



Document Control Desk, Director
 Office of Nuclear Material Safety and Safeguards
 U. S. Nuclear Regulatory Commission
 Washington, DC 20555-0001

Direct tel: 803-647-1000

cc: USNRC, Region II
 245 Peachtree Center Ave, NE, Suite 1200
 Atlanta, Georgia 30303-1257

Our ref: LTR-RAC-22-17

Subject: SNM-1107/70-1151
 NRC Semi-Annual Discharge Report
 July – December 2021

February 24, 2022

Dear Sir:

The following report fulfills regulatory requirements as listed in 10 CFR 40.65 and 10 CFR 70.59, "Effluent Monitoring Reporting Requirements." For the six-month period of July 1, 2021, through December 31, 2021, the following quantities of radionuclides were released to the unrestricted area by the Westinghouse Electric Company's Columbia, South Carolina Nuclear Fuel Plant:

Discharge	Total 6-month emissions (µCi)	Parameter	Total 6-month Measured Concentration	Regulatory Concentration Limit
Gaseous	293	Uranium (analyzed as gross alpha)	1.9E ⁻¹⁶ µCi/mL*	5 E ⁻¹⁴ µCi/mL
Liquid Effluent #	1,164	U-234	2.0E ⁻⁰⁸ µCi/mL	3 E ⁻⁰⁷ µCi/mL
	66	U-235		
	203	U-238		
	1,302	Tc-99	1.8E ⁻⁰⁸ µCi/mL	6 E ⁻⁰⁵ µCi/mL

* Includes a dispersion factor of 1000 to account for dilution between the release point and the nearest site boundary.
 # Sum of fractions (SOF) equates to less than 1.0.

As shown above, the effluent releases are within the NRC's regulatory limits designed to protect public health and safety.

Gaseous effluent results were obtained from point source gross alpha analysis of stack gas effluent, and the individual radionuclide activity composition is inferred from the calculated average enrichment (85.23% U-234, 3.29% U-235, and 11.47% U-238). Tc-99 is not reported for gaseous effluents as the quantities of Tc-99 detected during benchmark testing of gaseous emissions were below the thresholds that would necessitate reporting.

Liquid effluent values were obtained by analysis of composite proportional samples prior to discharge to the Congaree River and basing the activity on the calculated average enrichment. All liquid discharges are pumped through a single discharge line to the Congaree River. Liquid effluent composites were analyzed by alpha spectroscopy, and significant quantities of U-236 were not detected using this method. The total liquid effluent volume released to the Congaree River during the second half of 2021 was 7.22 E⁺¹⁰ milliliters (mL).

Calculated values have been reported for all results, due to variability of minimum detection concentrations (MDC). Negative values are reported as zero.

To meet the requested dosage information outlined in Regulatory Guide 4.16, Section 6.1, LTR-EHS-22-09, "2021 Annual Assessment of Public Dose due to Liquid and Gaseous Effluents" is attached.

Sincerely,

A handwritten signature in black ink that reads "Jeff Ferguson". The signature is written in a cursive style with a large, stylized "J" and "F".

Jeff Ferguson
Manager, Environment, Health and Safety

Attachment:

LTR-EHS-22-09, "2021 Annual Assessment of Public Dose due to Liquid and Gaseous Effluents"



Westinghouse Electric Company
Nuclear Fuel
Columbia Fuel Site
5801 Bluff Rd
Hopkins, South Carolina 29061
USA

To: Cynthia Teague, Diana Joyner

Date: February 21, 2022

cc: Jeff Ferguson, Patrick Donnelly, Nancy Parr, Anna Miller

From: David Wagoner
Ext: 1919
Fax: 803.695.4158

Your ref:
Our ref: LTR-EHS-22-09

Subject: **2021 Annual Assessment of Public Dose due to Liquid and Gaseous Effluents**

Effluents released from plant operations are monitored to determine the quantities of radionuclides discharged into the environment. The cumulative radioactivity released is summarized semi-annually and annually and input into models developed by the NRC and EPA to estimate the potential dose to the public.

The whole body and organ dose via the following pathways is determined in this assessment:

Dose due to Gaseous Effluents by Direct Inhalation

- The whole body dose was estimated using EPA's COMPLY Code at level 2 complexity. The organ dose was estimated by calculating the X/Q factor using the results of the COMPLY analysis for stack #1210 (Conv 1-A Ex), the measured release quantity, and the 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).

Dose due to Liquid Effluents by Ingestion of Potable Water

- Estimated using equations and recommended values in Regulatory Guide 1.109, Doses from Liquid Effluent Pathways (RG 1.109). Dose conversion factors are referenced from FGR 11.

Dose due to Liquid Effluents by Ingestion of Fish

- Estimated using equations and recommended values in RG 1.109. Dose conversion factors are referenced from FGR 11.

Dose due to Liquid Effluents by Irradiation from Shoreline Deposition

- Estimated using equations and recommended values in RG 1.109. Dose conversion factors are referenced from Federal Guidance report No 12, "External Exposure to Radionuclides in Air, Water, and Soil."

Bounding dose assessments for direct inhalation and for ingestion are performed using conservative assumptions to determine the maximum potential dose to a hypothetical individual member of the public. The inhalation dose is determined for the hypothetical individual standing at the nearest site

boundary (595 meters) for twelve months. The ingestion dose from liquid effluent and external dose from sediment deposition is determined at the point at which the liquid effluent leaves the diffuser in the Congaree River.

