

APPENDIX A

WASTE CONTAINER INVENTORY CALCULATIONS

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From Table A-1, the volume of a waste canister is 0.89 cubic meter.

According to Table A-2, the average radioactivity of waste material in the canister is 3.72 PE-Ci/cubic meter.

Total PE-C Average PE-Ci per Container

Therefore, the average radioactivity of waste material in the canister shipped to WIPP is 3.31 PE-Ci (3.72 PE-Ci/cubic meter x 0.89 cubic meter).

The radioactivity of a waste canister used in the SAR analysis is 80 PE-Ci for direct loaded waste and 240 PE-Ci for double contained waste.

Therefore, the average bounding radioactivity of a waste canister shipped to WIPP is 1.4% (3.35 PE-Ci/240 PE-Ci) of the radioactivity used in the SAR analysis or the radioactivity of a waste canister analyzed in the SAR is about 240 times the average radioactivity of a waste canister shipped to WIPP.

From the data in Table A-1, the total radioactivity (last column in Table A-1 (based on average radioactivity of 3.72 PE-Ci/m³) of the waste in different waste forms stored at different Generator Sites, and based on shipping requirements, almost no waste in the complex can exceed the bounding 240 PE-Ci per waste canister used in the SAR analysis.

The weighting factors used in the PE-Ci conversion in Table A-2 is taken from DOE/EH-0071, "Internal Dose Conversion Factors for Calculation of Dose to the Public", July 1988.

Table A-1 Radioactivity and Volume at Generator Sites by Waste Form

Final Waste Form Consolidated By Generator Site	Stored Volume, M ³	Projected Volume, M ³	Equivalent Number of Canisters*	Total PE-Ci
Combustible	3.6E+01	4.9E+01	41	
IN	2.1E+01	0.0E+00	24	7.9E+01
LA	1.5E+01	4.9E+01	17	5.6E+01
Filter	4.9E+01	4.6E+01	55	
WV	4.9E+01	4.6E+01	55	1.8E+02
Heterogeneous	2.3E+03	4.4E+03	2578	
BC	5.8E+02	0.0E+00	653	2.2E+03
BT	0.0E+00	6.7E+00	0	0.0E+00
IN	5.0E+01	0.0E+00	56	1.9E+02
KA	2.5E+00	5.8E+01	3	9.3E+00
LA	1.2E+01	0.0E+00	13	4.3E+01
OR	1.4E+03	2.4E+02	1609	5.3E+03
RL	2.0E+02	4.1E+03	224	7.4E+02
WV	1.8E+01	0.0E+00	20	6.6E+01
Inorganic Non-Metal	4.6E+01	1.0E+02	52	
AW	0.0E+00	2.1E+01	0	0.0E+00
IN	4.6E+01	0.0E+00	52	1.7E+02
Lead/Cadmium Metal Waste	7.1E+00	6.7E+01	8	
AW	0.0E+00	6.2E+00	0	0.0E+00
ET	8.9E-01	0.0E+00	1	3.3E+00
IN	3.6E+00	0.0E+00	4	1.3E+01
RL	2.7E+00	6.1E+01	3	9.9E+00
Solidified Inorganics	1.1E+03	2.3E+02	1240	
AW	1.8E+00	2.8E+01	2	6.6E+00
IN	6.5E+01	0.0E+00	73	2.4E+02
OR	1.0E+03	2.1E+02	1165	3.9E+03
Solidified Organics	3.6E+00	0.0E+00	4	
IN	3.6E+00	0.0E+00	4	1.3E+01
Uncategorized Metal	3.5E+02	1.7E+04	396	
AW	1.8E+01	0.0E+00	20	6.5E+01
IN	3.1E+01	0.0E+00	35	1.1E+02
LA	6.8E+01	5.0E+01	76	2.5E+02
RL	0.0E+00	1.7E+04	0	0.0E+00
WV	2.4E+02	0.0E+00	266	8.8E+02
Unknown	6.3E+00	8.3E-01	7	
ET	5.4E+00	8.3E-01	6	2.0E+01
OR	8.9E-01	0.0E+00	1	3.3E+00
Totals	3.9E+03	2.2E+04	4381	1.5E+04

