3.72E+02	1.00E+03	2.04E-08	2.11E+05	2.04E-08	6.15E-02	4.96E-02	6.65E-06	2.42E-06
Te-123	0.00E+00	0.00E+00	0.00E+00	1.00E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-123m	0.00E+00	0.00E+00	0.00E+00	3.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	0.00E+00	0.00E+00	7.54E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232	2.59E+01	3.48E-02	2.72E-10	1.41E+10	2.72E-10	8.20E-04	3.45E-07	8.20E-08	2.98E-08
U-232	0.00E+00	1.74E+01	2.87E-10	6.89E+01	2.70E-10	8.11E-04	1.62E-04	8.27E-08	3.01E-08
U-233	2.14E+03	1.24E+02	2.45E-08	1.59E+05	2.45E-08	7.37E-02	1.24E-03	7.39E-06	2.69E-06
U-234	9.50E+02	2.52E+00	1.00E-08	2.46E+05	1.00E-08	3.02E-02	2.50E-05	3.02E-06	1.10E-06
U-235	2.49E+01	1.04E-01	2.63E-10	3.80E+06	2.63E-10	7.91E-04	1.04E-06	7.91E-08	2.88E-08
U-236	2.07E+00	6.09E-02	2.28E-11	2.34E+07	2.28E-11	6.85E-05	6.04E-07	6.85E-09	2.49E-09
U-238	9.44E+02	3.32E+00	9.97E-09	4.47E+09	9.97E-09	3.00E-02	3.30E-05	3.00E-06	1.09E-06
U-239	0.00E+00	0.00E+00	0.00E+00	4.46E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	0.00E+00	0.00E+00	7.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65	0.00E+00	0.00E+00	0.00E+00	6.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-95	2.63E+04	1.28E+02	2.78E-07	1.75E-01	3.60E-18	1.08E-11	1.65E-14	1.08E-15	3.94E-16
TRU Activity	1.02E+04	1.16E+01	1.08E-07	2.90E+06	1.04E-07	4.39E-01	1.90E-02	4.41E-05	1.60E-05

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Nos. ORNL/TM/-13351 and ORNL/TM-13351, Addendum 1. The radionuclide concentration was then calculated for the elapsed time (6.33 years) from when the data were analyzed and the startup of the treatment process (April 1001) based on radionuclide decay. Also, an average density of 1.3 g/mL was used for the sludge which was calculated from sludge data provided in ORNL/TM-13351. An average density of 1.15 g/mL was obtained for the supernate from Table 4.1, p. 3, of ORNL/TM-13351, Addendum 1.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp - [In(2)/t_{½}*T] ,$$

where:

A = decayed radionuclide composition;
Ao = the original concentration in Ci/g;
$t_{½}$ = the half-life of the specific radionuclide as obtained from the website www.dne.bnl.gov/CoN/index.html;
T = the time between sample analysis (December 1996) to the time of process startup (April 2003), which is 6.33 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D of 40 *Code of Federal Regulations* (*CFR*) 61:

Emissions Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors form Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Demister Adjustment Factor = 0.10
First High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

The demister is only applicable for the gas from the vitrifier. The tank vents bypass the demister.

[f]A density of 2.6 g/mL was used for the treated waste (Spence 1998).

[g]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the sludge/supernate will be processed (2.5 years).

[h]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Bq = becquerel. mL = milliliter.
Ci = curie. TRU = transuranic.
g = gram.

Table B.2-6. Estimated radionuclide emissions for remediation of CH solids for the Vitrification Alternative

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide half life, $t_{1/2}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions: After control project life[e] (Ci)	Radionuclide emissions: Annualized[f] (Ci/year)
Ac-227	1.10E-05	2.18E+01	8.95E-06	8.95E-12	8.95E-18	7.16E-18
Ag-110		7.80E-07				
Ag-110m		6.84E-01				
Am-241[g,f]	5.77E+02	4.32E+02	5.92E+02	5.92E-04	5.92E-10	4.74E-10
Am-243	1.16E+01	7.37E+03	1.16E+01	1.16E-05	1.16E-11	9.26E-12
Au-196		1.69E-02				
Au-198		7.38E-03				
Bk-249	5.77E+00	8.76E-01	3.16E-02	3.16E-08	3.16E-14	2.53E-14
C-14	1.88E-04	5.73E+03	1.87E-04	1.87E-10	1.87E-16	1.50E-16
Ce-144		7.80E-01				
Cf-249	1.68E-02	3.51E+02	1.66E-02	1.66E-08	1.66E-14	1.32E-14
Cf-252	2.09E+01	2.65E+00	3.73E+00	3.73E-06	3.73E-12	2.98E-12
Cm-240	1.10E-03	7.39E-02	1.73E-30	1.73E-36	1.73E-42	1.39E-42
Cm-242	7.46E+01	1.63E+02	7.25E+01	7.25E-05	7.25E-11	5.80E-11
Cm-243		2.91E+01				
Cm-244	2.57E+03	1.81E+01	2.00E+03	2.00E-03	2.00E-09	1.60E-09
Cm-245	3.39E-03	8.50E+03	3.39E-03	3.39E-09	3.39E-15	2.71E-15
Cm-246	1.10E-05	4.73E+03	1.10E-05	1.10E-11	1.10E-17	8.82E-18
Cm-248	2.90E-02	3.40E+05	2.90E-02	2.90E-08	2.90E-14	2.32E-14
Co-60	4.30E-03	5.27E+00	1.81E-03	1.81E-09	1.81E-15	1.45E-15
Cs-134		2.06E+00				
Cs-137	3.31E+03	3.01E+01	2.84E+03	2.84E-03	2.84E-09	2.28E-09
Es-253	8.83E+00	5.60E-02	3.76E-35	3.76E-41	3.76E-47	3.01E-47
Es-254m	1.20E+01	4.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	7.17E-04	1.35E+01	5.12E-04	5.12E-10	5.12E-16	4.09E-16
Eu-154		8.59E+00	0.00E+00			
Eu-155		4.76E+00				
Fe-59	4.42E+00	1.22E-01	2.57E-16	2.57E-22	2.57E-28	2.06E-28
Gd-153		6.61E-01				
H-3		1.23E+01				
I-129		1.57E+07				
I-131		2.20E-02				
Nb-95		9.58E-02				
Ni-63	1.22E-04	1.00E+02	1.17E-04	1.17E-10	1.17E-16	9.36E-17
Np-237	7.06E-01	2.14E+06	7.06E-01	7.06E-07	7.06E-13	5.65E-13
Pa-231	3.48E-01	3.28E+04	3.48E-01	3.48E-07	3.48E-13	2.78E-13
Pm-147	5.13E+00	2.62E+00	9.00E-01	9.00E-07	9.00E-13	7.20E-13
Po-209	2.21E-06	1.02E+02	2.11E-06	2.11E-12	2.11E-18	1.69E-18
Pu-238	4.26E+03	8.77E+01	4.04E+03	4.04E-03	4.04E-09	3.23E-09
Pu-239	1.13E+03	2.41E+04	1.13E+03	1.13E-03	1.13E-09	9.00E-10
Pu-240	1.06E+03	6.56E+03	1.06E+03	1.06E-03	1.06E-09	8.50E-10
Pu-241	3.19E+03	1.44E+01	2.32E+03	2.32E-03	2.32E-09	1.86E-09
Pu-242	2.64E-01	3.73E+05	2.64E-01	2.64E-07	2.64E-13	2.11E-13
Pu-244		8.00E+05				
Ra-223	1.32E-03	3.13E-02	6.89E-67	6.89E-73	6.89E-79	5.51E-79

Table B.2-6 (continued)

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions: After control project life[e] (Ci)	Radionuclide emissions: Annualized[f] (Ci/year)
Ra-226	1.78E+00	1.60E+03	1.77E+00	1.77E-06	1.77E-12	1.42E-12
Ru-106		1.02E+00				
Sb-125		2.76E+00				
Sr-90	1.99E+03	2.88E+01	1.70E+03	1.70E-03	1.70E-09	1.36E-09
Tc-99	1.96E+01	2.11E+05	1.96E+01	1.96E-05	1.96E-11	1.57E-11
Te-123	2.87E-05	1.00E+08	2.87E-05	2.87E-11	2.87E-17	2.30E-17
Te-123m	8.77E-04	3.28E-01	8.02E-10	8.02E-16	8.02E-22	6.42E-22
Th-230	1.32E-05	7.54E+04	1.32E-05	1.32E-11	1.32E-17	1.06E-17
Th-232	8.73E-04	1.41E+10	8.73E-04	8.73E-10	8.73E-16	6.98E-16
U-232	3.48E-01	6.89E+01	3.25E-01	3.25E-07	3.25E-13	2.60E-13
U-233	1.11E+02	1.59E+05	1.11E+02	1.11E-04	1.11E-10	8.92E-11
U-234	1.84E+01	2.46E+05	1.84E+01	1.84E-05	1.84E-11	1.47E-11
U-235	7.87E-03	3.80E+06	7.87E-03	7.87E-09	7.87E-15	6.29E-15
U-236	1.07E-04	2.34E+07	1.07E-04	1.07E-10	1.07E-16	8.57E-17
U-238	4.79E-02	4.47E+09	4.79E-02	4.79E-08	4.79E-14	3.83E-14
U-239		4.46E-05				
Y-90	1.99E+03	7.31E-03	2.14E-268	2.14E-274	2.14E-280	1.71E-280
Zn-65	3.09E-03	6.69E-01	3.38E-06	3.38E-12	3.38E-18	2.71E-18
Zr-95		1.75E-01				
TRU Activity	7.06E+03		6.84E+03	6.84E-03	6.84E-09	5.47E-09

[a]Composition data obtained from U.S. Department of Energy Memorandum: *TRU Waste Baseline Inventory Report for Oak Ridge*, June 1996. The data were then scaled up from $906.22m^3$ to $1000m^3$.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp - [In(2)/t_{½}*T] ,$$

where:

A = Decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{½}$ = the half-life of the specific radionuclide as obtained from the website www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (January 2003), which is 6.58 years.

[c]An emissions factor of the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = .000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor	=	0.01
Hot Cell GAC Adjustment Factor	=	0.10
First HEPA Filter Adjustment Factor	=	0.01
Second HEPA Filter Adjustment Factor	=	0.01

The demister is only applicable for the gas from the vitrifier. The tank vents bypass the demister.

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the contact-handled (CH) solids will be processed (1.25 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

TRU = transuranic.

Table B.2-7. Estimated radionuclide emissions for TRU waste remediation of RH solids for the Vitrification Alternative

Radionuclide	Radionuclide Composition[a] (Ci)	Radionuclide half life, $t_{1/2}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.12E-03	2.18E+01	8.69E-04	8.69E-10	8.69E-16	5.80E-16
Ag-110		7.80E-07				
Ag-110m		6.84E-01				
Am-241[h]	4.02E+01	4.32E+02	3.97E+01	3.97E-05	3.97E-11	2.65E-11
Am-243	9.99E-05	7.37E+03	9.99E-05	9.99E-11	9.99E-17	6.66E-17
Au-196		1.69E-02				
Au-198		7.38E-03				
Bk-249	2.00E-04	8.76E-01	4.07E-07	4.07E-13	4.07E-19	2.72E-19
C-14		5.73E+03				
Ce-144		7.80E-01				
Cf-249	1.51E-02	3.51E+02	1.48E-02	1.48E-08	1.48E-14	9.89E-15
Cf-252	5.20E+01	2.65E+00	6.71E+00	6.71E-06	6.71E-12	4.47E-12
Cm-240		7.39E-02				
Cm-242		1.63E+02				
Cm-243		2.91E+01				
Cm-244	4.99E+02	1.81E+01	3.70E+02	3.70E-04	3.70E-10	2.47E-10
Cm-245		8.50E+03				
Cm-246		4.73E+03				
Cm-248		3.40E+05				
Co-60	7.81E+00	5.27E+00	2.79E+00	2.79E-06	2.79E-12	1.86E-12
Cs-134		2.06E+00				
Cs-137	1.33E+02	3.01E+01	1.11E+02	1.11E-04	1.11E-10	7.43E-11
Es-253		5.60E-02				
Es-254m		4.48E-03				
Eu-152		1.35E+01				
Eu-154		8.59E+00				
Eu-155		4.76E+00				
Fe-59		1.22E-01				
Gd-153		6.61E-01				
H-3		1.23E+01				
I-129		1.57E+07				
I-131	5.00E-01	2.20E-02	3.63E-108	3.63E-114	3.63E-120	2.42E-120
Nb-95		9.58E-02				
Ni-63		1.00E+02				
Np-237	2.00E-01	2.14E+06	2.00E-01	2.00E-07	2.00E-13	1.33E-13
Pa-231		3.28E+04				
Pm-147		2.62E+00				
Po-209		1.02E+02				
Pu-238	2.94E+01	8.77E+01	2.77E+01	2.77E-05	2.77E-11	1.85E-11
Pu-239	7.31E+00	2.41E+04	7.31E+00	7.31E-06	7.31E-12	4.87E-12
Pu-240	9.08E-06	6.56E+03	9.08E-06	9.08E-12	9.08E-18	6.05E-18
Pu-241	9.27E+00	1.44E+01	6.36E+00	6.36E-06	6.36E-12	4.24E-12
Pu-242		3.73E+05				
Pu-244		8.00E+05				
Ra-223	1.12E-03	3.13E-02	5.52E-79	5.52E-85	5.52E-91	3.68E-91

Table B.2-7 (continued)

Radionuclide	Radionuclide Composition[a] (Ci)	Radionuclide half life, $t_{1/2}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ra-226		1.60E+03				
Ru-106		1.02E+00				
Sb-125		2.76E+00				
Sr-90	4.83E+01	2.88E+01	4.00E+01	4.00E-05	4.00E-11	2.67E-11
Tc-99		2.11E+05				
Te-123		1.00E+08				
Te-123m		3.28E-01				
Th-230		7.54E+04				
Th-232	1.12E-03	1.41E+10	1.12E-03	1.12E-09	1.12E-15	7.43E-16
U-232		6.89E+01				
U-233	4.51E+00	1.59E+05	4.51E+00	4.51E-06	4.51E-12	3.01E-12
U-234		2.46E+05				
U-235	4.30E-04	3.80E+06	4.30E-04	4.30E-10	4.30E-16	2.87E-16
U-236		2.34E+07				
U-238	9.99E-05	4.47E+09	9.99E-05	9.99E-11	9.99E-17	6.66E-17
U-239		4.46E-05				
Y-90	4.83E+01	7.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65		6.69E-01				
Zr-95		1.75E-01				
TRU Activity	7.71E+01		7.49E+01	7.49E-05	7.49E-11	4.99E-11

[a]Composition data obtained from U.S. Department of Energy Memorandum: *TRU Waste Baseline Inventory Report for Oak Ridge*, June 1996.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp - [In(2)/t_{1/2}*T] ,$$

where:

A = decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the website www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (January 2004), which is 7.83 years.

