



Westinghouse Electric Company
Nuclear Fuel
Columbia Fuel Site
P.O. Drawer R
Columbia, South Carolina 29250
USA

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Your ref:
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Date: February 21, 2012

Subject: Assessment of Public Radiological Dose from Liquid and Gaseous Effluents for Calendar Year 2011

Effluents released from plant operations are monitored to determine the quantities of radio nuclides discharged into the environment. The accumulated activities for the period starting 1-1-2011 and ending 12-31-2011 were summarized and input into dose models developed by the NRC/EPA to estimate commitment rates from the following pathways:

- Air Effluents by Direct Inhalation – Estimated by running EPA's COMPLY Code at level 2 complexity. The organ dose was estimated by calculating the X/Q factor used in the COMPLY analysis of stack number 6 using the measured release quantity and dose conversion factors from Federal Guidance Report No 11, "Limiting Values of Radionuclide Intake and Air concentration Factors for Inhalation, Submersion, and Ingestion"(FGR 11) for inhalation.
- Liquid Effluents by Ingestion of Potable Water – Estimated from formulas and recommended values in Regulatory Guide 1.109, Doses from Liquid Effluent Pathways (RG1.109). Dose conversion factors were taken from FGR 11.
- Liquid Effluents by Ingestion of Fish – Estimated from formulas and recommended values in RG 1.109. Dose conversion factors were taken from FGR 11.
- Liquid Effluents by Irradiation from Shoreline Deposits – Estimated from formulas and recommended values in RG 1.109. Dose conversion factors were taken from Federal Guidance report No 12, "External Exposure to Radionuclides in Air, Water, and Soil"

The radiological impacts were assessed by calculating the maximum total body dose and selected organ doses at the nearest site boundary.

- The inhalation dose is determined at the nearest site boundary at a distance of 595 meters.
- The ingestion dose from liquid and external dose from sediment is determined at the point at which the liquid effluent leaves the diffuser in the Congaree River.

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The release rates (source term) for gaseous effluent used in all of the calculations are taken from measured values obtained from daily air samples, one per stack for 47 stacks, measured for gross alpha. The release rates (source term) for liquid effluent, used in all of the calculations, is taken from monthly composite liquid effluent samples which are sent to an off-site lab for isotopic analysis. There is potential for technetium in our feed material and the liquid effluent is also tested for this isotope. Air samples were also tested for Tc-99 and no detectable quantities were found.

The total activities measured and /or estimated for calendar year 2011 were:

401.6 μ Ci of Uranium released as gaseous effluent
6.9 mCi of Uranium released in liquid effluent
14.1 mCi of Technetium released in liquid effluent

For airborne effluents released into the environment, the pathways considered for the individual dose calculations included direct inhalation and an estimate of the dose to the maximally exposed organ (lung and bone). For liquid effluent releases, the pathways included potable water, aquatic food (fish) and shoreline deposition. The models and various assumptions used in the liquid effluent environmental pathways are taken from Regulatory guide 1.109 and the details of both the gaseous and liquid dose calculations are documented in the attached spreadsheets listed below:

Attachment 1:	Dose From Gaseous Effluents
Attachment 2:	Lung/Bone Organ Dose for Gaseous Effluent
Attachment 3:	Dose from Liquid Effluent Pathways Potable Water Total
Attachment 4:	Dose from Liquid Effluent Pathways Potable Water Bone
Attachment 5:	Dose from Liquid Effluent Pathways Aquatic Foods Total
Attachment 6:	Dose from Liquid Effluent Pathways Aquatic Foods Bone
Attachment 7:	Dose from Liquid Effluent Pathways Sediment
Attachment 8:	2011 Liquid Effluent Totals
Attachment 9:	Uranium Specific Activity

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The results summarized in the table below indicate that the critical pathway is due to inhalation resulting in a maximum whole body dose of 0.160 mRem/yr and a lung dose of 1.45 mRem/yr. These doses are well below both the 25 mrem annual dose limit as well as the 10 mrem ALARA limit.

Results			
Pathways	Total Body (mRem/yr)	Organ Dose (mRem/yr)	Organ Dose (mRem/yr)
		Bone	Lung
Air Effluents			
Direct inhalation*	0.16	5.50-03	1.45
Liquid Effluents			
Potable Water	1.67E-04	2.44E-03	
Aquatic Food(Fish)	1.03E-05	1.40E-04	
Shoreline Deposit	5.47E-09		
Total (mRem/Yr)	0.16	8.04E-03	1.45

* 80 % residence time



Dan Colwell
Manager, Environment, Health & Safety Operations
RSO



Technical Review by Anna Pearson
Assistant RSO, Principle Engineer
Environment, Health & Safety