* Volume of Waste Canister is 0.89 cubic meters

See legend at bottom of Table A-3 for generator site names

TABLE A-2 pu-239 Equivalent Radioactivity of RH Waste

	RH-TRU Waste	RH-TRU Waste	Effective Dose *	Ratio of Pu239 to Ei	RH-TRU Waste	RH-TRU Waste	Comments
	Ai/m ³	Ai	Ei	Total PE-Ci	Average PE-Ci	AM/m ³	See App b for equation
	Ci/m ³	Total Ci	rem/uCi		PE-Ci	PE-Ci/m ³	
Ac225	1.66E-05	1.18E-01	1.0E+01	5.1E+01	2.30E-03	3.25E-07	
Ac227	1.07E-07	7.58E-04	6.7E+03	7.6E-02	9.95E-03	1.41E-06	
Ac228	1.10E-05	7.79E-02	2.9E-01	1.8E+03	4.43E-05	6.25E-09	
Ag110	2.46E-13	1.74E-09					No contribution to PE-Ci
Ag110m	1.85E-11	1.31E-07	5.3E-02	9.6E+03	1.36E-11	1.92E-15	
Am241	8.42E-01	5.96E+03	5.2E+02	9.8E-01	6.08E+03	8.59E-01	
Am243	3.23E-08	2.29E-04	5.2E+02	9.8E-01	2.33E-04	3.29E-08	
Am245	4.06E-20	2.87E-16	6.6E-05	7.7E+06	3.72E-23	5.25E-27	
At217	1.66E-05	1.18E-01					No contribution to PE-Ci
Ba137m	2.89E+01	2.05E+05					No contribution to PE-Ci
Bi210	1.01E-09	7.15E-06	1.9E-01	2.7E+03	2.66E-09	3.76E-13	
Bi211	1.07E-07	7.58E-04					No contribution to PE-Ci
Bi212	1.04E-05	7.36E-02	2.1E-02	2.4E+04	3.03E-06	4.28E-10	
Bi213	1.66E-05	1.18E-01	1.7E-02	3.0E+04	3.92E-06	5.53E-10	
Bi214	5.05E-09	3.58E-05	6.3E-03	8.1E+04	4.42E-10	6.24E-14	
Bk249	2.80E-15	1.98E-11	1.3E+00	3.9E+02	5.05E-14	7.14E-18	
C14	2.90E-04	2.05E+00	2.1E-03	2.4E+05	8.45E-06	1.19E-09	
Cd113m	7.71E-11	5.46E-07	1.4E+00	3.6E+02	1.50E-09	2.12E-13	
Ce144	7.24E-04	5.13E+00	3.5E-01	1.5E+03	3.52E-03	4.97E-07	
Cf249	6.31E-07	4.47E-03	5.5E+02	9.3E-01	4.82E-03	6.80E-07	
Cf252	1.82E-04	1.29E+00	1.3E+02	3.9E+00	3.28E-01	4.64E-05	
Cm243	6.99E-03	4.95E+01	3.5E+02	1.5E+00	3.40E+01	4.80E-03	
Cm244	4.45E-02	3.15E+02	2.7E+02	1.9E+00	1.67E+02	2.36E-02	
Cm245	2.07E-10	1.47E-06	5.4E+02	9.4E-01	1.55E-06	2.19E-10	
Cm248	2.89E-08	2.05E-04	1.9E+03	2.7E-01	7.62E-04	1.08E-07	
Co58	1.75E-15	1.24E-11	7.1E-03	7.2E+04	1.72E-16	2.44E-20	
Co60	1.47E+00	1.04E+04	1.5E-01	3.4E+03	3.06E+00	4.32E-04	
Cr51	4.29E-10	3.04E-06	2.6E-04	2.0E+06	1.55E-12	2.19E-16	
Cs134	2.60E-03	1.84E+01	4.7E-02	1.1E+04	1.70E-03	2.40E-07	
Cs135	1.66E-08	1.18E-04	4.5E-03	1.1E+05	1.04E-09	1.46E-13	
Cs137	3.05E+01	2.16E+05	3.2E-02	1.6E+04	1.35E+01	1.91E-03	
Eu152	1.73E-01	1.22E+03	2.2E-01	2.3E+03	5.28E-01	7.46E-05	
Eu154	8.34E-02	5.90E+02	2.6E-01	2.0E+03	3.01E-01	4.25E-05	
Eu155	1.67E-02	1.18E+02	3.9E-02	1.3E+04	9.04E-03	1.28E-06	
Fe55	2.38E-05	1.69E-01	2.6E-03	2.0E+05	8.59E-07	1.21E-10	
Fr221	1.66E-05	1.18E-01	1.1E-02	4.6E+04	2.53E-06	3.58E-10	
Fr223	1.48E-09	1.05E-05	6.1E-03	8.4E+04	1.25E-10	1.77E-14	
H3	9.33E-06	6.61E-02	6.3E-05	8.1E+06	8.16E-09	1.15E-12	
Kr85	2.37E-04	1.68E+00					No contribution to PE-Ci
Mn54	3.32E-06	2.35E-02	6.4E-03	8.0E+04	2.95E-07	4.17E-11	
Nb95	9.45E-05	6.69E-01	4.5E-03	1.1E+05	5.90E-06	8.34E-10	
Nb95m	3.17E-07	2.24E-03	2.2E-03	2.3E+05	9.68E-09	1.37E-12	