[c]An emissions factor of the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = 0.000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Facto	=	0.01
Hot Cell GAC Adjustment Factor	=	0.10
First HEPA Filter Adjustment Factor	=	0.01
Second HEPA Filter Adjustment Factor	=	0.01

The demister is only applicable for the gas from the vitrifier. The tank vents bypass the demister.

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the contact-handled (CH) solids will be processed (1.5 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

TRU = transuranic.

Table B.2-8. Summary of TRU waste remediation hourly particulate emissions (lbs/h) for the Vitrification Alternative

Metals	Classification	Average hourly emissions (lbs/h)					Maximum hourly emissions[a] (lbs/h)	Average annual emissions[b] (tons/year)
		Sludge and supernate	CH solids	RH solids	CH/RH solids	Total		
TSP		6.86E-04	1.71E-04	1.71E-04	1.71E-04	7.78E-04	9.72E-04	2.43E-03
Total HAP		3.02E-07	5.13E-04	5.13E-04	5.12E-04	2.76E-04	3.45E-04	3.13E-04
Silver (Ag)		2.17E-09	1.71E-04	1.71E-04	1.71E-04	9.18E-05	1.15E-04	1.04E-04
Aluminum (Al)		2.14E-06				2.14E-06	2.68E-06	2.43E-06
Arsenic (As)	HAP	5.31E-09				5.31E-09	6.64E-09	6.03E-09
Boron (B)		3.79E-09				3.79E-09	4.74E-09	4.30E-09
Barium (Ba)		2.56E-08				2.56E-08	3.20E-08	2.91E-08
Beryllium (Be)	HAP	4.91E-10				4.91E-10	6.14E-10	5.58E-10
Bismuth (Bi)		9.84E-10				9.84E-10	1.23E-09	1.12E-09
Calcium (Ca)		6.92E-06				6.92E-06	8.65E-06	7.85E-06
Cadmium (Cd)	HAP	2.59E-09	1.71E-04	1.71E-04	1.71E-04	9.18E-05	1.15E-04	1.04E-04
Cerium (Ce)		1.35E-10				1.35E-10	1.69E-10	1.53E-10
Cobalt (Co)	HAP	1.03E-09				1.03E-09	1.29E-09	1.17E-09
Chromium (Cr)	HAP	9.24E-08				9.24E-08	1.16E-07	1.05E-07
Cesium (Cs)		1.71E-09				1.71E-09	2.14E-09	1.94E-09
Copper (Cu)		1.46E-08				1.46E-08	1.82E-08	1.65E-08
Iron (Fe)		1.16E-06				1.16E-06	1.44E-06	1.31E-06
Gallium (Ga)		1.20E-10				1.20E-10	1.50E-10	1.36E-10
Mercury (Hg)	HAP	1.78E-08	1.71E-04	1.71E-04	1.71E-04	9.18E-05	1.15E-04	1.04E-04
Iodine (I)		5.39E-09				5.39E-09	6.74E-09	6.12E-09
Potassium (K)		5.83E-06				5.83E-06	7.29E-06	6.62E-06
Lanthanum (La)		1.46E-11				1.46E-11	1.82E-11	1.65E-11
Lithium (Li)		9.73E-09				9.73E-09	1.22E-08	1.10E-08
Magnesium (Mg)		1.15E-06				1.15E-06	1.43E-06	1.30E-06
Manganese (Mn)	HAP	2.79E-08				2.79E-08	3.49E-08	3.16E-08
Molybdenum (Mo)		4.52E-10				4.52E-10	5.65E-10	5.13E-10
Sodium (Na)		3.17E-05				3.17E-05	3.96E-05	3.59E-05
Niobium (Nb)		0.00E+00				0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	HAP	1.74E-08				1.74E-08	2.17E-08	1.97E-08
Phosphorus (P)		3.53E-06				3.53E-06	4.42E-06	4.01E-06
Lead (Pb)	HAP	1.24E-07	1.71E-04	1.71E-04	1.71E-04	9.20E-05	1.15E-04	1.04E-04
Rubidium (Rb)		4.30E-10				4.30E-10	5.38E-10	4.88E-10
Antimony (Sb)	HAP	7.64E-09				7.64E-09	9.55E-09	8.66E-09
Selenium (Se)	HAP	5.33E-09				5.33E-09	6.67E-09	6.05E-09
Silicon (Si)		6.26E-07				6.26E-07	7.82E-07	7.10E-07
Tin (Sn)		1.39E-10				1.39E-10	1.73E-10	1.57E-10
Strontium (Sr)		2.83E-08				2.83E-08	3.54E-08	3.22E-08
Thorium (Th)		1.57E-06				1.57E-06	1.96E-06	1.78E-06
Titanium (Ti)		1.86E-10				1.86E-10	2.32E-10	2.11E-10
Thallium (Th)		3.86E-09				3.86E-09	4.82E-09	4.38E-09
Uranium (U)		1.30E-05				1.30E-05	1.62E-05	1.47E-05
Vanadium (V)		8.00E-10				8.00E-10	1.00E-09	9.08E-10
Tungsten (W)		1.68E-10				1.68E-10	2.10E-10	1.90E-10
Zinc (Zn)		4.06E-08				4.06E-08	5.07E-08	4.60E-08
Zirconium (Zr)		1.09E-11				1.09E-11	1.37E-11	1.24E-11

[a]Maximum hourly is estimated by multiplying average hourly rate by 1.25.
[b]Average annual emissions are the average hourly emissions multiplied by the operational hours and then divided by 2.75 years.
CH = contact handled. lb = pound. TRU = transuranic.
h = hour. RH = remote handled.
HAP = hazardous air pollutant. TSP = total suspended particulate.

Table B.2-9. Estimated metals emissions for remediation of sludge and supernate waste for the Vitrification Alternative

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
TSP		1.30E-01	5.34E+07	1.18E+05	5.34E+03	1.18E+01	6.86E-04
Silver (Ag)	3.17E-06	4.11E-07	1.69E+02	3.73E-01	1.69E-02	3.73E-05	2.17E-09
Aluminum (Al)	3.12E-03	4.05E-04	1.67E+05	3.67E+02	1.67E+01	3.67E-02	2.14E-06
Arsenic (As)	7.75E-06	1.00E-06	4.13E+02	9.12E-01	4.13E-02	9.12E-05	5.31E-09
Boron (B)	5.53E-06	7.17E-07	2.95E+02	6.51E-01	2.95E-02	6.51E-05	3.79E-09
Barium (Ba)	3.74E-05	4.84E-06	1.99E+03	4.40E+00	1.99E-01	4.40E-04	2.56E-08
Beryllium (Be)	7.17E-07	9.29E-08	3.83E+01	8.43E-02	3.83E-03	8.43E-06	4.91E-10
Bismuth (Bi)	1.44E-06	1.86E-07	7.66E+01	1.69E-01	7.66E-03	1.69E-05	9.84E-10
Calcium (Ca)	1.01E-02	1.31E-03	5.39E+05	1.19E+03	5.39E+01	1.19E-01	6.92E-06
Cadmium (Cd)	3.78E-06	4.90E-07	2.02E+02	4.45E-01	2.02E-02	4.45E-05	2.59E-09
Cerium (Ce)	1.97E-07	2.55E-08	1.05E+01	2.31E-02	1.05E-03	2.31E-06	1.35E-10
Cobalt (Co)	1.50E-06	1.94E-07	8.01E+01	1.76E-01	8.01E-03	1.76E-05	1.03E-09
Chromium (Cr)	1.35E-04	1.75E-05	7.19E+03	1.59E+01	7.19E-01	1.59E-03	9.24E-08
Cesium (Cs)	2.50E-06	3.23E-07	1.33E+02	2.94E-01	1.33E-02	2.94E-05	1.71E-09
Copper (Cu)	2.13E-05	2.75E-06	1.13E+03	2.50E+00	1.13E-01	2.50E-04	1.46E-08
Iron (Fe)	1.68E-03	2.18E-04	8.99E+04	1.98E+02	8.99E+00	1.98E-02	1.16E-06
Gallium (Ga)	1.75E-07	2.27E-08	9.36E+00	2.06E-02	9.36E-04	2.06E-06	1.20E-10
Mercury (Hg)	2.59E-05	3.36E-06	1.38E+03	3.05E+00	1.38E-01	3.05E-04	1.78E-08
Iodine (I)	7.86E-06	1.02E-06	4.20E+02	9.25E-01	4.20E-02	9.25E-05	5.39E-09
Potassium (K)	8.51E-03	1.10E-03	4.54E+05	1.00E+03	4.54E+01	1.00E-01	5.83E-06
Lanthanum (La)	2.13E-08	2.76E-09	1.13E+00	2.50E-03	1.13E-04	2.50E-07	1.46E-11
Lithium (Li)	1.42E-05	1.84E-06	7.57E+02	1.67E+00	7.57E-02	1.67E-04	9.73E-09
Magnesium (Mg)	1.67E-03	2.16E-04	8.91E+04	1.97E+02	8.91E+00	1.97E-02	1.15E-06
Manganese (Mn)	4.07E-05	5.27E-06	2.17E+03	4.78E+00	2.17E-01	4.78E-04	2.79E-08
Molybdenum (Mo)	6.59E-07	8.54E-08	3.52E+01	7.76E-02	3.52E-03	7.76E-06	4.52E-10
Sodium (Na)	4.62E-02	5.99E-03	2.47E+06	5.44E+03	2.47E+02	5.44E-01	3.17E-05
Niobium (Nb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	2.53E-05	3.28E-06	1.35E+03	2.98E+00	1.35E-01	2.98E-04	1.74E-08
Phosphorus (P)	5.15E-03	6.68E-04	2.75E+05	6.06E+02	2.75E+01	6.06E-02	3.53E-06
Lead (Pb)	1.81E-04	2.35E-05	9.66E+03	2.13E+01	9.66E-01	2.13E-03	1.24E-07
Rubidium (Rb)	6.27E-07	8.13E-08	3.35E+01	7.38E-02	3.35E-03	7.38E-06	4.30E-10
Antimony (Sb)	1.11E-05	1.44E-06	5.94E+02	1.31E+00	5.94E-02	1.31E-04	7.64E-09
Selenium (Se)	7.78E-06	1.01E-06	4.15E+02	9.15E-01	4.15E-02	9.15E-05	5.33E-09
Silicon (Si)	9.13E-04	1.18E-04	4.87E+04	1.07E+02	4.87E+00	1.07E-02	6.26E-07
Tin (Sn)	2.02E-07	2.62E-08	1.08E+01	2.38E-02	1.08E-03	2.38E-06	1.39E-10
Strontium (Sr)	4.13E-05	5.36E-06	2.21E+03	4.86E+00	2.21E-01	4.86E-04	2.83E-08
Thorium (Th)	2.29E-03	2.96E-04	1.22E+05	2.69E+02	1.22E+01	2.69E-02	1.57E-06
Titanium (Ti)	2.71E-07	3.51E-08	1.45E+01	3.19E-02	1.45E-03	3.19E-06	1.86E-10
Thallium (Th)	5.62E-06	7.29E-07	3.00E+02	6.62E-01	3.00E-02	6.62E-05	3.86E-09
Uranium (U)	1.90E-02	2.46E-03	1.01E+06	2.23E+03	1.01E+02	2.23E-01	1.30E-05

Table B.2-9 (continued)

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
Vanadium (V)	1.17E-06	1.51E-07	6.23E+01	1.37E-01	6.23E-03	1.37E-05	8.00E-10
Tungsten (W)	2.45E-07	3.17E-08	1.31E+01	2.88E-02	1.31E-03	2.88E-06	1.68E-10
Zinc (Zn)	5.92E-05	7.67E-06	3.16E+03	6.96E+00	3.16E-01	6.96E-04	4.06E-08
Zirconium (Zr)	1.59E-08	2.07E-09	8.51E-01	1.88E-03	8.51E-05	1.88E-07	1.09E-11

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Nos. ONRL/TM-13351 and ORNL/TM-13351, Addendum 1. An average density of 1.3 g/mL was used for the sludge which was calculated from sludge data provided in ORNL/TM-13351. Given the volume stated in the request for proposal (RFP) of 900 m^3 of sludge, there is 1,700,000 kg of sludge mass. An average density of 1.15 g/mL was obtained for the supernate from Table 4.1, p. 3, of ORNL/TM-13351, Addendum 1. Given the volume stated in the RFP of 1600 m^3 of supernate, there is 1,840,000 kg of supernate mass.