Gaseous Effluent Discharges -												
Calendar year 2011												
Released												
Total uCi												
Ci/s												
U234												
U235												
U238												
Stack Height												
Meter												
1st half												
2nd half												
uCi Uranium /6months												
uCi URANIUM/ 6months												
uCi/d												
uCi/h												
uCi/s												
U234												
U235												
U238												
1	FURNACE EX LINE 1	13	3.99	4.78	8.77	2.40E-02	1.00E-03	2.78E-07	2.36E-13	8.34E-15	3.34E-14	
2	FURNACE EX LINE 2	13	3.75	4.72	8.47	2.32E-02	9.67E-04	2.69E-07	2.28E-13	8.06E-15	3.22E-14	
3	FURNACE EX LINE 3	13	4.18	4.8	8.98	2.46E-02	1.03E-03	2.85E-07	2.42E-13	8.54E-15	3.42E-14	
4	FURNACE EX LINE 4	13	3.93	4.49	8.42	2.31E-02	9.61E-04	2.67E-07	2.27E-13	8.01E-15	3.20E-14	
5	FURNACE EX LINE 5	13	4.64	6.68	11.32	3.10E-02	1.29E-03	3.59E-07	3.06E-13	1.08E-14	4.31E-14	
6	NEW DECON RM	13	2.78	28.5	31.28	8.57E-02	3.57E-03	9.92E-07	8.43E-13	2.98E-14	1.19E-13	
7	MET LAB EX	10	2.2	3.18	5.38	1.47E-02	6.14E-04	1.71E-07	1.45E-13	5.12E-15	2.05E-14	
8	INCINER EX	13	13.29	4.96	18.25	5.00E-02	2.08E-03	5.79E-07	4.92E-13	1.74E-14	6.94E-14	
9	SUPPL INC EX	13	1.88	3.67	5.55	1.52E-02	6.34E-04	1.76E-07	1.50E-13	5.28E-15	2.11E-14	
10	CONVERS 1-A EX	16	7.77	8.11	15.88	4.35E-02	1.81E-03	5.04E-07	4.28E-13	1.51E-14	6.04E-14	
11	CONVERSION 1-B	16	0	0	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
12	S-1030-A	16	13.19	15.04	28.23	7.73E-02	3.22E-03	8.95E-07	7.61E-13	2.69E-14	1.07E-13	
13	S-1030-B	16	1.73	3.2	4.93	1.35E-02	5.63E-04	1.56E-07	1.33E-13	4.69E-15	1.88E-14	
14	MAINT ENCL 4B	13	0	0	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
15	CONV ENCL EX 4C	13	6.66	9.94	16.60	4.55E-02	1.89E-03	5.26E-07	4.47E-13	1.58E-14	6.32E-14	
16	CONV ENCL EX 4D	13	0	0	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
17	CONV EMERG EX 4E	13	0.99	1.61	2.60	7.12E-03	2.97E-04	8.24E-08	7.01E-14	2.47E-15	9.89E-15	
18	CHEM LAB FILTERED EX	17	7.68	8.73	16.41	4.50E-02	1.87E-03	5.20E-07	4.42E-13	1.56E-14	6.24E-14	
19	DECON ROOM EX	13	2.2	3.23	5.43	1.49E-02	6.20E-04	1.72E-07	1.46E-13	5.17E-15	2.07E-14	
20	CAL COMBGAS LN 1	12	0.53	1.52	2.05	5.62E-03	2.34E-04	6.50E-08	5.53E-14	1.95E-15	7.80E-15	
21	CAL COMBGAS LN 2	12	0.29	0.57	0.86	2.36E-03	9.82E-05	2.73E-08	2.32E-14	8.18E-16	3.27E-15	
22	CAL COMBGAS LN 3	12	0.37	0.57	0.94	2.68E-03	1.07E-04	2.98E-08	2.53E-14	8.94E-16	3.58E-15	
23	CAL COMBGAS LN 4	12	0.32	0.46	0.78	2.14E-03	8.90E-05	2.47E-08	2.10E-14	7.42E-16	2.97E-15	
24	CAL COMBGAS LN 5	12	1.14	1.28	2.42	6.63E-03	2.76E-04	7.67E-08	6.52E-14	2.30E-15	9.21E-15	
25	CHEM LAB # 2	16	1.83	4.81	6.64	1.82E-02	7.58E-04	2.11E-07	1.79E-13	6.32E-15	2.53E-14	
26	CHEM LAB #3	12	0.42	0.45	0.87	2.38E-03	9.93E-05	2.76E-08	2.34E-14	8.28E-16	3.31E-15	
27	HP LAB EX	15	0.81	0.96	1.77	4.85E-03	2.02E-04	5.61E-08	4.77E-14	1.68E-15	6.74E-15	
28	DEV LAB 1 EX	13	3.41	5.15	8.56	2.35E-02	9.77E-04	2.71E-07	2.31E-13	8.14E-15	3.26E-14	
29	DEV LAB 2 EX	12	4.15	8.26	12.41	3.40E-02	1.42E-03	3.94E-07	3.34E-13	1.18E-14	4.72E-14	
30	PELLET COMBINED	13	6.15	7.19	13.34	3.65E-02	1.52E-03	4.23E-07	3.60E-13	1.27E-14	5.08E-14	
31	SOLV X N	13	3.86	4.52	8.38	2.30E-02	9.57E-04	2.66E-07	2.26E-13	7.97E-15	3.19E-14	
32	SOLV X S	13	2.19	3.22	5.41	1.48E-02	6.18E-04	1.72E-07	1.46E-13	5.15E-15	2.06E-14	
34	MAP COMBINED	15	0	0	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
35	ABF HOOD TORIT EX	12	2.31	3.01	5.32	1.46E-02	6.07E-04	1.69E-07	1.43E-13	5.08E-15	2.02E-14	
36	IFBA EX	10	5.89	6.02	11.91	3.26E-02	1.36E-03	3.78E-07	3.21E-13	1.13E-14	4.53E-14	
37	MAINT WELD EX	11	3.51	4.18	7.69	2.11E-02	8.78E-04	2.44E-07	2.07E-13	7.32E-15	2.93E-14	
38	AC-3	15	4.83	5.36	10.19	2.79E-02	1.16E-03	3.23E-07	2.75E-13	9.69E-15	3.88E-14	
39	PELLET LINE 6	12	3.87	3.8	7.67	2.10E-02	8.76E-04	2.43E-07	2.07E-13	7.30E-15	2.92E-14	
40	AC-5	17	4.73	5.53	10.26	2.81E-02	1.17E-03	3.25E-07	2.77E-13	9.78E-15	3.90E-14	
41	AC-8	11	4.93	5.5	10.43	2.86E-02	1.19E-03	3.31E-07	2.81E-13	9.92E-15	3.97E-14	
42	AMMONIA FUME SC 1008-A	17	3.21	4.27	7.48	2.05E-02	8.54E-04	2.37E-07	2.02E-13	7.12E-15	2.85E-14	
43	AMMONIA FUME SC 1008-B	17	0	0	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
44	AC-4	15	6.67	5.25	11.92	3.27E-02	1.36E-03	3.78E-07	3.21E-13	1.13E-14	4.54E-14	
45	HOT OIL RM EX	12	7.8	13.22	21.02	5.76E-02	2.40E-03	6.67E-07	5.67E-13	2.00E-14	8.00E-14	
46	ERBIA FURNACE EX	18	10.16	10.33	20.49	5.61E-02	2.34E-03	6.50E-07	5.52E-13	1.95E-14	7.80E-14	
47	ERBIA SCRUBBER EX	18	5.39	5.53	10.92	2.99E-02	1.25E-03	3.46E-07	2.94E-13	1.04E-14	4.16E-14	
48	ERBIA CHANGE ROOM	18	2.54	2.83	5.37	1.47E-02	6.13E-04	1.70E-07	1.45E-13	5.11E-15	2.04E-14	
					401.60							
									1.08E-11	3.82E-13	1.53E-12	
									Sum of Offsite Dose			
									0.20	mRem/yr		
									0.16	80% residence time		
Result is substantially less than 10 mRem/yr												