TABLE A-2 pu-239 Equivalent Radioactivity of RH Waste

	RH-TRU Waste	RH-TRU Waste	Effective Dose	Ratio of Pu239 to Ei	RH-TRU Waste	RH-TRU Waste	Comments
	Ai/m ³	Ai	Ei	WF	AM	AM/m ³	See App b for equation
	Ci/m ³	Total Ci	rem/uCi		PE-Ci	PE-Ci/m ³	
Ni63	1.40E-04	9.91E-01	3.0E-03	1.7E+05	5.83E-06	8.24E-10	
Np237	4.02E-04	2.85E+00	4.9E+02	1.0E+00	2.73E+00	3.86E-04	
Np239	3.23E-08	2.29E-04	2.2E-03	2.3E+05	9.86E-10	1.39E-13	
Np240m	3.12E-15	2.21E-11					No contribution to PE-Ci
Pa231	2.70E-07	1.91E-03	1.3E+03	3.9E-01	4.87E-03	6.88E-07	
Pa233	4.02E-04	2.85E+00	8.6E-03	5.9E+04	4.80E-05	6.78E-09	
Pa234	1.92E-06	1.36E-02	7.4E-04	6.9E+05	1.97E-08	2.79E-12	
Pa234m	1.48E-03	1.05E+01					No contribution to PE-Ci
Pb209	1.66E-05	1.18E-01	9.0E-05	5.7E+06	2.07E-08	2.93E-12	
Pb210	1.01E-09	7.15E-06	1.3E+01	3.9E+01	1.82E-07	2.57E-11	
Pb211	1.07E-07	7.58E-04	8.0E-03	6.4E+04	1.19E-08	1.68E-12	
Pb212	1.04E-05	7.36E-02	1.6E-01	3.2E+03	2.31E-05	3.26E-09	
Pb214	5.05E-09	3.58E-05	6.7E-03	7.6E+04	4.70E-10	6.63E-14	
Pd107	2.45E-09	1.73E-05	1.3E-02	3.9E+04	4.42E-10	6.25E-14	
Pm147	1.52E-03	1.08E+01	3.4E-02	1.5E+04	7.17E-04	1.01E-07	
Po210	1.01E-09	7.15E-06	8.1E+00	6.3E+01	1.14E-07	1.60E-11	
Po211	3.00E-10	2.12E-06					No contribution to PE-Ci
Po212	6.66E-05	4.72E-01					No contribution to PE-Ci
Po213	1.62E-05	1.15E-01					No contribution to PE-Ci
Po214	5.05E-09	3.58E-05					No contribution to PE-Ci
Po215	1.07E-07	7.58E-04					No contribution to PE-Ci
Po216	1.04E-05	7.36E-02					No contribution to PE-Ci
Po218	5.05E-09	3.58E-05					No contribution to PE-Ci
Pr144	7.16E-04	5.07E+00	4.2E-05	1.2E+07	4.17E-07	5.90E-11	
Pu238	2.05E-01	1.45E+03	4.6E+02	1.1E+00	1.31E+03	1.85E-01	
Pu239	1.45E+00	1.03E+04	5.1E+02	1.0E+00	1.03E+04	1.45E+00	
Pu240	7.15E-01	5.06E+03	5.1E+02	1.0E+00	5.06E+03	7.15E-01	
Pu241	2.00E+01	1.42E+05	1.0E+01	5.1E+01	2.78E+03	3.92E-01	
Pu242	2.11E-05	1.49E-01	4.8E+02	1.1E+00	1.41E-01	1.99E-05	
Pu244	3.12E-15	2.21E-11	4.8E+02	1.1E+00	2.08E-11	2.94E-15	
Ra223	1.07E-07	7.58E-04	7.5E+00	6.8E+01	1.11E-05	1.57E-09	
Ra224	1.04E-05	7.36E-02	2.9E+00	1.8E+02	4.19E-04	5.91E-08	
Ra225	1.66E-05	1.18E-01	7.5E+00	6.8E+01	1.73E-03	2.44E-07	
Ra226	5.05E-09	3.58E-05	7.9E+00	6.5E+01	5.54E-07	7.82E-11	
Ra228	1.10E-05	7.79E-02	4.2E+00	1.2E+02	6.41E-04	9.06E-08	
Rh106	1.54E-03	1.09E+01	2.0E-04	2.6E+06	4.28E-06	6.04E-10	
Rn219	1.07E-07	7.58E-04					No contribution to PE-Ci
Rn220	1.04E-05	7.36E-02					No contribution to PE-Ci
Rn222	5.05E-09	3.58E-05					No contribution to PE-Ci
Ru106	1.54E-03	1.09E+01					No contribution to PE-Ci
Sb125	2.67E-04	1.89E+00	9.8E-03	5.2E+04	3.63E-05	5.13E-09	
Sb126	4.46E-06	3.16E-02	1.0E-02	5.1E+04	6.19E-07	8.75E-11	