[b]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Concentration = 2.0 gr/dscf = 0.1296 g/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

The operating schedule was presented from Sect. 2.3 of this Environmental Impact Statement:

Air Flow Rate	=	400 dscfm (calculated from a first pass material balance of the vitrification process)
Process Operating Schedule	=	2,175 years life; 260 d/year; 24 h/d; and 60 min/h
Calculated Operating Hours	=	17,160 h

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

First HEPA Filter Removal = 99%.

Second HEPA Filter Removal = 99%.

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pound Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = killogram.

lb = pound.

m = meter.

mL = milliliter.

Table B.2-10. Metal emissions for remediation of TRU/RH solid wastes using 40 *CFR* 61 Appendix D calculation procedures for the Vitrification Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	Uncontrolled metals emissions[b,c] (lbs)	Metals emissions after control[d] (g)	Metals emissions after control[d] (lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	20	2.00E-02	4.41E-05	2.00E-08	4.41E-11	8.75E-15
Cadmium (Cd)	100	1.00E-01	2.20E-4	1.00E-07	2.20E-10	4.37E-14
Mercury (Hg)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	4.37E-14
Lead (Pb)	980	9.80E-01	2.16E-03	9.80E-07	2.16E-09	4.29E-13
Total	1200					
	Concentration (g/dscf)[f]	**Uncontrolled TSP emissions (g)**	**Uncontrolled TSP emissions (lbs)**	**TSP emissions after control (g)**	**TSP emissions after control (lbs)**	**Average hourly emissions (lbs/h)**
TSP	0.1296	3.92E+08	8.64E+05	3.92E+02	8.64E-01	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emissions Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.3 of this Environmental Impact Statement:

Process Operating Schedule = 1.5 years life; 210 d/year; 16 h/d; and 60 min/h

Calculated Operating Hours = 5040 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01

First HEPA Filter Adjustment Factor = 0.01

Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

d = day.

dscf = dry standard cubic foot.

ft = foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

min = minutes.

RH = remote handled.

TRU = transuranic.

Table B.2-11. Metal emissions for remediation of TRU/CH solid wastes using 40 *CFR* Appendix D calculation procedures for the Vitrification Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	Uncontrolled metals emissions[b,c] (lbs)	Metals emissions after control[d] (g)	Metals emissions after control[d] (lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	3.50E-14
Cadmium (Cd)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	1.40E-13
Mercury (Hg)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	1.40E-13
Lead (Pb)	3500	3.50E+00	7.72E-03	3.50E-06	7.72E-09	1.22E-12
Total	1200					
	Concentration[f] (g/dscf)	**Uncontrolled TSP emissions (g)**	**Uncontrolled TSP emissions (lbs)**	**TSP emissions after control (g)**	**TSP emissions after control (lbs)**	**Average hourly emissions (lbs/h)**
TSP	0.1296	4.90E+08	1.08E+06	4.90+02	1.08E-00	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emissions Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.3 of this Environmental Impact Statement:

Process Operating Schedule = 1.25 years life; 210 d/year; 16 h/d; and 60 min/h

Calculated Operating Hours = 4200 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01

First HEPA Filter Adjustment Factor = 0.01

Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

CH = contact handled.

d = day.

dscf = dry standard cubic foot.

ft = foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

min = minute.

TRU = transuranic.

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APPENDIX B.3

SUMMARIES OF MATERIAL BALANCE FOR CEMENTATION PROCESS

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Table B.3-1. Material balance for the cementation process in the Cementation Alternative for sludge

Stream No.	Units	101[a] Sludge in MVSTs	102 Stabilization additives	103 Setting additives	104[b] Decon water	105 Treated sludge	106 To 55-gal drums	108 Pack for shipping	110 pH Adj. additive	111 Cement dust
							6507 Drums	2170 72B Casks		
					Metals					
Ag	kg	9.2			0	9.2	9.2	9.2	0	0
Al	kg	9,374.6			0	9,374.6	9,374.6	9,374.6	0	0
As	kg	20.1			0	20.1	20.1	20.1	0	0
B	kg	14.6			0	14.6	14.6	14.6	0	0
Ba	kg	109.6			0	109.6	109.6	109.6	0	0
Be	kg	2.1			0	2.1	2.1	2.1	0	0
Bi	kg	0.0			0	0.0	0.0	0.0	0	0
Ca	kg	28,197.5			0	28,197.5	28,197.5	28,197.5	0	0
Cd	kg	10.8			0	10.8	10.8	10.8	0	0
Ce	kg	0.0			0	0.0	0.0	0.0	0	0
Co	kg	4.3			0	4.3	4.3	4.3	0	0
Cr	kg	394.8			0	394.8	394.8	394.8	0	0
Cs	kg	4.6			0	4.6	4.6	4.6	0	0
Cu	kg	62.6			0	62.6	62.6	62.6	0	0
Fe	kg	5,054.3			0	5,054.3	5,054.3	5,054.3	0	0
Ga	kg	0.0			0	0.0	0.0	0.0	0	0
Hg	kg	76.8			0	76.8	76.8	76.8	0	0
I	kg	0.0			0	0.0	0.0	0.0	0	0
K	kg	7,465.9			0	7,465.9	7,465.9	7,465.9	0	0
La	kg	0.0			0	0.0	0.0	0.0	0	0
Li	kg	0.0			0	0.0	0.0	0.0	0	0
Mg	kg	4,741.1			0	4,741.1	4,741.1	4,741.1	0	0
Mn	kg	121.9			0	121.9	121.9	121.9	0	0
Mo	kg	0.0			0	0.0	0.0	0.0	0	0
Na	kg	51,354.2			0	51,354.2	51,354.2	51,354.2	0	0
Nb	kg	0.0			0	0.0	0.0	0.0	0	0
Ni	kg	74.2			0	74.2	74.2	74.2	0	0
P	kg	15,395.7			0	15,395.7	15,395.7	15,395.7	0	0
Pb	kg	540.8			0	540.8	540.8	540.8	0	0
Rb	kg	0.0			0	0.0	0.0	0.0	0	0
Sb	kg	31.9			0	31.9	31.9	31.9	0	0
Se	kg	21.9			0	21.9	21.9	21.9	0	0
Si	kg	2,659.2			0	2,659.2	2,659.2	2,659.2	0	0
Sn	kg	0.0			0	0.0	0.0	0.0	0	0
Sr	kg	103.8			0	103.8	103.8	103.8	0	0
Th	kg	6,865.1			0	6,865.1	6,865.1	6,865.1	0	0
Ti	kg	0.0			0	0.0	0.0	0.0	0	0
Tl	kg	14.1			0	14.1	14.1	14.1	0	0
U	kg	56,349.4			0	56,349.4	56,349.4	56,349.4	0	0
V	kg	3.4			0	3.4	3.4	3.4	0	0
W	kg	0.0			0	0.0	0.0	0.0	0	0
Zn	kg	155.9			0	155.9	155.9	155.9	0	0
Zr	kg	0.0			0	0.0	0.0	0.0	0	0
					Concrete additives					
IRPC	kg		85,528			81,455	81,455	81,455	0	4,073
Perlite	kg			213,819		203,637	203,637	203,637	0	10,182
Fly Ash	kg		204,316			194,587	194,587	194,587	0	9,729

Table B.3-1 (continued)

Stream No.	Units	101[a] Sludge in MVSTs	102 Stabilization additives	103 Setting additives	104[b] Decon water	105 Treated sludge	106 To 55-gal drums	108 Pack for shipping	110 pH Adj. additive	111 Cement dust
Slag	kg		353,989			337,133	337,133	337,133	0	16,857
Cement	kg		213,819			203,637	203,637	203,637	0	10,182
					Anions					
CO3-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Br-	kg	592.8			0	592.8	5.93E+02	5.93E+02	0	0
CO3--	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Cl-	kg	550.7			0	550.7	5.51E+02	5.51E+02	0	0
CrO4--	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
F-	kg	1,639.3			0	1,639.3	1.64E+03	1.64E+03	0	0
OH-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
NO3-	kg	22,816.3			0	22,816.3	2.28E+04	2.28E+04	0	0
NO2-	kg	1,767.6			0	1,767.6	1.77E+03	1.77E+03	0	0
PO4-	kg	3,185.9			0	3,185.9	3.19E+03	3.19E+03	0	0
SO4--	kg	4,465.8			0	4,465.8	4.47E+03	4.47E+03	0	0
CN-	kg	6.3			0	6.3	6.32E+00	6.32E+00	0	0
C2H3O2-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
C6H5O7---	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
HCO2-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
C2O4--	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Phthlates	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
					Totals					
Carbon	kg	12,401				12,401	12,401	12,401	0	0
Metal	kg	189,234	0	0	0	189,234	189,234	189,234	0	0
Concrete	kg	0	857,652	213,819	0	1,020,449	1,020,449	1,020,449	0	51,022
Anions	kg	35,025	0	0	0	35,025	35,025	35,025	0	0
H20	kg	945,741	0	0	0	945,741	945,741	945,741	0	0
Mass	kg	1,244,450	857,652	213,819	0	2,264,899	2,190,449	2,190,449	0	51,022
SpG		1.3				1.76	1.76	1.76		
					Radioisotopic activity					
Au-198	Ci	1.17E-246	0	0	0	1.17E-246	1.17E-246	1.17E-246	0	0
Ce-144	Ci	1.52E+00	0	0	0	1.52E+00	1.52E+00	1.52E+00	0	0
Cf-252	Ci	2.47E-01	0	0	0	2.47E-01	2.47E-01	2.47E-01	0	0
Cm-243	Ci	2.83E+02	0	0	0	2.83E+02	2.83E+02	2.83E+02	0	0
Cm-244	Ci	9.11E+02	0	0	0	9.11E+02	9.11E+02	9.11E+02	0	0
Co-60	Ci	4.76E+02	0	0	0	4.76E+02	4.76E+02	4.76E+02	0	0
Cs-134	Ci	2.00E+01	0	0	0	2.00E+01	2.00E+01	2.00E+01	0	0
Cs-137	Ci	1.59E+04	0	0	0	1.59E+04	1.59E+04	1.59E+04	0	0
Eu-152	Ci	3.04E+03	0	0	0	3.04E+03	3.04E+03	3.04E+03	0	0
Eu-154	Ci	1.35E+03	0	0	0	1.35E+03	1.35E+03	1.35E+03	0	0
Eu-155	Ci	2.76E+02	0	0	0	2.76E+02	2.76E+02	2.76E+02	0	0
H-3	Ci	7.80E-01	0	0	0	7.80E-01	7.80E-01	7.80E-01	0	0
Nb-95	Ci	5.70E-18	0	0	0	5.70E-18	5.70E-18	5.70E-18	0	0
Np-237	Ci	2.46E-01	0	0	0	2.46E-01	2.46E-01	2.46E-01	0	0
Pu-238	Ci	1.87E+02	0	0	0	1.87E+02	1.87E+02	1.87E+02	0	0
Pu-239	Ci	9.59E+01	0	0	0	9.59E+01	9.59E+01	9.59E+01	0	0
Pu-240	Ci	3.00E+01	0	0	0	3.00E+01	3.00E+01	3.00E+01	0	0
Pu-241	Ci	2.53E+02	0	0	0	2.53E+02	2.53E+02	2.53E+02	0	0
Pu-242	Ci	6.48E-02	0	0	0	6.48E-02	6.48E-02	6.48E-02	0	0
Pu-244	Ci	6.01E-03	0	0	0	6.01E-03	6.01E-03	6.01E-03	0	0
Ru-106	Ci	9.27E+00	0	0	0	9.27E+00	9.27E+00	9.27E+00	0	0

Table B.3-1 (continued)

Stream No.	Units	101[a] Sludge in MVSTs	102 Stabilization additives	103 Setting additives	104[b] Decon water	105 Treated sludge	106 To 55-gal drums	108 Pack for shipping	110 pH Adj. additive	111 Cement dust
Sr-90	Ci	5.06E+04	0	0	0	5.06E+04	5.06E+04	5.06E+04	0	0
Tc-99	Ci	1.18E+01	0	0	0	1.18E+01	1.18E+01	1.18E+01	0	0
Th-232	Ci	8.18E-01	0	0	0	8.18E-01	8.18E-01	8.18E-01	0	0
U-233	Ci	6.76E+01	0	0	0	6.76E+01	6.76E+01	6.76E+01	0	0
U-234	Ci	3.01E+01	0	0	0	3.01E+01	3.01E+01	3.01E+01	0	0
U-235	Ci	7.86E-01	0	0	0	7.86E-01	7.86E-01	7.86E-01	0	0
U-236	Ci	6.55E-02	0	0	0	6.55E-02	6.55E-02	6.55E-02	0	0
U-238	Ci	2.98E+01	0	0	0	2.98E+01	2.98E+01	2.98E+01	0	0
Zr-95	Ci	2.89E-08	0	0	0	2.89E-08	2.89E-08	2.89E-08	0	0
TRU Act.	Ci	5.66E+02	0	0	0	5.66E+02	5.66E+02	5.66E+02	0	0

[a]Stream No. 101: The mass includes the remote-handled/contact-handled (RH/CH) Non-Debris Waste Stream.
[b]Stream No. 104: Decontaminated waste water would be processed with the supernate.
Ci = curie.
MVST = Melton Valley Storage Tank.
TRU = transuranic.