O:\Regulatory\EH&S Operations\Environment\Environment 2011\2011 annual stack for whole year.xlsx

Doses from Liquid Effluent Pathway														
Potable Water		Whole Body-Ingestion												
730 ltrs	Usage by adult	U	10CFR20	7.3 x 10 ⁵ (ml) which is the annual water intake of "Reference Man."										
31293 mixing - dilution	Dilution at diffuser	M												
0.3 cubic ft/sec	Average discharge	F	Congaree Flow Effluent Flow	9388 cubic feet/sec	see Nureg-1118 Environmental Assessment for renewam ...SNM-1107 May 1985									
2.83E-04 U-234	mRem/pCi	D	EPA Limiting Values of Radionuclide Intake.....		effective	bone	effective	bone						
2.66E-04 U-235	mRem/pCi	D	FRG no 11 1988		Sv/Bq	Sv/Bq	mRem/pCi	mRem/pCi						
2.69E-04 U-236	mRem/pCi	D	Exposure-to-dose conversion factors for ingestion		U-234	7.66E-08	1.13E-06	2.83E-04	4.18E-03	for comparison only				
2.55E-04 U-238	mRem/pCi	D			U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03					
1.46E-06 Tc-99	mRem/pCi	D			U-236	7.26E-08	1.07E-06	2.69E-04	3.96E-03	Part 20 table 2		soluble forms		
					U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03	Dose Conversion				
					Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07					
12 hrs	transit time	t-p	reg guide 1.109 table E-15							U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05
3.23557E-10 U-234	decay const	A	Nuclide		T(1/2) yr	T(1/2) hr	A			U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05
1.12404E-13 U-235	decay const	A	URANIUM234		2.45E+05	2.14E+09	3.24E-10			U-236	3.00E-07	7.30E+05	2.19E-01	2.19E+05
3.38075E-12 U-236	decay const	A	URANIUM235		7.04E+08	6.17E+12	1.12E-13			U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05
1.77058E-14 U-238	decay const	A	URANIUM236		2.34E+07	2.05E+11	3.38E-12			Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07
3.71407E-10 Tc-99	decay const	A	URANIUM238		4.47E+09	3.91E+13	1.77E-14			ICRP 69	Comparison			
			TC-99		2.13E+06	1.87E+09	3.71E-10							
0.9999999961 U-234	exp(-lambda*p)													
1.0000000000 U-235	exp(-lambda*p)													
1.0000000000 U-236	exp(-lambda*p)													
1.0000000000 U-238	exp(-lambda*p)									adult	5.00E-08	0.006	1.85E-04	
0.9999999955 Tc-99	exp(-lambda*p)									infant	3.70E-07	0.037	1.37E-03	
										bone-adult	7.90E-07	0.079	2.92E-03	
Annual Release rate														
0.0069230 total uranium(Ci)	Q		summation of liquid effluent alpha activity for 2011	see Total Liq tab										
			% of activity based on current nominal uranium isotopic	see u activity tab										
5.8914E-03 U-234 release fraction	Ci		URANIUM234	85.100%										
2.2154E-04 U-235 release fraction	Ci		URANIUM235	3.200%										
6.9230E-06 U-236 release fraction	Ci		URANIUM236	0.100%										
8.0306E-04 U-238 release fraction	Ci		URANIUM238	11.600%										
1.4089E-02 Tc-99 release fraction	Ci		TC-99											
check U sum														
1.67E-06 U-234	release fraction*dose factor*exp(-lambda*tp)													
5.89E-08 U-235	release fraction*dose factor*exp(-lambda*tp)													
1.86E-09 U-236	release fraction*dose factor*exp(-lambda*tp)													
2.04E-07 U-238	release fraction*dose factor*exp(-lambda*tp)													
2.06E-08 Tc-99	release fraction*dose factor*exp(-lambda*tp)													
1.96E-06 all nuclides	sum of nuclides													
85.53473 usage	1100*(usage*dilution)/flow													
1.67E-04 mRem/yr	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.													