TABLE A-2 pu-239 Equivalent Radioactivity of RH Waste

	RH-TRU Waste	RH-TRU Waste	Effective Dose	Ratio of Pu239 to Ei	RH-TRU Waste	RH-TRU Waste	Comments
	Ai/m ³	Ai	Ei	WF	AM	AM/m ³	See App b for equation
	Ci/m ³	Total Ci	rem/uCi		PE-Ci	PE-Ci/m ³	
Sb126m	3.18E-08	2.25E-04	2.8E-05	1.8E+07	1.24E-11	1.75E-15	
Se79	1.44E-08	1.02E-04	8.9E-03	5.7E+04	1.78E-09	2.51E-13	
Sm151	5.05E-05	3.58E-01	2.9E-02	1.8E+04	2.03E-05	2.87E-09	
Sn119m	1.35E-10	9.56E-07	5.3E-03	9.6E+04	9.93E-12	1.40E-15	
Sn121m	9.45E-07	6.69E-03	8.9E-03	5.7E+04	1.17E-07	1.65E-11	
Sn126	3.18E-08	2.25E-04	8.6E-02	5.9E+03	3.80E-08	5.36E-12	
Sr90	2.95E+01	2.09E+05	1.3E+00	3.9E+02	5.32E+02	7.52E-02	
Ta182	5.95E-12	4.21E-08	3.7E-02	1.4E+04	3.06E-12	4.32E-16	
Tc99	8.26E-07	5.85E-03	7.5E-03	6.8E+04	8.60E-08	1.21E-11	
Tel125m	6.57E-05	4.65E-01	6.7E-03	7.6E+04	6.11E-06	8.63E-10	
Tel127	2.41E-13	1.71E-09	2.9E-04	1.8E+06	9.70E-16	1.37E-19	
Tel127m	2.47E-13	1.75E-09	1.9E-02	2.7E+04	6.51E-14	9.20E-18	
Th227	1.06E-07	7.50E-04	1.6E+01	3.2E+01	2.35E-05	3.33E-09	
Th228	1.04E-05	7.36E-02	3.1E+02	1.6E+00	4.48E-02	6.32E-06	
Th229	1.66E-05	1.18E-01	2.0E+03	2.6E-01	4.61E-01	6.51E-05	
Th230	1.07E-06	7.58E-03	3.2E+02	1.6E+00	4.75E-03	6.71E-07	
Th231	6.53E-04	4.62E+00	8.1E-04	6.3E+05	7.34E-06	1.04E-09	
Th232	1.31E-05	9.27E-02	1.6E+03	3.2E-01	2.91E-01	4.11E-05	
Th234	1.48E-03	1.05E+01	3.3E-02	1.5E+04	6.78E-04	9.58E-08	
Tl207	1.07E-07	7.58E-04					No contribution to PE-Ci
Tl208	3.74E-06	2.65E-02					No contribution to PE-Ci
Tl209	3.58E-07	2.53E-03					No contribution to PE-Ci
U233	2.23E-02	1.58E+02	1.3E+02	3.9E+00	4.02E+01	5.68E-03	
U234	6.03E-03	4.27E+01	1.3E+02	3.9E+00	1.09E+01	1.54E-03	