Table B.3-2. Material balance for the cementation process in the Cementation Alternative for supernate

Stream No.	Units	151 Supernate in MVSTs	152 Stabilization additives	153 Setting additives	154[a] Decon water	155 Treated supernate	156 To 55-gal drums	158 Pack for shipping	160 pH Adj. additive	161 Cement dust
							12,403 Drums	776 Super Tigers		
					Metals					
Ag	kg	0.3			0	0.3	0.3	0.3	0	0
Al	kg	22.5			0	22.5	22.5	22.5	0	0
As	kg	3.2			0	3.2	3.2	3.2	0	0
B	kg	2.0			0	2.0	2.0	2.0	0	0
Ba	kg	2.9			0	2.9	2.9	2.9	0	0
Be	kg	0.0			0	0.0	0.0	0.0	0	0
Bi	kg	4.3			0	4.3	4.3	4.3	0	0
Ca	kg	2,182.2			0	2,182.2	2,182.2	2,182.2	0	0
Cd	kg	0.6			0	0.6	0.6	0.6	0	0
Ce	kg	0.6			0	0.6	0.6	0.6	0	0
Co	kg	0.3			0	0.3	0.3	0.3	0	0
Cr	kg	10.9			0	10.9	10.9	10.9	0	0
Cs	kg	2.9			0	2.9	2.9	2.9	0	0
Cu	kg	1.4			0	1.4	1.4	1.4	0	0
Fe	kg	17.4			0	17.4	17.4	17.4	0	0
Ga	kg	0.5			0	0.5	0.5	0.5	0	0
Hg	kg	1.3			0	1.3	1.3	1.3	0	0
I	kg	23.7			0	23.7	23.7	23.7	0	0
K	kg	18,136.1			0	18,136.1	18,136.1	18,136.1	0	0
La	kg	0.1			0	0.1	0.1	0.1	0	0
Li	kg	42.7			0	42.7	42.7	42.7	0	0
Mg	kg	285.6			0	285.6	285.6	285.6	0	0
Mn	kg	0.5			0	0.5	0.5	0.5	0	0
Mo	kg	2.0			0	2.0	2.0	2.0	0	0
Na	kg	87,725.4			0	87,725.4	87,725.4	87,725.4	0	0
Nb	kg	0.0			0	0.0	0.0	0.0	0	0
Ni	kg	2.0			0	2.0	2.0	2.0	0	0
P	kg	111.8			0	111.8	111.8	111.8	0	0
Pb	kg	4.0			0	4.0	4.0	4.0	0	0
Rb	kg	1.9			0	1.9	1.9	1.9	0	0
Sb	kg	1.6			0	1.6	1.6	1.6	0	0
Se	kg	1.5			0	1.5	1.5	1.5	0	0
Si	kg	88.2			0	88.2	88.2	88.2	0	0
Sn	kg	0.6			0	0.6	0.6	0.6	0	0
Sr	kg	20.6			0	20.6	20.6	20.6	0	0
Th	kg	17.6			0	17.6	17.6	17.6	0	0
Ti	kg	0.8			0	0.8	0.8	0.8	0	0
Tl	kg	2.8			0	2.8	2.8	2.8	0	0
U	kg	695.6			0	695.6	695.6	695.6	0	0
V	kg	0.1			0	0.1	0.1	0.1	0	0
W	kg	0.7			0	0.7	0.7	0.7	0	0
Zn	kg	22.2			0	22.2	22.2	22.2	0	0
Zr	kg	0.0			0	0.0	0.0	0.0	0	0
					Concrete Additives					
IRPC	kg		0			0	0	0	0	0

Table B.3-2 (continued)

Stream No.	Units	151 Supernate in MVSTs	152 Stabilization additives	153 Setting additives	154[a] Decon water	155 Treated supernate	156 To 55-gal drums	158 Pack for shipping	160 pH Adj. additive	161 Cement dust
Perlite	kg			93,989		89,513	89,513	89,513	0	4,476
Fly Ash	kg		380,901			362,763	362,763	362,763	0	18,138
Slag	kg		999,247			951,664	951,664	951,664	0	47,583
Cement	kg		999,247			951,664	951,664	951,664	0	47,583
					Anions					
CO3-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Br-	kg	4,806.9			0	4,806.9	4.81E+03	4.81E+03	0	0
CO3--	kg	188.3			0	188.3	1.88E+02	1.88E+02	0	0
Cl-	kg	10,059.6			0	10,059.6	1.01E+04	1.01E+04	0	0
CrO4--	kg	3,856.8			0	3,856.8	3.86E+03	3.86E+03	0	0
F-	kg	34.4			0	34.4	3.44E+01	3.44E+01	0	0
OH-	kg	514.6			0	514.6	5.15E+02	5.15E+02	0	0
NO3-	kg	4,965.1			0	4,965.1	4.97E+03	4.97E+03	0	0
NO2-	kg	298,431.9			0	298,431.9	2.98E+05	2.98E+05	0	0
PO4-	kg	4,861.4			0	4,861.4	4.86E+03	4.86E+03	0	0
SO4--	kg	2,216.5			0	2,216.5	2.22E+03	2.22E+03	0	0
CN-	kg	4,099.8			0	4,099.8	4.10E+03	4.10E+03	0	0
C2H3O2-	kg	0.1			0	0.1	1.12E-01	1.12E-01	0	0
C6H5O7---	kg	396.6			0	396.6	3.97E+02	3.97E+02	0	0
HCO2-	kg	141.9			0	141.9	1.42E+02	1.42E+02	0	0
C2O4--	kg	301.1			0	301.1	3.01E+02	3.01E+02	0	0
Phthlates	kg	389.9			0	389.9	3.90E+02	3.90E+02	0	0
					Totals					
Carbon	kg	1,478				1,478	1,478	1,478	0	0
Metal	kg	109,442	0	0	0	109,442	109,442	109,442	0	0
Concrete	kg	0	2,379,396	93,989	0	2,355,604	2,355,604	2,355,604	0	117,780
Anions	kg	335,265	0	0	0	335,265	335,265	335,265	0	0
H20	kg	1,395,293	0	0	220,000	1,615,293	1,395,293	1,395,293	0	0
Mass	kg	1,840,000	2,379,396	93,989	220,000	4,415,604	4,195,604	4,195,604	0	117,780
SpG		1.3			1	1.8	1.8	1.8		
					Radioisotopic Activity					
C-14	Ci	4.12E+00	0	0	0	4.12E+00	4.12E+00	4.12E+00	0	0
Ce-144	Ci	5.31E-01	0	0	0	5.31E-01	5.31E-01	5.31E-01	0	0
Cf-252	Ci	2.27E-02	0	0	0	2.27E-02	2.27E-02	2.27E-02	0	0
Cm-244	Ci	3.12E+01	0	0	0	3.12E+01	3.12E+01	3.12E+01	0	0
Co-60	Ci	1.82E+01	0	0	0	1.82E+01	1.82E+01	1.82E+01	0	0
Cs-134	Ci	6.58E+01	0	0	0	6.58E+01	6.58E+01	6.58E+01	0	0
Cs-137	Ci	1.05E+04	0	0	0	1.05E+04	1.05E+04	1.05E+04	0	0
Eu-152	Ci	1.31E+02	0	0	0	1.31E+02	1.31E+02	1.31E+02	0	0
Eu-154	Ci	4.68E+01	0	0	0	4.68E+01	4.68E+01	4.68E+01	0	0
Eu-155	Ci	2.09E+01	0	0	0	2.09E+01	2.09E+01	2.09E+01	0	0
H-3	Ci	5.45E+00	0	0	0	5.45E+00	5.45E+00	5.45E+00	0	0
Nb-95	Ci	1.79E-16	0	0	0	1.79E-16	1.79E-16	1.79E-16	0	0
Pu-238	Ci	1.75E-01	0	0	0	1.75E-01	1.75E-01	1.75E-01	0	0
Pu-239	Ci	1.50E-01	0	0	0	1.50E-01	1.50E-01	1.50E-01	0	0
Pu-240	Ci	1.47E-01	0	0	0	1.47E-01	1.47E-01	1.47E-01	0	0
Pu-241	Ci	2.24E+00	0	0	0	2.24E+00	2.24E+00	2.24E+00	0	0
Pu-242	Ci	7.35E-03	0	0	0	7.35E-03	7.35E-03	7.35E-03	0	0
Pu-244	Ci	8.65E-04	0	0	0	8.65E-04	8.65E-04	8.65E-04	0	0
Ru-106	Ci	2.82E+00	0	0	0	2.82E+00	2.82E+00	2.82E+00	0	0

Table B.3-2 (continued)

Stream No.	Units	151 Supernate in MVSTs	152 Stabilization additives	153 Setting additives	154[a] Decon water	155 Treated supernate	156 To 55-gal drums	158 Pack for shipping	160 pH Adj. additive	161 Cement dust
Sr-90	Ci	4.20E+02	0	0	0	4.20E+02	4.20E+02	4.20E+02	0	0
Tc-99	Ci	4.97E+01	0	0	0	4.97E+01	4.97E+01	4.97E+01	0	0
Th-232	Ci	1.73E-03	0	0	0	1.73E-03	1.73E-03	1.73E-03	0	0
U-233	Ci	6.19E+00	0	0	0	6.19E+00	6.19E+00	6.19E+00	0	0
U-234	Ci	1.25E-01	0	0	0	1.25E-01	1.25E-01	1.25E-01	0	0
U-235	Ci	5.19E-03	0	0	0	5.19E-03	5.19E-03	5.19E-03	0	0
U-236	Ci	3.03E-03	0	0	0	3.03E-03	3.03E-03	3.03E-03	0	0
U-238	Ci	1.65E-01	0	0	0	1.65E-01	1.65E-01	1.65E-01	0	0
Zr-95	Ci	5.95E-09	0	0	0	5.95E-09	5.95E-09	5.95E-09	0	0
TRU Act.	Ci	2.72E+00	0	0	0	2.72E+00	2.72E+00	2.72E+00	0	0

[a]Stream No. 154: Includes grout washings and decon. from sludge and supernate processing - assumed to be ~3 gal/drum.
Ci = curie.
kg = kilogram.
MVST = Melton Valley Storage Tank.
TRU = transuranic.

Table B.3-3. Summary of annualized radionuclide emissions for the Cementation Alternative (Ci/year)