Doses from Liquid Effluent Pathway														
Potable Water		Bone Surface Ingestion												
730	liters	Usage by adult	U	10CFR20 7.3 x 10 ³ (ml) which is the annual water intake of "Reference Man."										
31293	mixing - dilution	Dilution at diffuser	M											
0.3	cubic ft/sec	Average discharge	F	Congaree Flow	9388	cubic feet/sec	see Nureg-1118 Environmental Assessment for renewam ...SNM-1107 May 1985							
				Effluent Flow	3.00E-01	cubic feet/sec								
4.18E-03	U-234	mRem/pCi	D-bone	EPA Limiting Values of Radioisotope Intake.....			effective	bone	effective	bone	Part 20 table 2 soluble forms			
3.88E-03	U-235	mRem/pCi	D-bone	FRG no 11 1988			Sv/Bq	Sv/Bq	mRem/pCi	mRem/pCi	Dose Conversion			
3.96E-03	U-236	mRem/pCi	D-bone	Exposure-to-dose conversion factors for ingestion			U-234	7.66E-08	1.13E-06	2.83E-04	4.18E-03	uCi/ml	milliliters	uCi
3.74E-03	U-238	mRem/pCi	D-bone				U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03			pCi
2.23E-07	Tc-99	mRem/pCi	D-bone				U-236	7.26E-08	1.07E-06	2.69E-04	3.96E-03	U-234	3.00E-07	7.30E+05
							U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03	U-235	3.00E-07	7.30E+05
							Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07	U-236	3.00E-07	7.30E+05
12	hrs	transit time	t-p	reg guide table E-15								U-238	3.00E-07	7.30E+05
												Tc-99	6.00E-05	7.30E+05
3.23557E-10	U-234	decay const	λ	Nuclide			T(1/2) yr	T(1/2) hr	λ					
1.12404E-13	U-235	decay const	λ	URANIUM234			2.45E+05	2.14E+09	3.24E-10	ICRP 69 Comparison				
3.38075E-12	U-236	decay const	λ	URANIUM235			7.04E+08	6.17E+12	1.12E-13					
1.77058E-14	U-238	decay const	λ	URANIUM236			2.34E+07	2.05E+11	3.38E-12					
3.71407E-10	Tc-99	decay const	λ	URANIUM238			4.47E+09	3.91E+13	1.77E-14					
				TC-99			2.13E+05	1.87E+09	3.71E-10					
0.9999999961	U-234	exp(-λt-p)										adult	5.00E-08	0.005
1.0000000000	U-235	exp(-λt-p)										infant	3.70E-07	0.037
1.0000000000	U-236	exp(-λt-p)										bone-adult	7.90E-07	0.079
1.0000000000	U-238	exp(-λt-p)												
0.9999999955	Tc-99	exp(-λt-p)												
Annual Release rate														
0.0069230	total uranium(Ci)	Q	summation of liquid effluent alpha activity see Total Liq tab											
			% of activity based on current nominal uranium isotope see u activity tab											
5.6914E-03	U-234 release fraction	Ci	URANIUM234	85.100%										
2.2154E-04	U-235 release fraction	Ci	URANIUM235	3.200%										
6.9230E-06	U-236 release fraction	Ci	URANIUM236	0.100%										
8.0306E-04	U-238 release fraction	Ci	URANIUM238	11.600%										
1.4089E-02	Tc-99 release fraction	Ci	TC-99											
check U sum	0.00692													
2.46E-05	U-234	release fraction *dose factor*exp(-λ*tp)												
8.61E-07	U-235	release fraction *dose factor*exp(-λ*tp)												
2.74E-08	U-236	release fraction *dose factor*exp(-λ*tp)												
3.00E-06	U-238	release fraction *dose factor*exp(-λ*tp)												
3.15E-09	Tc-99	release fraction *dose factor*exp(-λ*tp)												
2.85E-05	all nuclides	sum of nuclides												
85.53473	usage	1100*(usage*dilution)/flow												
2.44E-03	mRem/yr	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.												