U235	6.53E-04	4.62E+00	1.2E+02	4.3E+00	1.09E+00	1.54E-04	
U236	1.37E-05	9.70E-02	1.2E+02	4.3E+00	2.28E-02	3.22E-06	
U237	4.91E-04	3.48E+00	3.3E-03	1.5E+05	2.25E-05	3.18E-09	
U238	1.48E-03	1.05E+01	1.2E+02	4.3E+00	2.47E+00	3.48E-04	
U240	3.12E-15	2.21E-11	2.1E-03	2.4E+05	9.10E-17	1.28E-20	
Y90	2.95E+01	2.09E+05	8.2E-03	6.2E+04	3.36E+00	4.74E-04	
Zr93	1.86E-07	1.32E-03	3.2E-01	1.6E+03	8.26E-07	1.17E-10	
Zr95	4.27E-05	3.02E-01	1.9E-02	2.7E+04	1.13E-05	1.59E-09	
Totals	1.43E+02	1.02E+06			2.63E+04	3.72E+00	

This Data is generated from the Table in Attachment A from the TWBIR Rev 3, June 1996

* DOE/EH-0071, "Internal dose Conversion Factors for Calculation of Dose to the Public", July 1988

Table A-3 Average PE-Ci per Container and Generator Site

Consolidated By Generator Site	Stored Volume, M ³	Projected Volume, M ³	Equivalent Number of Cannisters	Total PE-Ci	Average PE-Ci per Container
AW	1.9E+01	5.6E+01	22	7.2E+01	3.25E+00
ET	6.3E+00	8.3E-01	7	2.3E+01	3.29E+00
LA	9.4E+01	9.9E+01	106	3.5E+02	3.29E+00
RL	2.0E+02	2.2E+04	227	7.5E+02	3.30E+00
WV	3.0E+02	4.6E+01	337	1.1E+03	3.35E+00
OR	2.5E+03	4.5E+02	2777	9.2E+03	3.31E+00
KA	2.5E+00	5.8E+01	3	9.3E+00	3.10E+00
BC	5.8E+02	0.0E+00	654	2.2E+03	3.36E+00
IN	2.2E+02	0.0E+00	248	8.2E+02	3.31E+00
Totals	3.9E+03	2.3E+04	4381	1.5E+04	3.32E+00

AW - ARGONNE NATIONAL LAB WEST
 BC - BATELLE COLUMBUS LABORATORY
 ET - ENERGY TECHNOLOGY ENGINEERING CENTER
 IN - IDAHO NATIONAL ENGINEERING LABORATORY
 KA - KNOLLS ATOMIC POWER LABORATORY
 LA - LAS ALAMOS NATIONAL LABORATORY
 OR - OAK RIDGE NATIONAL LABORATORY
 RL - HANFORD SITE
 WV - WEST VALLEY DEMONSTRATION PROJECT