Radionuclide	Sludge emissions	Supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Ac-227	0.00E+00	0.00E+00	3.58E-18	2.78E-16	1.54E-16	1.54E-16
Ag-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ag-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241	3.55E-08	2.97E-10	2.37E-10	1.32E-11	1.15E-10	3.59E-08
Am-243	0.00E+00	0.00E+00	4.63E-12	3.33E-17	2.11E-12	2.11E-12
Au-196	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Au-198	1.95E-254	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.95E-254
Bk-249	0.00E+00	0.00E+00	1.27E-14	5.05E-20	5.75E-15	5.75E-15
C-14	0.00E+00	7.37E-08	7.50E-17	0.00E+00	3.41E-17	7.37E-08
Ce-144	2.53E-08	9.49E-09	0.00E+00	0.00E+00	0.00E+00	3.48E-08
Cf-249	0.00E+00	0.00E+00	6.62E-15	4.93E-15	5.70E-15	5.70E-15
Cf-252	4.11E-09	4.05E-10	1.49E-12	1.61E-12	1.56E-12	4.52E-09
Cm-240	0.00E+00	0.00E+00	6.94E-43	0.00E+00	3.15E-43	3.15E-43
Cm-242	0.00E+00	0.00E+00	2.90E-11	0.00E+00	1.32E-11	1.32E-11
Cm-243	4.71E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.71E-06
Cm-244	1.52E-05	5.58E-07	7.99E-10	1.18E-10	4.27E-10	1.57E-05
Cm-245	0.00E+00	0.00E+00	1.35E-15	0.00E+00	6.16E-16	6.16E-16
Cm-246	0.00E+00	0.00E+00	4.41E-18	0.00E+00	2.00E-18	2.00E-18
Cm-248	0.00E+00	0.00E+00	1.16E-14	0.00E+00	5.28E-15	5.28E-15
Co-60	7.94E-06	3.25E-07	7.24E-16	7.89E-13	4.31E-13	8.26E-06
Cs-134	3.33E-07	1.18E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-06
Cs-137	2.64E-04	1.87E-04	1.14E-09	3.61E-11	5.37E-10	4.52E-04
Es-253	0.00E+00	0.00E+00	1.50E-47	0.00E+00	6.83E-48	6.83E-48
Es-254m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	5.07E-05	2.34E-06	2.05E-16	0.00E+00	9.30E-17	5.31E-05
Eu-154	2.25E-05	8.35E-07	0.00E+00	0.00E+00	0.00E+00	2.33E-05
Eu-155	4.60E-06	3.73E-07	0.00E+00	0.00E+00	0.00E+00	4.98E-06
Fe-59	0.00E+00	0.00E+00	1.03E-28	0.00E+00	4.67E-29	4.67E-29
Gd-153	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H-3	1.30E-08	9.74E-08	0.00E+00	0.00E+00	0.00E+00	1.10E-07
I-129	0.00E+00	1.16E-10	0.00E+00	0.00E+00	0.00E+00	1.16E-10
I-131	0.00E+00	0.00E+00	0.00E+00	9.51E-138	5.19E-138	5.19E-138
Nb-95	9.50E-26	3.19E-24	0.00E+00	0.00E+00	0.00E+00	3.28E-24
Ni-63	0.00E+00	0.00E+00	4.68E-17	0.00E+00	2.13E-17	2.13E-17
Np-237	4.09E-09	0.00E+00	2.82E-13	6.66E-14	1.65E-13	4.10E-09
Pa-231	0.00E+00	0.00E+00	1.39E-13	0.00E+00	6.32E-14	6.32E-14
Pm-147	0.00E+00	0.00E+00	3.60E-13	0.00E+00	1.64E-13	1.64E-13
Po-209	0.00E+00	0.00E+00	8.44E-19	0.00E+00	3.84E-19	3.84E-19
Pu-238	3.11E-06	3.13E-09	1.62E-09	9.14E-12	7.40E-10	3.12E-06
Pu-239	1.60E-06	2.69E-09	4.50E-10	2.43E-12	2.06E-10	1.60E-06
Pu-240	5.01E-07	2.62E-09	4.25E-10	3.03E-18	1.93E-10	5.03E-07
Pu-241	4.22E-06	4.01E-08	9.29E-10	2.00E-12	4.24E-10	4.26E-06
Pu-242	1.08E-09	1.31E-10	1.05E-13	0.00E+00	4.80E-14	1.21E-09
Pu-244	1.00E-10	1.54E-11	0.00E+00	0.00E+00	0.00E+00	1.16E-10
Ra-223	0.00E+00	0.00E+00	2.76E-79	1.75E-103	1.25E-79	1.25E-79
Ra-226	0.00E+00	0.00E+00	7.09E-13	0.00E+00	3.22E-13	3.22E-13
Ru-106	1.54E-07	5.04E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-07
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	8.43E-04	7.50E-06	6.78E-10	1.29E-11	3.15E-10	8.50E-04
Tc-99	1.96E-07	8.88E-07	7.86E-12	0.00E+00	3.57E-12	1.08E-06

Table B.3-3 (continued)

Radionuclide	Sludge emissions	Supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Te-123	0.00E+00	0.00E+00	1.15E-17	0.00E+00	5.22E-18	5.22E-18
Te-123m	0.00E+00	0.00E+00	3.21E-22	0.00E+00	1.46E-22	1.46E-22
Th-230	0.00E+00	0.00E+00	5.30E-18	0.00E+00	2.41E-18	2.41E-18
Th-232	1.36E-08	3.09E-11	3.49E-16	3.72E-16	3.61E-16	1.37E-08
U-232	0.00E+00	1.46E-08	1.30E-13	0.00E+00	5.92E-14	1.46E-08
U-233	1.13E-06	1.11E-07	4.46E-11	1.50E-12	2.11E-11	1.24E-06
U-234	5.01E-07	2.24E-09	7.37E-12	0.00E+00	3.35E-12	5.03E-07
U-235	1.31E-08	9.27E-11	3.15E-15	1.43E-16	1.51E-15	1.32E-08
U-236	1.09E-09	5.41E-11	4.29E-17	0.00E+00	1.95E-17	1.14E-09
U-238	4.97E-07	2.95E-09	1.92E-14	3.33E-17	8.73E-15	5.00E-07
U-239	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	0.00E+00	8.55E-281	0.00E+00	3.89E-281	3.89E-281
Zn-65	0.00E+00	0.00E+00	1.35E-18	0.00E+00	6.15E-19	6.15E-19
Zr-95	4.82E-16	1.06E-16	0.00E+00	0.00E+00	0.00E+00	5.88E-16

Ci = curie.
CH = contact handled.
RH = remote handled.

Table B.3-4. Estimated radionuclide emissions for TRU waste remediation of sludge for the Cementation Alternative

Radionuclide	Radionuclide (Bq/g)	Composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
						Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227			2.18E+01			0.00E+00	0.00E+00
Ag-110			7.80E-07			0.00E+00	0.00E+00
Ag-110m			6.84E-01			0.00E+00	0.00E+00
Am-241[g]			4.32E+02		2.13E-03	2.13E-07	3.55E-08
Am-243			7.37E+03			0.00E+00	0.00E+00
Au-196			1.69E-02			0.00E+00	0.00E+00
Au-198	3732.39	1.01E-07	7.38E-03	1.00E-255	1.17E-249	1.17E-253	1.95E-254
Bk-249	0		8.76E-01		0.00E+00	0.00E+00	0.00E+00
C-14	0		5.73E+03		0.00E+00	0.00E+00	0.00E+00
Ce-144	10647.08	2.88E-07	7.80E-01	1.30E-09	1.52E-03	1.52E-07	2.53E-08
Cf-249	0		3.51E+02		0.00E+00	0.00E+00	0.00E+00
Cf-252	38.27	1.03E-09	2.65E+00	2.11E-10	2.47E-04	2.47E-08	4.11E-09
Cm-240	0		7.39E-02		0.00E+00	0.00E+00	0.00E+00
Cm-242	0		1.63E+02		0.00E+00	0.00E+00	0.00E+00
Cm-243	10330.07	2.79E-07	2.91E+01	2.42E-07	2.83E-01	2.83E-05	4.71E-06
Cm-244	36370.20	9.83E-07	1.81E+01	7.79E-07	9.11E-01	9.11E-05	1.52E-05
Cm-245	0		8.50E+03		0.00E+00	0.00E+00	0.00E+00
Cm-246	0		4.73E+03		0.00E+00	0.00E+00	0.00E+00
Cm-248	0		3.40E+05		0.00E+00	0.00E+00	0.00E+00
Co-60	33519.35	9.06E-07	5.27E+00	4.07E-07	4.76E-01	4.76E-05	7.94E-06
Cs-134	4893.24	1.32E-07	2.06E+00	1.71E-08	2.00E-02	2.00E-06	3.33E-07
Cs-137	577076.13	1.56E-05	3.01E+01	1.36E-05	1.59E+01	1.59E-03	2.64E-04
Es-253	0		5.60E-02		0.00E+00	0.00E+00	0.00E+00
Es-254m	0		4.48E-03		0.00E+00	0.00E+00	0.00E+00
Eu-152	131531.25	3.55E-06	1.35E+01	2.60E-06	3.04E+00	3.04E-04	5.07E-05
Eu-154	69723.86	1.88E-06	8.59E+00	1.15E-06	1.35E+00	1.35E-04	2.25E-05
Eu-155	21166.34	5.72E-07	4.76E+00	2.36E-07	2.76E-01	2.76E-05	4.60E-06
Fe-59	0		1.22E-01		0.00E+00	0.00E+00	0.00E+00
Gd-153	0		6.61E-01		0.00E+00	0.00E+00	0.00E+00
H-3	34.73	9.39E-10	1.23E+01	6.66E-10	7.80E-04	7.80E-08	1.30E-08
I-129	0		1.57E+07		0.00E+00	0.00E+00	0.00E+00
I-131	0		2.20E-02		0.00E+00	0.00E+00	0.00E+00
Nb-95	2296.02	6.21E-08	9.58E-02	4.87E-27	5.70E-21	5.70E-25	9.50E-26
Ni-63	0		1.00E+02		0.00E+00	0.00E+00	0.00E+00
Np-237	7.77	2.10E-10	2.14E+06	2.10E-10	2.46E-04	2.46E-08	4.09E-09
Pa-231	0		3.28E+04		0.00E+00	0.00E+00	0.00E+00
Pm-147	0		2.62E+00		0.00E+00	0.00E+00	0.00E+00
Po-209	0		1.02E+02		0.00E+00	0.00E+00	0.00E+00
Pu-238	6198.78	1.68E-07	8.77E+01	1.60E-07	1.87E-01	1.87E-05	3.11E-06
Pu-239	3031.95	8.19E-08	2.41E+04	8.19E-08	9.59E-02	9.59E-06	1.60E-06
Pu-240	950.28	2.57E-08	6.56E+03	2.57E-08	3.00E-02	3.00E-06	5.01E-07
Pu-241	10716.94	2.90E-07	1.44E+01	2.16E-07	2.53E-01	2.53E-05	4.22E-06
Pu-242	2.05	5.54E-11	3.73E+05	5.54E-11	6.48E-05	6.48E-09	1.08E-09
Pu-244	0.19	5.14E-12	8.00E+05	5.14E-12	6.01E-06	6.01E-10	1.00E-10
Ra-223	0		3.13E-02		0.00E+00	0.00E+00	0.00E+00
Ra-226	0		1.60E+03		0.00E+00	0.00E+00	0.00E+00
Ru-106	18256.71	4.93E-07	1.02E+00	7.92E-09	9.27E-03	9.27E-07	1.54E-07
Sb-125	0		2.76E+00		0.00E+00	0.00E+00	0.00E+00
Sr-90	1850860.69	5.00E-05	2.88E+01	4.32E-05	5.06E+01	5.06E-03	8.43E-04
Tc-99	372.46	1.01E-08	2.11E+05	1.01E-08	1.18E-02	1.18E-06	1.96E-07
Te-123	0		1.00E+08		0.00E+00	0.00E+00	0.00E+00
Te-123m	0		3.28E-01		0.00E+00	0.00E+00	0.00E+00
Th-230	0		7.54E+04		0.00E+00	0.00E+00	0.00E+00

Table B.3-4 (continued)

Radionuclide	Radionuclide (Bq/g)	Composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
						Project life[e] (Ci)	Annualized[f] (Ci/year)
Th-232	25.88	6.99E-10	1.41E+10	6.99E-10	8.18E-04	8.18E-08	1.36E-08
U-232	0		6.89E+01		0.00E+00	0.00E+00	0.00E+00
U-233	2136.82	5.78E-08	1.59E+05	5.78E-08	6.76E-02	6.76E-06	1.13E-06
U-234	950.46	2.57E-08	2.46E+05	2.57E-08	3.01E-02	3.01E-06	5.01E-07
U-235	24.86	6.72E-10	3.80E+06	6.72E-10	7.86E-04	7.86E-08	1.31E-08
U-236	2.07	5.59E-11	2.34E+07	5.59E-11	6.55E-05	6.55E-09	1.09E-09
U-238	943.56	2.55E-08	4.47E+09	2.55E-08	2.98E-02	2.98E-06	4.97E-07
U-239	0		4.46E-05		0.00E+00	0.00E+00	0.00E+00
Y-90	0		7.31E-03		0.00E+00	0.00E+00	0.00E+00
Zn-65	0		6.69E-01		0.00E+00	0.00E+00	0.00E+00
Zr-95	26302.35	7.11E-07	1.75E-01	2.47E-17	2.89E-11	2.89E-15	4.82E-16

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (December 1996) to the time of process startup (January 2003), which is 6.08 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Cementation High-Efficiency Particulate Air (HEPA)
Filters System 1 Adjustment Factor = 0.01
Cementation HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the remote-handled (RH) sludges will be processed (6 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Bq = becquerel.

Ci = curie.

g = gram.

TRU = transuranic.