Doses from Liquid Effluent Pathway																		
Aquatic Foods		Whole Body																
21 Kg	Usage by adult	U	see regulatory guide 1.109 page 1.109-40 table E-5, Recommended Values for U(ap)															
31293 mixing - dilution	Dilution at diffuser	M	Congaree Flow		9388	cubic feet/sec		see Nureg-1118 Environmental Assessment for renewam ...SNM-1107 May 1985										
0.3 cubic ft/sec	Average discharge	F	Effluent Flow		3.00E-01	cubic feet/sec												
2.83E-04 U-234	mRem/pCi	D	EPA Limiting Values of Radioisotope Intake.....				effective	bone	effective	bone								
2.66E-04 U-235	mRem/pCi	D	FRG no 11 1988				U-234	7.66E-08	1.13E-06	2.83E-04	4.18E-03	for comparison only						
2.69E-04 U-236	mRem/pCi	D	Exposure-to-dose conversion factors for ingestion				U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03							
2.55E-04 U-238	mRem/pCi	D					U-236	7.26E-08	1.07E-06	2.69E-04	3.96E-03	Part 20 table 2 soluble forms						
1.46E-06 Tc-99	mRem/pCi	D					U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03	Dose Conversion						
24 hrs	transit time	t-p	reg guide table E-15				Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07	uCi/ml	milliliters	uCi	pCi	mRem	mRem/pCi	
3.23557E-10 U-234	decay const	A	Nuclide		T(1/2) yr	T(1/2) hr	A					U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50 2.28E-04	
1.12404E-13 U-235	decay const	A	URANIUM234		2.45E+05	2.14E+09	3.24E-10					U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50 2.28E-04	
3.38075E-12 U-236	decay const	A	URANIUM235		7.04E+08	6.17E+12	1.12E-13					U-236	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50 2.28E-04	
1.77058E-14 U-238	decay const	A	URANIUM236		2.34E+07	2.05E+11	3.38E-12					U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50 2.28E-04	
3.71407E-10 Tc-99	decay const	A	URANIUM238		4.47E+09	3.91E+13	1.77E-14					Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07	50 1.14E-06	
			TC-99		2.13E+05	1.87E+09	3.71E-10					ICRP 69 Comparison						
0.99999999223 U-234	exp(-At-p)												Sv/Bq	Rem/Bq	mRem/pCi			
1.00000000000 U-235	exp(-At-p)																	
0.99999999992 U-236	exp(-At-p)												adult	5.00E-08	0.005	1.85E-04		
1.00000000000 U-238	exp(-At-p)												infant	3.70E-07	0.037	1.37E-03		
0.99999999109 Tc-99	exp(-At-p)												bone-adult	7.90E-07	0.079	2.92E-03		
Annual Release rate																		
0.0069230	total uranium(Ci)	Q	summation of liquid effluent alpha activity for 2011		see Total Lij tab													
			% of activity based on current nominal uranium isotopic		see u activity tab													
5.8914E-03 U-234 release fraction	Ci	URANIUM234	85.100%															
2.2154E-04 U-235 release fraction	Ci	URANIUM235	3.200%															
6.9230E-06 U-236 release fraction	Ci	URANIUM236	0.100%															
8.0306E-04 U-238 release fraction	Ci	URANIUM238	11.600%															
1.4089E-02 Tc-99 release fraction	Ci	TC-99																
check U sum	0.00692																	
			bioaccumulation factor										BNWL-2075					
3.34E-06 U-234	release fraction *bioaccumulation factor*dose factor*exp(-At*p)		2										UC-11					
1.18E-07 U-235	release fraction *bioaccumulation factor*dose factor*exp(-At*p)		2										Methodology for Calculation of Radiation Doses					
3.72E-09 U-236	release fraction *bioaccumulation factor*dose factor*exp(-At*p)		2										in the Environs from Nuclear Fuel					
4.09E-07 U-238	release fraction *bioaccumulation factor*dose factor*exp(-At*p)		2										Cycle Facilities					
3.09E-07 Tc-99	release fraction *bioaccumulation factor*dose factor*exp(-At*p)		15															
4.18E-06 all nuclides	sum of nuclides																	
2.46059 usage	1100*(usage*dilution)/flow																	
1.03E-05 mRem/yr	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.																	