Table B.3-5. Estimated radionuclide emissions for waste remediation of supernate for the Cementation Alternative

Radionuclide	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227		2.18E+01			0.00E+00	0.00E+00
Ag-110		7.80E-07			0.00E+00	0.00E+00
Ag-110m		6.84E-01			0.00E+00	0.00E+00
Am-241[g]		4.32E+02		1.66E-05	1.66E-09	2.97E-10
Am-243		7.37E+03			0.00E+00	0.00E+00
Au-196		1.69E-02			0.00E+00	0.00E+00
Au-198		7.38E-03		0.00E+00	0.00E+00	0.00E+00
Bk-249		8.76E-01		0.00E+00	0.00E+00	0.00E+00
C-14	2.24E-09	5.73E+03	2.24E-09	4.12E-03	4.12E-07	7.37E-08
Ce-144	3.07E-08	7.80E-01	2.89E-10	5.31E-04	5.31E-08	9.49E-09
Cf-249		3.51E+02		0.00E+00	0.00E+00	0.00E+00
Cf-252	4.86E-11	2.65E+00	1.23E-11	2.27E-05	2.27E-09	4.05E-10
Cm-240		7.39E-02		0.00E+00	0.00E+00	0.00E+00
Cm-242		1.63E+02		0.00E+00	0.00E+00	0.00E+00
Cm-243		2.91E+01		0.00E+00	0.00E+00	0.00E+00
Cm-244	2.08E-08	1.81E+01	1.70E-08	3.12E-02	3.12E-06	5.58E-07
Cm-245		8.50E+03		0.00E+00	0.00E+00	0.00E+00
Cm-246		4.73E+03		0.00E+00	0.00E+00	0.00E+00
Cm-248		3.40E+05		0.00E+00	0.00E+00	0.00E+00
Co-60	1.97E-08	5.27E+00	9.88E-09	1.82E-02	1.82E-06	3.25E-07
Cs-134	2.09E-07	2.06E+00	3.58E-08	6.58E-02	6.58E-06	1.18E-06
Cs-137	6.44E-06	3.01E+01	5.71E-06	1.05E+01	1.05E-03	1.87E-04
Es-253		5.60E-02		0.00E+00	0.00E+00	0.00E+00
Es-254m		4.48E-03		0.00E+00	0.00E+00	0.00E+00
Eu-152	9.31E-08	1.35E+01	7.11E-08	1.31E-01	1.31E-05	2.34E-06
Eu-154	3.88E-08	8.59E+00	2.54E-08	4.68E-02	4.68E-06	8.35E-07
Eu-155	2.44E-08	4.76E+00	1.14E-08	2.09E-02	2.09E-06	3.73E-07
Fe-59		1.22E-01		0.00E+00	0.00E+00	0.00E+00
Gd-153		6.61E-01		0.00E+00	0.00E+00	0.00E+00
H-3	3.98E-09	1.23E+01	2.96E-09	5.45E-03	5.45E-07	9.74E-08
I-129	3.53E-12	1.57E+07	3.53E-12	6.49E-06	6.49E-10	1.16E-10
I-131		2.20E-02		0.00E+00	0.00E+00	0.00E+00
Nb-95	3.05E-09	9.58E-02	9.71E-26	1.79E-19	1.79E-23	3.19E-24
Ni-63		1.00E+02		0.00E+00	0.00E+00	0.00E+00
Np-237		2.14E+06		0.00E+00	0.00E+00	0.00E+00
Pa-231		3.28E+04		0.00E+00	0.00E+00	0.00E+00
Pm-147		2.62E+00		0.00E+00	0.00E+00	0.00E+00
Po-209		1.02E+02		0.00E+00	0.00E+00	0.00E+00
Pu-238	9.92E-11	8.77E+01	9.51E-11	1.75E-04	1.75E-08	3.13E-09
Pu-239	8.18E-11	2.41E+04	8.18E-11	1.50E-04	1.50E-08	2.69E-09
Pu-240	7.97E-11	6.56E+03	7.96E-11	1.47E-04	1.47E-08	2.62E-09
Pu-241	1.57E-09	1.44E+01	1.22E-09	2.24E-03	2.24E-07	4.01E-08
Pu-242	4.00E-12	3.73E+05	4.00E-12	7.35E-06	7.35E-10	1.31E-10
Pu-244	4.70E-13	8.00E+05	4.70E-13	8.65E-07	8.65E-11	1.54E-11
Ra-223		3.13E-02		0.00E+00	0.00E+00	0.00E+00
Ra-226		1.60E+03		0.00E+00	0.00E+00	0.00E+00
Ru-106	5.44E-08	1.02E+00	1.53E-09	2.82E-03	2.82E-07	5.04E-08

Table B.3-5 (continued)

Radionuclide	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Sb-125		2.76E+00		0.00E+00	0.00E+00	0.00E+00
Sr-90	2.59E-07	2.88E+01	2.28E-07	4.20E-01	4.20E-05	7.50E-06
Tc-99	2.70E-08	2.11E+05	2.70E-08	4.97E-02	4.97E-06	8.88E-07
Te-123		1.00E+08		0.00E+00	0.00E+00	0.00E+00
Te-123m		3.28E-01		0.00E+00	0.00E+00	0.00E+00
Th-230		7.54E+04		0.00E+00	0.00E+00	0.00E+00
Th-232	9.40E-13	1.41E+10	9.40E-13	1.73E-06	1.73E-10	3.09E-11
U-232	4.70E-10	6.89E+01	4.46E-10	8.20E-04	8.20E-08	1.46E-08
U-233	3.36E-09	1.59E+05	3.36E-09	6.19E-03	6.19E-07	1.11E-07
U-234	6.82E-11	2.46E+05	6.82E-11	1.25E-04	1.25E-08	2.24E-09
U-235	2.82E-12	3.80E+06	2.82E-12	5.19E-06	5.19E-10	9.27E-11
U-236	1.65E-12	2.34E+07	1.65E-12	3.03E-06	3.03E-10	5.41E-11
U-238	8.98E-11	4.47E+09	8.98E-11	1.65E-04	1.65E-08	2.95E-09
U-239		4.46E-05		0.00E+00	0.00E+00	0.00E+00
Y-90		7.31E-03		0.00E+00	0.00E+00	0.00E+00
Zn-65		6.69E-01		0.00E+00	0.00E+00	0.00E+00
Zr-95	3.47E-09	1.75E-01	3.23E-18	5.95E-12	5.95E-16	1.06E-16

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351, Addendum 1.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (October 1997) to the time of process startup (January 2003), which is 5.25 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CRF)* 61:

Emissions Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Cementation High-Efficiency Particulate Air (HEPA) Filters System 1 Adjustment Factor = 0.01

Cementation HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the remote-handled (RH) sludges will be processed (6 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

g = gram.

Table B.3-6. Estimated radionuclide emissions TRU waste remediation of CH solids for the Cementation Alternative

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.10E-05	2.18E+01	8.95E-06	8.95E-12	8.95E-18	3.58E-18
Ag-110		7.80E-07				
Ag-110m		6.84E-01				
Am-241[g]	5.77E+02	4.32E+02	5.92E+02	5.92E-04	5.92E-10	2.37E-10
Am-243	1.16E+01	7.37E+03	1.16E+01	1.16E-05	1.16E-11	4.63E-12
Au-196		1.69E-02				
Au-198		7.38E-03				
Bk-249	5.77E+00	8.76E-01	3.16E-02	3.16E-08	3.16E-14	1.27E-14
C-14	1.88E-04	5.73E+03	1.87E-04	1.87E-10	1.87E-16	7.50E-17
Ce-144		7.80E-01				
Cf-249	1.68E-02	3.51E+02	1.66E-02	1.66E-08	1.66E-14	6.62E-15
Cf-252	2.09E+01	2.65E+00	3.73E+00	3.73E-06	3.73E-12	1.49E-12
Cm-240	1.10E-03	7.39E-02	1.73E-30	1.73E-36	1.73E-42	6.94E-43
Cm-242	7.46E+01	1.63E+02	7.25E+01	7.25E-05	7.25E-11	2.90E-11
Cm-243		2.91E+01				
Cm-244	2.57E+03	1.81E+01	2.00E+03	2.00E-03	2.00E-09	7.99E-10
Cm-245	3.39E-03	8.50E+03	3.39E-03	3.39E-09	3.39E-15	1.35E-15
Cm-246	1.10E-05	4.73E+03	1.10E-05	1.10E-11	1.10E-17	4.41E-18
Cm-248	2.90E-02	3.40E+05	2.90E-02	2.90E-08	2.90E-14	1.16E-14
Co-60	4.30E-03	5.27E+00	1.81E-03	1.81E-09	1.81E-15	7.24E-16
Cs-134		2.06E+00				
Cs-137	3.31E+03	3.01E+01	2.84E+03	2.84E-03	2.84E-09	1.14E-09
Es-253	8.83E+00	5.60E-02	3.76E-35	3.76E-41	3.76E-47	1.50E-47
Es-254m	1.20E+01	4.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	7.17E-04	1.35E+01	5.12E-04	5.12E-10	5.12E-16	2.05E-16
Eu-154		8.59E+00	0.00E+00			
Eu-155		4.76E+00				
Fe-59	4.42E+00	1.22E-01	2.57E-16	2.57E-22	2.57E-28	1.03E-28
Gd-153		6.61E-01				
H-3		1.23E+01				
I-129		1.57E+07				
I-131		2.20E-02				
Nb-95		9.58E-02				
Ni-63	1.22E-04	1.00E+02	1.17E-04	1.17E-10	1.17E-16	4.68E-17
Np-237	7.06E-01	2.14E+06	7.06E-01	7.06E-07	7.06E-13	2.82E-13
Pa-231	3.48E-01	3.28E+04	3.48E-01	3.48E-07	3.48E-13	1.39E-13
Pm-147	5.13E+00	2.62E+00	9.00E-01	9.00E-07	9.00E-13	3.60E-13
Po-209	2.21E-06	1.02E+02	2.11E-06	2.11E-12	2.11E-18	8.44E-19
Pu-238	4.26E+03	8.77E+01	4.04E+03	4.04E-03	4.04E-09	1.62E-09
Pu-239	1.13E+03	2.41E+04	1.13E+03	1.13E-03	1.13E-09	4.50E-10
Pu-240	1.06E+03	6.56E+03	1.06E+03	1.06E-03	1.06E-09	4.25E-10
Pu-241	3.19E+03	1.44E+01	2.32E+03	2.32E-03	2.32E-09	9.29E-10
Pu-242	2.64E-01	3.73E+05	2.64E-01	2.64E-07	2.64E-13	1.05E-13
Pu-244		8.00E+05				
Ra-223	1.32E-03	3.13E-02	6.89E-67	6.89E-73	6.89E-79	2.76E-79
Ra-226	1.78E+00	1.60E+03	1.77E+00	1.77E-06	1.77E-12	7.09E-13
Ru-106		1.02E+00				

Table B.3-6 (continued)

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Sb-125		2.76E+00				
Sr-90	1.99E+03	2.88E+01	1.70E+03	1.70E-03	1.70E-09	6.78E-10
Tc-99	1.96E+01	2.11E+05	1.96E+01	1.96E-05	1.96E-11	7.86E-12
Te-123	2.87E-05	1.00E+08	2.87E-05	2.87E-11	2.87E-17	1.15E-17
Te-123m	8.77E-04	3.28E-01	8.02E-10	8.02E-16	8.02E-22	3.21E-22
Th-230	1.32E-05	7.54E+04	1.32E-05	1.32E-11	1.32E-17	5.30E-18
Th-232	8.73E-04	1.41E+10	8.73E-04	8.73E-10	8.73E-16	3.49E-16
U-232	3.48E-01	6.89E+01	3.25E-01	3.25E-07	3.25E-13	1.30E-13
U-233	1.11E+02	1.59E+05	1.11E+02	1.11E-04	1.11E-10	4.46E-11
U-234	1.84E+01	2.46E+05	1.84E+01	1.84E-05	1.84E-11	7.37E-12
U-235	7.87E-03	3.80E+06	7.87E-03	7.87E-09	7.87E-15	3.15E-15
U-236	1.07E-04	2.34E+07	1.07E-04	1.07E-10	1.07E-16	4.29E-17
U-238	4.79E-02	4.47E+09	4.79E-02	4.79E-08	4.79E-14	1.92E-14
U-239		4.46E-05				
Y-90	1.99E+03	7.31E-03	2.14E-268	2.14E-274	2.14E-280	8.55E-281
Zn-65	3.09E-03	6.69E-01	3.38E-06	3.38E-12	3.38E-18	1.35E-18
Zr-95		1.75E-01				
TRU Activity	7.06E+03		6.84E+03	6.84E-03	6.84E-09	2.74E-09

[a]Composition data obtained from U.S. Department of Energy Memorandum, "TRU Waste Baseline Inventory Report for Oak Ridge," June 1996. The data were then scaled up from 906.22 m^3 to 1000 m^3.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (January 2003), which is 6.58 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CRF)* 61:

0.000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor	= 0.01
Glovebox/Hot Cell HEPA Filters Adjustment Factor	= 0.10
Primary HEPA Filters Adjustment Factor	= 0.01
Secondary HEPA Filters Adjustment Factor	= 0.01

[f]The annualized emissions are calculated by taken the controlled emissions from the project life and dividing by the length of time (in years) the contact-handled (CH) solids will be processed (2.5 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

TRU = transuranic.