Doses from Liquid Effluent Pathway														
Aquatic Foods Bone														
21 Kg	Usage by adult	U	see regulatory guide 1.109 page 1.109-40 table E-5, Recommended Values for U(ap)											
31293 mixing - dilution	Dilution at diffuser	M	Congaree Flow	9388 cubic feet/sec	see Nureg-1118 Environmental Assessment for renewam ...SNM-1107 May 1985									
0.3 cubic ft/sec	Average discharge	F	Effluent Flow	3.00E-01 cubic feet/sec										
4.18E-03 U-234	mRem/pCi	D	EPA Limiting Values of Radioisotope Intake.....			effective	bone	effective	bone	for comparison only				
3.88E-03 U-235	mRem/pCi	D	FRG no 11	1988	U-234	7.66E-08	1.13E-06	2.83E-04	4.18E-03	Part 20 table 2				
3.96E-03 U-236	mRem/pCi	D	Exposure-to-dose conversion factors for ingestion		U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03	Dose Conversion				
3.74E-03 U-238	mRem/pCi	D			U-236	7.26E-08	1.07E-06	2.69E-04	3.96E-03	uCi/ml	milliliters	uCi	pCi	mRem
2.23E-07 Tc-99	mRem/pCi	D			U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03	U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05
					Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07	U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05
24 hrs	transit time	t-p	reg guide 1.109	table E-15						U-236	3.00E-07	7.30E+05	2.19E-01	2.19E+05
3.23557E-10 U-234	decay const	A	Nuclide		T(1/2) yr		T(1/2) hr			U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05
1.12404E-13 U-235	decay const	A	URANIUM234		2.45E+05		2.14E+09	3.24E-10		Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07
3.38075E-12 U-236	decay const	A	URANIUM235		7.04E+08		6.17E+12	1.12E-13						
1.77058E-14 U-238	decay const	A	URANIUM236		2.34E+07		2.05E+11	3.38E-12		ICRP 69 Comparison				
3.71407E-10 Tc-99	decay const	A	URANIUM238		4.47E+09		3.91E+13	1.77E-14		Sv/Bq	Rem/Bq	mRem/pCi		
			TC-99		2.13E+05		1.87E+09	3.71E-10						
0.99999999223 U-234	exp(-lambda*p)									adult	5.00E-08	0.005	1.85E-04	
1.00000000000 U-235	exp(-lambda*p)									Infant	3.70E-07	0.037	1.37E-03	
0.99999999992 U-236	exp(-lambda*p)									bone-adult	7.90E-07	0.079	2.92E-03	
1.00000000000 U-238	exp(-lambda*p)													
0.99999999109 Tc-99	exp(-lambda*p)													
Annual Release rate														
0.0069230	total uranium(Ci)		summation of liquid effluent alpha activity for 2011	see Total Liq tab										
5.8914E-03 U-234 release fra	Ci		% of activity based on current nominal uranium isotopic	see u activity tab										
2.2154E-04 U-235 release fra	Ci		URANIUM234	85.100%										
6.9230E-06 U-236 release fra	Ci		URANIUM235	3.200%										
8.0306E-04 U-238 release fra	Ci		URANIUM236	0.100%										
1.4089E-02 Tc-99 release fra	Ci		URANIUM238	11.600%										
			TC-99											
check U sum	0.00692													
4.93E-05 U-234	release fraction "bioaccumulation factor" dose factor exp(-lambda*tp)					bioaccumulation factor	BNWL-2075							
1.72E-06 U-235	release fraction "bioaccumulation factor" dose factor exp(-lambda*tp)					2	UC-11							
5.48E-08 U-236	release fraction "bioaccumulation factor" dose factor exp(-lambda*tp)					2	Methodology for Calculation of Radiation Doses							
6.00E-06 U-238	release fraction "bioaccumulation factor" dose factor exp(-lambda*tp)					2	In the Environs from Nuclear Fuel							
4.72E-08 Tc-99	release fraction "bioaccumulation factor" dose factor exp(-lambda*tp)					15	Cycle Facilities							
5.71E-06 all nuclides	sum of nuclides													
2.46059 usage	T100*(usage*dilution)/flow													
1.40E-04 mRem/yr	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.													

Doses from Liquid Effluent Pathway												
Shore Line Deposits		Whole Body										
12 hr		Usage by adult	U	see regulatory guide 1.109 page 1.109-40 table E-5, Recommended Values for U(ap)								
31293 mixing - dilution		Dilution at difuser	M									
0.3 cubic ft/sec		Average discharge	F	Congaree Flow Effluent Flow		9388	cubic feet/sec	see Nureg-1118 Environmental Assessment for renewam ...SNM-1107 May 1				
				Sv/s:Bq/m^2		mrem/hr:pCi/m^2	3.00E-01	cubic feet/sec				
9.86E-12	U-234	mRem*m^2/pCi*hr	D	U-234	7.40E-19	9.86E-12	EPA FRG 12	Dose Coeff for exposure to contaminated ground surface				
1.97E-09	U-235	mRem*m^2/pCi*hr	D	U-235	1.48E-16	1.97E-09						
8.66E-12	U-236	mRem*m^2/pCi*hr	D	U-236	6.50E-19	8.66E-12						
7.34E-12	U-238	mRem*m^2/pCi*hr	D	U-238	5.51E-19	7.34E-12						
1.04E-12	Tc-99	mRem*m^2/pCi*hr	D	Tc-99	7.80E-20	1.04E-12						
12 hrs		transit time	t-p	see regulatory guide 1.109 page 1.109-69 table E-15, Recommended Values ...							t-i	
131040 hrs		xposure time of sediment	t-b	page 1.109-68								
3.23557E-10	U-234	decay const	λ				Nuclide	T(1/2) yr	T(1/2) hr	λ	T(1/2) day	
1.12404E-13	U-235	decay const	λ				URANIUM234	2.45E+05	2.14E+09	3.24E-10	8.90E+07	
3.38075E-12	U-236	decay const	λ				URANIUM235	7.04E+08	6.17E+12	1.12E-13	2.56E+11	
1.77058E-14	U-238	decay const	λ				URANIUM236	2.34E+07	2.05E+11	3.38E-12	8.52E+09	
3.71407E-10	Tc-99	decay const	λ				URANIUM238	4.47E+09	3.91E+13	1.77E-14	1.63E+12	
							TC-99	2.13E+05	1.87E+09	3.71E-10	7.75E+07	
0.0000423980	U-234	exp(-λt-p)*[1-exp(-λt-b)]										
0.0000000147	U-235	exp(-λt-p)*[1-exp(-λt-b)]										
0.0000004430	U-236	exp(-λt-p)*[1-exp(-λt-b)]										
0.0000000023	U-238	exp(-λt-p)*[1-exp(-λt-b)]										
0.0000486679	Tc-99	exp(-λt-p)*[1-exp(-λt-b)]										
Annual Release rate												
0.0069230	total uranium(Ci)	Q	summation of liquid effluent alpha activity for 2011		see Total Liq tab		see u activity tab					
5.8914E-03	U-234 release fraction	Ci	URANIUM234	85.100%								
2.2154E-04	U-235 release fraction	Ci	URANIUM235	3.200%								
6.9230E-06	U-236 release fraction	Ci	URANIUM236	0.100%								
8.0306E-04	U-238 release fraction	Ci	URANIUM238	11.600%								
1.4089E-02	Tc-99 release fraction	Ci	TC-99									
check U sum		0.00692										
2.19E-10	U-234	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i										
1.65E-09	U-235	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i										
2.26E-13	U-236	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i										
2.22E-11	U-238	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i										
5.52E-11	Tc-99	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i										
1.94E-09	all nuclides	sum of nuclides										
2.812101	usage	11000*(usage*dilution*shore width factor)/flow		see regulatory guide 1.109 page 1.109-40 table A-2,Shore width...								
5.47E-09	mRem/yr	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.										