Table B.3-7. Estimated radionuclide emissions for waste remediation of RH solids for the Cementation Alternative

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control Project life[e] (Ci)	Radionuclide emissions after control Annualized[f] (Ci/year)
Ac-227	1.12E-03	2.18E+01	8.35E-04	8.35E-10	8.35E-16	2.78E-16
Ag-110		7.80E-07			0.00E+00	0.00E+00
Ag-110m		6.84E-01			0.00E+00	0.00E+00
Am-241[g]	4.02E+01	4.32E+02	3.96E+01	3.96E-05	3.96E-11	1.32E-11
Am-243	9.99E-05	7.37E+03	9.98E-05	9.98E-11	9.98E-17	3.33E-17
Au-196		1.69E-02			0.00E+00	0.00E+00
Au-198		7.38E-03			0.00E+00	0.00E+00
Bk-249	2.00E-04	8.76E-01	1.52E-07	1.52E-13	1.52E-19	5.05E-20
C-14		5.73E+03			0.00E+00	0.00E+00
Ce-144		7.80E-01			0.00E+00	0.00E+00
Cf-249	1.51E-02	3.51E+02	1.48E-02	1.48E-08	1.48E-14	4.93E-15
Cf-252	5.20E+01	2.65E+00	4.84E+00	4.84E-06	4.84E-12	1.61E-12
Cm-240		7.39E-02			0.00E+00	0.00E+00
Cm-242		1.63E+02			0.00E+00	0.00E+00
Cm-243		2.91E+01			0.00E+00	0.00E+00
Cm-244	4.99E+02	1.81E+01	3.53E+02	3.53E-04	3.53E-10	1.18E-10
Cm-245		8.50E+03			0.00E+00	0.00E+00
Cm-246		4.73E+03			0.00E+00	0.00E+00
Cm-248		3.40E+05			0.00E+00	0.00E+00
Co-60	7.81E+00	5.27E+00	2.37E+00	2.37E-06	2.37E-12	7.89E-13
Cs-134		2.06E+00			0.00E+00	0.00E+00
Cs-137	1.33E+02	3.01E+01	1.08E+02	1.08E-04	1.08E-10	3.61E-11
Es-253		5.60E-02			0.00E+00	0.00E+00
Es-254m		4.48E-03			0.00E+00	0.00E+00
Eu-152		1.35E+01			0.00E+00	0.00E+00
Eu-154		8.59E+00			0.00E+00	0.00E+00
Eu-155		4.76E+00			0.00E+00	0.00E+00
Fe-59		1.22E-01			0.00E+00	0.00E+00
Gd-153		6.61E-01			0.00E+00	0.00E+00
H-3		1.23E+01			0.00E+00	0.00E+00
I-129		1.57E+07			0.00E+00	0.00E+00
I-131	5.00E-01	2.20E-02	2.85E-125	2.85E-131	2.85E-137	9.51E-138
Nb-95		9.58E-02			0.00E+00	0.00E+00
Ni-63		1.00E+02			0.00E+00	0.00E+00
Np-237	2.00E-01	2.14E+06	2.00E-01	2.00E-07	2.00E-13	6.66E-14
Pa-231		3.28E+04			0.00E+00	0.00E+00
Pm-147		2.62E+00			0.00E+00	0.00E+00
Po-209		1.02E+02			0.00E+00	0.00E+00
Pu-238	2.94E+01	8.77E+01	2.74E+01	2.74E-05	2.74E-11	9.14E-12
Pu-239	7.31E+00	2.41E+04	7.30E+00	7.30E-06	7.30E-12	2.43E-12
Pu-240	9.08E-06	6.56E+03	9.08E-06	9.08E-12	9.08E-18	3.03E-18
Pu-241	9.27E+00	1.44E+01	5.99E+00	5.99E-06	5.99E-12	2.00E-12
Pu-242		3.73E+05			0.00E+00	0.00E+00
Pu-244		8.00E+05			0.00E+00	0.00E+00
Ra-223	1.12E-03	3.13E-02	5.25E-91	5.25E-97	5.25E-103	1.75E-103
Ra-226		1.60E+03			0.00E+00	0.00E+00
Ru-106		1.02E+00			0.00E+00	0.00E+00

Table B.3-7 (continued)

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control Project life[e] (Ci)	Annualized[f] (Ci/year)
Sb-125		2.76E+00			0.00E+00	0.00E+00
Sr-90	4.83E+01	2.88E+01	3.88E+01	3.88E-05	3.88E-11	1.29E-11
Tc-99		2.11E+05			0.00E+00	0.00E+00
Te-123		1.00E+08			0.00E+00	0.00E+00
Te-123m		3.28E-01			0.00E+00	0.00E+00
Th-230		7.54E+04			0.00E+00	0.00E+00
Th-232	1.12E-03	1.41E+10	1.12E-03	1.12E-09	1.12E-15	3.72E-16
U-232		6.89E+01			0.00E+00	0.00E+00
U-233	4.51E+00	1.59E+05	4.51E+00	4.51E-06	4.51E-12	1.50E-12
U-234		2.46E+05			0.00E+00	0.00E+00
U-235	4.30E-04	3.80E+06	4.30E-04	4.30E-10	4.30E-16	1.43E-16
U-236		2.34E+07			0.00E+00	0.00E+00
U-238	9.99E-05	4.47E+09	9.99E-05	9.99E-11	9.99E-17	3.33E-17
U-239		4.46E-05			0.00E+00	0.00E+00
Y-90	4.83E+01	7.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65		6.69E-01			0.00E+00	0.00E+00
Zr-95		1.75E-01			0.00E+00	0.00E+00

[a]Composition data obtained from U.S. Department of Energy Memorandum, "TRU Waste Baseline Inventory Report for Oak Ridge," June 1996.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (July 2005), which is 9.08 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = 0.000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor	=	0.01
Glovebox/Hot Cell HEPA Filters Adjustment Factor	=	0.10
Primary HEPA Filters Adjustment Factor	=	0.01
Secondary HEPA Filters Adjustment Factor	=	0.01

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the RH solids will be processed (1.5 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

Table B.3-8. Summary of TRU waste remediation hourly particulate emissions (lb/h) for the Cementation Alternative

Metals	Class.	Average hourly emissions (lbs/h)							Maximum hourly emissions[a] (lbs/h)	Average annual emissions[b] (tons/year)
		Sludge	Supernate	Sludge and supernate	CH solids	RH solids	CH/RH solids	Total		
TSP		4.29E-03	4.29E-03	4.29E-03	1.71E-04	1.71E-04	1.71E-04	4.29E-03	5.37E-03	3.31E-03
Total HAP		4.76E-06	6.04E-08	1.75E-06	2.26E-12	5.16E-13	1.31E-12	4.57E-06	5.72E-06	1.29E-06
Silver (Ag)		3.38E-08	7.45E-10	1.26E-08	5.25E-14	8.75E-15	2.86E-14	3.25E-08	4.06E-08	9.34E-09
Aluminum (Al)		3.43E-05	5.25E-08	1.24E-05				3.30E-05	4.13E-05	9.16E-06
Arsenic (As)	HAP	7.36E-08	7.49E-09	3.13E-08				7.08E-08	8.84E-08	2.31E-08
Boron (B)		5.36E-08	4.70E-09	2.23E-08				5.15E-08	6.44E-08	1.65E-08
Barium (Ba)		4.01E-07	6.82E-09	1.49E-07				3.86E-07	4.82E-07	1.10E-07
Beryllium (Be)	HAP	7.84E-09	3.73E-11	2.84E-09				7.54E-09	9.42E-09	2.10E-09
Bismuth (Bi)		0.00E+00	1.01E-08	6.45E-09				0.00E+00	0.00E+00	4.77E-09
Calcium (Ca)		1.03E-04	5.08E-06	4.04E-05				9.93E-05	1.24E-04	2.99E-05
Cadmium (Cd)	HAP	3.94E-08	1.45E-09	1.51E-08	2.10E-13	4.37E-14	1.19E-13	3.79E-08	4.74E-08	1.12E-08
Cerium (Ce)		0.00E+00	1.38E-09	8.83E-10				0.00E+00	0.00E+00	6.54E-10
Cobalt (Co)	HAP	1.56E-08	5.96E-10	5.99E-09				1.50E-08	1.87E-08	4.43E-09
Chromium (Cr)	HAP	1.45E-06	2.54E-08	5.36E-07				1.39E-06	1.74E-06	3.97E-07
Cesium (Cs)		1.70E-08	6.71E-09	1.04E-08				1.63E-08	2.04E-08	7.69E-09
Copper (Cu)		2.29E-07	3.20E-09	8.45E-08				2.20E-07	2.75E-07	6.25E-08
Iron (Fe)		1.85E-05	4.06E-08	6.68E-06				1.78E-05	2.22E-05	4.94E-06
Gallium (Ga)		0.00E+00	1.23E-09	7.88E-10				0.00E+00	0.00E+00	5.83E-10
Mercury (Hg)	HAP	2.81E-07	2.94E-09	1.03E-07	2.10E-13	4.37E-14	1.19E-13	2.70E-07	3.38E-07	7.62E-08
Iodine (I)		0.00E+00	5.51E-08	3.53E-08				0.00E+00	0.00E+00	2.61E-08
Potassium (K)		2.73E-05	4.22E-05	3.69E-05				2.63E-05	3.29E-05	2.73E-05
Lanthanum (La)		0.00E+00	1.49E-10	9.55E-11				0.00E+00	0.00E+00	7.07E-11
Lithium (Li)		0.00E+00	9.95E-08	6.37E-08				0.00E+00	0.00E+00	4.71E-08
Magnesium (Mg)		1.74E-05	6.65E-07	6.67E-06				1.67E-05	2.09E-05	4.93E-06
Manganese (Mn)	HAP	4.46E-07	1.23E-09	1.61E-07				4.29E-07	5.36E-07	1.19E-07
Molybdenum (Mo)		0.00E+00	4.62E-09	2.96E-09				0.00E+00	0.00E+00	2.19E-09
Sodium (Na)		1.88E-04	2.04E-04	1.98E-04				1.81E-04	2.26E-04	1.47E-04
Niobium (Nb)		0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	HAP	2.72E-07	4.58E-09	1.01E-07				2.61E-07	3.27E-07	7.45E-08
Phosphorus (P)		5.64E-05	2.60E-07	2.04E-05				5.42E-05	6.77E-05	1.51E-05
Lead (Pb)	HAP	1.98E-06	9.43E-09	7.18E-07	1.84E-12	4.29E-13	1.07E-12	1.90E-06	2.38E-06	5.31E-07
Rubidium (Rb)		0.00E+00	4.40E-09	2.82E-09				0.00E+00	0.00E+00	2.08E-09
Antimony (Sb)	HAP	1.17E-07	3.69E-09	4.44E-08				1.12E-07	1.41E-07	3.29E-08
Selenium (Se)	HAP	8.03E-08	3.50E-09	3.11E-08				7.71E-08	9.64E-08	2.30E-08
Silicon (Si)		9.74E-06	2.05E-07	3.63E-06				9.36E-06	1.17E-05	2.69E-06
Tin (Sn)		0.00E+00	1.42E-09	9.07E-10				0.00E+00	0.00E+00	6.71E-10
Strontium (Sr)		3.80E-07	4.80E-08	1.67E-07				3.66E-07	4.57E-07	1.24E-07
Thorium (Th)		2.51E-05	4.10E-08	9.07E-06				2.42E-05	3.02E-05	6.71E-06
Titanium (Ti)		0.00E+00	1.90E-09	1.22E-09				0.00E+00	0.00E+00	9.01E-10
Thallium (Th)		5.16E-08	6.60E-09	2.28E-08				4.96E-08	6.20E-08	1.69E-08
Uranium (U)		2.06E-04	1.62E-06	7.52E-05				1.98E-04	2.48E-04	5.57E-05
Vanadium (V)		1.23E-08	3.35E-10	4.65E-09				1.19E-08	1.48E-08	3.44E-09
Tungsten (W)		0.00E+00	1.71E-09	1.10E-09				0.00E+00	0.00E+00	8.13E-10
Zinc (Zn)		5.71E-07	5.18E-08	2.38E-07				5.49E-07	6.86E-07	1.76E-07
Zirconium (Zr)		0.00E+00	1.12E-10	7.16E-11				0.00E+00	0.00E+00	5.30E-11

[a]Maximum hourly is estimated by multiplying the average hourly rate by 1.25.
[b]Average annual emissions are the average hourly emissions multiplied by the operational hours and then divided by 6 years.
h = hour. HAP = hazardous air pollutant. lb = pound. TRU = transuranic. TSP = total suspended particulate.