FIRST HALF LIQUID DISCHARGES						Quantity Released, uCi		Ci
Radionuclide	Volume(ml)	uCi/ml	Error	LLD,uCi/ml				
U234	6.211E+10	4.12459E-08	+/-	3.55E-09	6E-10	2561.9	2.5619E-03	
U235		1.45574E-09	+/-	8.06E-10	6E-10	90.4	9.0421E-05	
U238		5.82294E-09	+/-	1.36E-09	6E-10	361.7	3.6168E-04	
Tc-99		1.17197E-07	+/-	1.28E-07	6E-10	7279.6	7.2796E-03	
subtotal Tc99						7279.6	7.2796E-03	
subtotal U						3014.0	3.0140E-03	
SECOND HALF LIQUID DISCHARGES						Quantity Released, uCi		Ci
Radionuclide	Volume(ml)	uCi/ml	Error	LLD,uCi/ml				
U234	7.065E+10	4.70312E-08	+/-	3.32E-09	6E-10	3322.6	3.3226E-03	
U235		1.65992E-09	+/-	7.91E-10	6E-10	117.3	1.1727E-04	
U238		6.63969E-09	+/-	1.33E-09	6E-10	469.1	4.6907E-04	
Tc-99		9.63888E-08	+/-	5.44E-09	6E-10	6809.5	6.8095E-03	
subtotal Tc99						6809.5	6.8095E-03	
Subtotal U						3908.9	3.9089E-03	
Total	Volume(ml)					Quantity Released, uCi		Ci
U234	1.328E+11	4.43244E-08				5884.5	5.8845E-03	
U235		1.56439E-09				207.7	2.0769E-04	
U238		6.25757E-09				830.8	8.3076E-04	
Tc-99		1.06124E-07				14089.1	1.4089E-02	
total U						6.923E+03	6.9230E-03	
total TC99						1.409E+04	1.4089E-02	
U234	0.851							5.8914E-03
U235	0.032							2.2154E-04
U236	0.001							6.9230E-06
U238	0.116							8.0306E-04
Tc-99	1							1.4089E-02

2011 First HALF LIQUID EFFLUENT RADIOACTIVITY DISCHARGES - NRC																	
Month	Average		Isotopic		uCi/ml E-06		uCi/ml E-06		uCi/ml E-06		Total uCi/month						
	kgal/day	kgal/month	U234 pCi/l	U234	U235 pCi/l	U235	U238 pCi/l	U238	SUM ISO	Tc-99 pCi/l	Tc-99	Sum U & Tc	U234	U-235	U-238	Tc-99	
JAN	86.285	2588.540	50.800	0.051	1.860	0.002	7.420	0.007	0.06008	191	0.191	0.251	514.312	18.831	75.122	1933.732	
FEB	110.745	2436.387	36.400	0.036	2.120	0.002	4.320	0.004	0.04284	104	0.104	0.147	427.218	24.882	50.703	1220.623	
MAR	101.406	3143.570	22.500	0.023	0.634	0.001	3.770	0.004	0.026904	132	0.132	0.159	267.716	7.544	44.857	1570.598	
APR	104.329	2816.890	24.700	0.025	1.060	0.001	4.540	0.005	0.0303	118	0.118	0.148	292.610	12.557	53.783	1397.894	
MAY	92.517	2497.960	32.900	0.033	1.420	0.001	4.870	0.005	0.03919	64.2	0.0642	0.103	357.145	15.415	52.866	696.922	
JUNE	97.571	2927.140	62.000	0.062	2.230	0.002	7.840	0.008	0.07207	41.5	0.0415	0.114	686.910	24.707	86.861	459.786	
													2545.910	103.935	364.192	3014.038 uCi U	
													2561.932	90.421	361.685	7279.555 10293.593 uCi U & Tc	
													4.173%				
													JAN	41.408	8.960	15.895	1285.780
													FEB	40.022	10.967	14.164	1572.306
													MAR	32.011	6.114	13.242	1335.700
													APR	30.236	7.100	12.976	1444.490
													MAY	34.789	8.110	13.406	1065.818
													JUNE	41.794	8.826	14.872	1259.236
													TOTAL	220.260	50.077	84.554	7963.329 8318.221
Isotopic Error xE-06 uCi/ml																	
	U234 pCi/l	U234	U235 pCi/l	U235	U238 pCi/l	U238	Tc-99 pCi/l	Tc-99									
JAN	4.090	0.00409	0.885	0.000885	1.57	0.00157	127	0.127									
FEB	3.080	0.00308	0.844	0.000844	1.09	0.00109	121	0.121									
MAR	2.780	0.00278	0.531	0.000531	1.15	0.00115	116	0.116									
APR	2.470	0.00247	0.58	0.00058	1.06	0.00106	118	0.118									
MAY	3.140	0.00314	0.732	0.000732	1.21	0.00121	96.2	0.0962									
JUNE	3.850	0.00385	0.813	0.000813	1.37	0.00137	116	0.116									
FIRST HALF LIQUID DISCHARGES																	
Radionuclide	uCi/ml		Error		LLD, uCi/ml		Quantity Released, uCi		Ci								
U234	4.12E-08		+/-		3.55E-09 6.00E-10		2561.9 0.002562										
U235	1.46E-09		+/-		8.06E-10 6.00E-10		90.4 9.04E-05										
U238	5.82E-09		+/-		1.36E-09 6.00E-10		361.7 0.000362 0.003014										
Tc-99	1.172E-07		+/-		1.282E-07 6.00E-10		7279.555 0.00728 1.213259 mCi/month										
sum							10293.6										