Table B.3-9. Estimated metals emissions for remediation of the TRU sludge for the Cementation Alternative

Metals	Metals[a] mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
TSP		1.30E-01	6.21E+07	1.37E+05	6.21E+03	1.37E+01	4.29E-03
Silver (Ag)	7.88E-06	1.02E-06	4.89E+02	1.08E+00	4.89E-02	1.08E-04	3.38E-08
Aluminum (Al)	8.01E-03	1.04E-03	4.97E+05	1.10E+03	4.97E+01	1.10E-01	3.43E-05
Arsenic (As)	1.72E-05	2.23E-06	1.07E+03	2.35E+00	1.07E-01	2.35E-04	7.36E-08
Boron (B)	1.25E-05	1.62E-06	7.76E+02	1.71E+00	7.76E-02	1.71E-04	5.36E-08
Barium (Ba)	9.37E-05	1.21E-05	5.81E+03	1.28E+01	5.81E-01	1.28E-03	4.01E-07
Beryllium (Be)	1.83E-06	2.37E-07	1.14E+02	2.50E-01	1.14E-02	2.50E-05	7.84E-09
Bismuth (Bi)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Calcium (Ca)	2.41E-02	3.12E-03	1.50E+06	3.30E+03	1.50E+02	3.30E-01	1.03E-04
Cadmium (Cd)	9.20E-06	1.19E-06	5.71E+02	1.26E+00	5.71E-02	1.26E-04	3.94E-08
Cerium (Ce)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt (Co)	3.64E-06	4.72E-07	2.26E+02	4.98E-01	2.26E-02	4.98E-05	1.56E-08
Chromium (Cr)	3.37E-04	4.37E-05	2.09E+04	4.62E+01	2.09E+00	4.62E-03	1.45E-06
Cesium (Cs)	3.96E-06	5.13E-07	2.46E+02	5.42E-01	2.46E-02	5.42E-05	1.70E-08
Copper (Cu)	5.35E-05	6.93E-06	3.32E+03	7.32E+00	3.32E-01	7.32E-04	2.29E-07
Iron (Fe)	4.32E-03	5.60E-04	2.68E+05	5.91E+02	2.68E+01	5.91E-02	1.85E-05
Gallium (Ga)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury (Hg)	6.56E-05	8.50E-06	4.07E+03	8.98E+00	4.07E-01	8.98E-04	2.81E-07
Iodine (I)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium (K)	6.38E-03	8.27E-04	3.96E+05	8.73E+02	3.96E+01	8.73E-02	2.73E-05
Lanthanum (La)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lithium (Li)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Magnesium (Mg)	4.05E-03	5.25E-04	2.51E+05	5.54E+02	2.51E+01	5.54E-02	1.74E-05
Manganese (Mn)	1.04E-04	1.35E-05	6.46E+03	1.42E+01	6.46E-01	1.42E-03	4.46E-07
Molybdenum (Mo)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium (Na)	4.39E-02	5.69E-03	2.72E+06	6.00E+03	2.72E+02	6.00E-01	1.88E-04
Niobium (Nb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	6.34E-05	8.22E-06	3.94E+03	8.68E+00	3.94E-01	8.68E-04	2.72E-07
Phosphorus (P)	1.32E-02	1.71E-03	8.17E+05	1.80E+03	8.17E+01	1.80E-01	5.64E-05
Lead (Pb)	4.62E-04	5.99E-05	2.87E+04	6.32E+01	2.87E+00	6.32E-03	1.98E-06
Rubidium (Rb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony (Sb)	2.73E-05	3.54E-06	1.69E+03	3.73E+00	1.69E-01	3.73E-04	1.17E-07
Selenium (Se)	1.87E-05	2.43E-06	1.16E+03	2.56E+00	1.16E-01	2.56E-04	8.03E-08
Silicon (Si)	2.27E-03	2.95E-04	1.41E+05	3.11E+02	1.41E+01	3.11E-02	9.74E-06
Tin (Sn)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium (Sr)	8.88E-05	1.15E-05	5.51E+03	1.21E+01	5.51E-01	1.21E-03	3.80E-07
Thorium (Th)	5.87E-03	7.60E-04	3.64E+05	8.03E+02	3.64E+01	8.03E-02	2.51E-05
Titanium (Ti)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium (Th)	1.21E-05	1.56E-06	7.48E+02	1.65E+00	7.48E-02	1.65E-04	5.16E-08
Uranium (U)	4.82E-02	6.24E-03	2.99E+06	6.59E+03	2.99E+02	6.59E-01	2.06E-04
Vanadium (V)	2.88E-06	3.73E-07	1.79E+02	3.94E-01	1.79E-02	3.94E-05	1.23E-08
Tungsten (W)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table B.3-9 (continued)

Metals	Metals[a] mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
Zinc (Zn)	1.33E-04	1.73E-05	8.27E+03	1.82E+01	8.27E-01	1.82E-03	5.71E-07
Zirconium (Zr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351. An average density of 1.3 g/mL was used for the sludge. Given the volume stated in the request for proposal of 900 m^3 of sludge, there is 1,170,000 kg of sludge mass.

[b]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Concentration = 1.0 gr/dscf = 0.1296 g/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

The operating schedule was presented from Sect. 2.4. of this Environmental Impact Statement:

The exhaust flow rate is based on obtaining one complete volume change of air in the cementation processing area every 15 min. Given that the hot cell is approximately 50 ft wide × 50 ft long × 15 ft high, the exhaust flowrate is 2500 dscfm.

Air Flow Rate = 2500 dscfm
Process Operating Schedule = 6 years life; 118.5 d/year, 8 h/d; and 60 min/h
Calculated Operating Hours = 5688 h

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 99%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

TRU = transuranic.

Table B.3-10. Estimated metals emissions for remediation of supernate waste for the Cementation Alternative

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
TSP		1.30E-01	1.11E+08	2.44E+05	1.11E+04	2.44E+01	4.29E-03
Silver (Ag)	1.74E-07	2.25E-08	1.92E+01	4.24E-02	1.92E-03	4.24E-06	7.45E-10
Aluminum (Al)	1.22E-05	1.59E-06	1.35E+03	2.98E+00	1.35E-01	2.98E-04	5.25E-08
Arsenic (As)	1.75E-06	2.27E-07	1.93E+02	4.26E-01	1.93E-02	4.26E-05	7.49E-09
Boron (B)	1.10E-06	1.42E-07	1.21E+02	2.67E-01	1.21E-02	2.67E-05	4.70E-09
Barium (Ba)	1.59E-06	2.06E-07	1.76E+02	3.88E-01	1.76E-02	3.88E-05	6.82E-09
Beryllium (Be)	8.70E-09	1.13E-09	9.62E-01	2.12E-03	9.62E-05	2.12E-07	3.73E-11
Bismuth (Bi)	2.35E-06	3.04E-07	2.60E+02	5.72E-01	2.60E-02	5.72E-05	1.01E-08
Calcium (Ca)	1.19E-03	1.54E-04	1.31E+05	2.89E+02	1.31E+01	2.89E-02	5.08E-06
Cadmium (Cd)	3.39E-07	4.40E-08	3.75E+01	8.27E-02	3.75E-03	8.27E-06	1.45E-09
Cerium (Ce)	3.22E-07	4.17E-08	3.56E+01	7.84E-02	3.56E-03	7.84E-06	1.38E-09
Cobalt (Co)	1.39E-07	1.80E-08	1.54E+01	3.39E-02	1.54E-03	3.39E-06	5.96E-10
Chromium (Cr)	5.93E-06	7.69E-07	6.56E+02	1.45E+00	6.56E-02	1.45E-04	2.54E-08
Cesium (Cs)	1.57E-06	2.03E-07	1.73E+02	3.82E-01	1.73E-02	3.82E-05	6.71E-09
Copper (Cu)	7.48E-07	9.69E-08	8.27E+01	1.82E-01	8.27E-03	1.82E-05	3.20E-09
Iron (Fe)	9.47E-06	1.23E-06	1.05E+03	2.31E+00	1.05E-01	2.31E-04	4.06E-08
Gallium (Ga)	2.87E-07	3.72E-08	3.17E+01	7.00E-02	3.17E-03	7.00E-06	1.23E-09
Mercury (Hg)	6.87E-07	8.90E-08	7.60E+01	1.67E-01	7.60E-03	1.67E-05	2.94E-09
Iodine (I)	1.29E-05	1.67E-06	1.42E+03	3.14E+00	1.42E-01	3.14E-04	5.51E-08
Potassium (K)	9.86E-03	1.28E-03	1.09E+06	2.40E+03	1.09E+02	2.40E-01	4.22E-05
Lanthanum (La)	3.48E-08	4.51E-09	3.85E+00	8.48E-03	3.85E-04	8.48E-07	1.49E-10
Lithium (Li)	2.32E-05	3.01E-06	2.57E+03	5.66E+00	2.57E-01	5.66E-04	9.95E-08
Magnesium (Mg)	1.55E-04	2.01E-05	1.72E+04	3.78E+01	1.72E+00	3.78E-03	6.65E-07
Manganese (Mn)	2.87E-07	3.72E-08	3.17E+01	7.00E-02	3.17E-03	7.00E-06	1.23E-09
Molybdenum (Mo)	1.08E-06	1.40E-07	1.19E+02	2.63E-01	1.19E-02	2.63E-05	4.62E-09
Sodium (Na)	4.77E-02	6.18E-03	5.27E+06	1.16E+04	5.27E+02	1.16E+00	2.04E-04
Niobium (Nb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	1.07E-06	1.39E-07	1.18E+02	2.61E-01	1.18E-02	2.61E-05	4.58E-09
Phosphorus (P)	6.08E-05	7.88E-06	6.72E+03	1.48E+01	6.72E-01	1.48E-03	2.60E-07
Lead (Pb)	2.20E-06	2.85E-07	2.43E+02	5.36E-01	2.43E-02	5.36E-05	9.43E-09
Rubidium (Rb)	1.03E-06	1.33E-07	1.13E+02	2.50E-01	1.13E-02	2.50E-05	4.40E-09
Antimony (Sb)	8.61E-07	1.12E-07	9.52E+01	2.10E-01	9.52E-03	2.10E-05	3.69E-09
Selenium (Se)	8.17E-07	1.06E-07	9.04E+01	1.99E-01	9.04E-03	1.99E-05	3.50E-09
Silicon (Si)	4.79E-05	6.21E-06	5.30E+03	1.17E+01	5.30E-01	1.17E-03	2.05E-07
Tin (Sn)	3.30E-07	4.28E-08	3.65E+01	8.06E-02	3.65E-03	8.06E-06	1.42E-09
Strontium (Sr)	1.12E-05	1.45E-06	1.24E+03	2.73E+00	1.24E-01	2.73E-04	4.80E-08
Thorium (Th)	9.57E-06	1.24E-06	1.06E+03	2.33E+00	1.06E-01	2.33E-04	4.10E-08
Titanium (Ti)	4.43E-07	5.75E-08	4.90E+01	1.08E-01	4.90E-03	1.08E-05	1.90E-09
Thallium (Th)	1.54E-06	1.99E-07	1.70E+02	3.75E-01	1.70E-02	3.75E-05	6.60E-09
Uranium (U)	3.78E-04	4.90E-05	4.18E+04	9.22E+01	4.18E+00	9.22E-03	1.62E-06
Vanadium (V)	7.83E-08	1.01E-08	8.65E+00	1.91E-02	8.65E-04	1.91E-06	3.35E-10

Table B.3-10 (continued)

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
Tungsten (W)	4.00E-07	5.18E-08	4.42E+01	9.75E-02	4.42E-03	9.75E-06	1.71E-09
Zinc (Zn)	1.21E-05	1.57E-06	1.34E+03	2.94E+00	1.34E-01	2.94E-04	5.18E-08
Zirconium (Zr)	2.61E-08	3.38E-09	2.88E+00	6.36E-03	2.88E-04	6.36E-07	1.12E-10

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351, Addendum 1. An average density of 1.15 g/mL was obtained for the supernate from Table 4.1, p. 3 of ORNL/TM-13351, Addendum 1. Given the volume stated in the request for proposal of 1600 m^3 of supernate, there is 1,840,000 kg of supernate mass.

[b]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Concentration = 2.0 gr/dscf = 0.1296 g/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

The operating schedule was presented from Sect. 2.4. of this Environmental Impact Statement:

The exhaust flow rate is based on obtaining one complete volume change of air in the cementation processing area every 15 min. Given that the hot cell is approximately 50 ft wide × 50 ft long × 15 ft high, the exhaust flowrate is 2500 dscfm.

Air Flow Rate = 2500 dscfm
Process Operating Schedule = 6 years life; 118.5 d/year, 8 h/d; and 60 min/h
Calculated Operating Hours = 5688 h

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 99%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

Table B.3-11. Metal emissions for remediation of TRU/CH solid wastes using 40 *CFR* 61 Appendix D calculation procedures for the Cementation Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	(lbs)	Metals emissions after control[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	100	1.00E-01	2.20-04	1.00E-07	2.20E-10	5.25E-14
Cadmium (Cd)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	2.10E-13
Mercury (Hg)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	2.10E-13
Lead (Pb)	3,500	3.50E+00	7.72E-03	3.50E-06	7.72E-09	1.84E-12
Total	4,400					

	Concentration[f] (g/dscf)	Uncontrolled TSP emissions (g)	(lbs)	TSP emissions after control (g)	(lbs)	Average hourly emissions (lbs/h)
TSP	0.1296	3.27E+08	7.20E+05	3.27E+02	7.02E-01	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.4 of this Environmental Impact Statement:

Process Operating Schedule = 3 years life; 210 d/year; 8 h/d; and 60 min/h
Calculated Operating Hours = 5040 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01
First HEPA Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

CH = contact handled.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

TRU = transuranic.

Table B.3-12. Metal emissions for remediation of TRU/CH solid wastes using 40 *CFR* 61 Appendix D calculation procedures for the Cementation Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	(lbs)	Metals emissions after control[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	20	2.00E-02	4.41E-05	2.00E-08	4.41E-11	8.75E-15
Cadmium (Cd)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	4.37E-14
Mercury (Hg)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	4.37E-14
Lead (Pb)	980	9.80E-01	2.16E-03	9.80E-07	2.16E-09	4.29E-13
Total	1200					

	Concentration[f] (g/dscf)	Uncontrolled TSP emissions (g)	(lbs)	TSP emissions after control (g)	(lbs)	Average hourly emissions (lbs/h)
TSP	0.1296	3.92E+08	8.64E+05	3.92E+02	8.64-01	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.4 of this Environmental Impact Statement:

Process Operating Schedule = 3 years life; 210 d/year; 8 h/d; and 60min/h
Calculated Operating Hours = 5040 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01
First HEPA Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

CH = contact handled.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

TRU = transuranic.

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APPENDIX B.4

FLOOR PLANS FOR THE PROPOSED LOW-TEMPERATURE DRYING WASTE TREATMENT FACILITY

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Figure B.4-1. 1st floor plan/Preferred Alternative.

Figure B.4-2. 2nd floor plan/Preferred Alternative.

Figure B.4-3. 3rd floor plan/Preferred Alternative.

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