* Fill in blue cells
 * Yellow cells contain reporting data

2011		Second HALF LIQUID EFFLUENT RADIOACTIVITY DISCHARGES - NRC																
Month	Average kgal/day	kgal/month	U234 pCi/l	Isotopic		uCi/ml E-06			U238	SUM ISO	Tc-99 pCi/l	uCi/ml E-06		Total uCi/month		U-238	Tc-99	
				U234	U235 pCi/l	U235	U238 pCi/l	Tc-99				Sum U & Tc	U234	U-235				
JULY	84.584	2283.770	53.100	0.053	2.420	0.002	8.120	0.008	0.06364	101	0.101	0.165	527.00	24.018	80.588	1002.391		
AUG	115.271	3458.130	70.600	0.071	2.570	0.003	12.900	0.013	0.08607	165	0.165	0.251	954.89	34.760	174.477	2015.709		
SEPT	104.907	3147.220	60.400	0.060	2.530	0.003	9.560	0.010	0.07249	111	0.111	0.183	719.50	30.138	113.881	1366.328		
OCT	110.438	3423.560	25.000	0.025	1.870	0.002	4.470	0.004	0.03134	136	0.136	0.167	323.96	24.232	57.923	1705.472		
NOV	100.662	3019.870	28.900	0.029	1.320	0.001	3.350	0.003	0.03357	32.2	0.0322	0.066	330.33	15.088	38.291	380.320		
DEC	107.495	3332.350	30.800	0.031	1.230	0.001	4.430	0.004	0.03646	27.8	0.0278	0.064	388.48	15.514	55.875	339.328		
													3244.150	143.749	521.035	3908.934 uCi U		
													@4.173 %	3322.594	117.268	469.072	6809.549	10718.483 uCi U & Tc
													JULY	36.62201	8.763478	14.39076		
													AUG	70.06117	14.87786	29.89096		
													SEPT	42.16915	9.577401	16.79619		
													OCT	29.54479	8.954146	12.47879		
													NOV	27.77531	6.789521	9.544192		
													DEC	28.12682	6.924496	10.96063		
													TOTAL	234.3	55.9	94.1	384.2	768.495

	Isotopic Error		x E-06 uCi/ml				Tc-99	Tc-99
	U234 pCi/l	U234	U235 pCi/l	U235	U238 pCi/l	U238		
JULY	3.69	0.00369	0.883	0.000883	1.45	0.00145	98.3	0.0983
AUG	5.18	0.00518	1.1	0.0011	2.21	0.00221	126	0.126
SEPT	3.54	0.00354	0.804	0.000804	1.41	0.00141	95.4	0.0954
OCT	2.28	0.00228	0.691	0.000691	0.963	0.000963	132	0.132
NOV	2.43	0.00243	0.594	0.000594	0.835	0.000835	96.3	0.0963
DEC	2.23	0.00223	0.549	0.000549	0.869	0.000869	134	0.134

SECOND HALF LIQUID DISCHARGES				Quantity Released, uCi	
Radionuclide	uCi/ml	Error	LLD, uCi/ml		
U234	4.70E-08	+/-	3.32E-09	6.00E-10	3322.6
U235	1.66E-09	+/-	7.91E-10	6.00E-10	117.3
U238	6.64E-09	+/-	1.33E-09	6.00E-10	469.1
Tc-99	9.639E-08	+/-	5.439E-09	6.00E-10	6809.549
				sum	10718.5

- * Fill in blue cells
- * Yellow cells contain reporting data

Based on 2011 nominals - 235 established by safeguards personnel, 234 and 236 by average pellet chemistry in 2010-2011 and 238 by diff

Nuclide	Concent.	Wt%	uCi/g	uCi/g	Bq/g	Nuclide	
U-235 Bas U Basis			Nuclide			% Activity	
U-232	0.00	0.00E+00	21300000	0.000	0.00E+00	0.000	
U-233	0.00	0.00E+00	9480	0.000	0.00E+00	0.000	
U-234	9,106	0.0380	6234	2.369	8.77E+04	0.851	0.85
U-235		4.173	2.14	0.089	3.31E+03	0.032	0.03
U-236	1,438	0.00600	64.7	0.004	1.44E+02	0.001	0.00
U-238		95.783	0.34	0.322	1.19E+04	0.116	0.12
Totals		100.000		2.784	103014.360	1.000	