The release rates for gaseous effluent are determined by gross alpha measurements performed on daily air samples, one per stack for 46 stacks (Attachment 1). The release rates for liquid effluent are determined by isotopic analysis of composite liquid effluent samples taken monthly (Attachment 3). Based on these results, the following quantities were released in calendar year 2021:

- 528.5 μCi of Uranium in gaseous effluent
- 3,064 μCi of Uranium in liquid effluent
- 3,310 μCi of Technetium in liquid effluent

Using these results and the methods previously mentioned the whole body dose, dose to the bone, and dose to the lung were determined for a hypothetical individual present at the nearest site boundary. Table 1 provides a summary of the results for each pathway. The gaseous and liquid effluents released during 2021 resulted in a potential whole body dose of 0.24 mrem, 0.008 mrem to the bone, and 1.89 mrem to the lung for an individual present at the nearest site boundary. The estimated whole body dose is well below the 25 mrem annual dose limit and the 1 mrem ALARA goal for a member of the public.

Table 1. 2021 Annual Dose to the Public from Liquid and Gaseous Effluents

	Whole Body Dose (mrem)	Organ Dose - Bone (mrem)	Organ Dose - Lung (mrem)
Gaseous Effluents			
Direct inhalation*	0.24	7.17E-03	1.89
Liquid Effluents			
Potable Water	7.33E-05	1.07E-03	-
Aquatic Food (Fish)	4.37E-06	6.18E-05	-
Shoreline Deposition	2.92E-09	-	-
<i>Total (mrem)</i>	<i>0.24</i>	<i>8.30E-03</i>	<i>1.89</i>

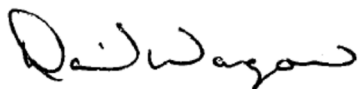
* Assumes 80 % residence time

There were no changes in source material and no release points were added during 2021. Gaseous effluent sample locations 1240, 1242, 1243, and 1246 were removed from the sampling program in the 2nd half of 2021 because these ventilation systems are outside the scope of the effluent monitoring program. All four systems are recirculating comfort air systems that are non-process related and do not exhaust to the atmosphere.

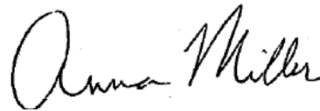
In addition, the height and diameter for each gaseous effluent stack were physically verified during the 2nd half of 2021. Several stack heights were identified to be incorrect, and SEPS-009-16 was revised to reflect the actual field measurements. Neither of these parameters are used for calculating release concentrations so there is no impact to the calculations performed by the Personnel Exposure System. Stack height is used by the Comply code to estimate dose to a member of the public, however, the impact on historical results was determined to be negligible based on re-runs of the Comply code using the revised stack heights.

The attachments below illustrate the method used to calculate each result listed in Table 1.

- Attachment 1: 2021 Gaseous Effluent Discharges
- Attachment 2: Lung/Bone Organ Dose due to Gaseous Effluent
- Attachment 3: 2021 Liquid Effluent Discharges
- Attachment 4: Whole Body Dose from Liquid Effluent Pathways - Potable Water
- Attachment 5: Dose to the Bone Surface from Liquid Effluent Pathways - Potable Water
- Attachment 6: Whole Body Dose from Liquid Effluent Pathways - Aquatic Foods
- Attachment 7: Dose to the Bone Surface from Liquid Effluent Pathways - Aquatic Foods
- Attachment 8: Whole Body Dose from Liquid Effluent Pathways – Shoreline Deposits
- Attachment 9: 2021 Isotopic Fractions
- Attachment 10: Comply Results



David Wagoner, CHP
Radiation Safety Engineer
EH&S Operations



Review by: Anna Miller
Manager, RSO
EH&S Operations

Attachment 1
2021 Gaseous Effluent Discharges

Sampling Location	Stack Height	Gross Alpha Concentration*	1st Half (Jan-Jun)	2nd Half (July-Dec)	Total uCi	Release Rate (Ci/s)			
Station Description	(m)	(uCi/mL)	uCi Uranium Released		Released	U234	U235	U238	
1239	MAINT WELD EX	9	4.74E-13	3.07	5.48	8.55	2.31E-13	8.92E-15	3.11E-14
1223	CALC COMB GAS LN 2	10	3.47E-13	0.60	0.59	1.19	3.22E-14	1.24E-15	4.33E-15
1226	CALC COMB GAS LN 5	10	2.74E-13	0.57	0.42	0.99	2.68E-14	1.03E-15	3.60E-15
1230	DEV LAB EX #1	10	4.92E-13	3.35	5.62	8.97	2.42E-13	9.36E-15	3.26E-14
1247	HOT OIL RM EX	11	5.73E-13	13.95	28.16	42.11	1.14E-12	4.39E-14	1.53E-13
1206	NEW DECON ROOM	11	1.50E-13	2.21	2.74	4.95	1.34E-13	5.16E-15	1.80E-14
1221	DECON ROOM EX	11	9.85E-13	9.43	17.17	26.60	7.19E-13	2.78E-14	9.67E-14
1231	DEV LAB EX #2	11	6.85E-13	4.46	7.92	12.38	3.35E-13	1.29E-14	4.50E-14
1243	AC-8	11	1.35E-13	5.19	3.59	8.78	2.37E-13	9.16E-15	3.19E-14
1251	WATERGLASS SCR S1190	12	4.75E-13	8.48	13.33	21.81	5.89E-13	2.28E-14	7.93E-14
1217	CONV ENCL EX 4-C	13	2.24E-13	7.39	9.95	17.34	4.69E-13	1.81E-14	6.31E-14
1218	CONV ENCL EX 4-D	13	4.49E-13	0.66	0.97	1.63	4.41E-14	1.70E-15	5.93E-15
1219	CONV EMERG EX 4E	13	5.71E-13	0.79	1.26	2.05	5.54E-14	2.14E-15	7.46E-15
1250	ERBIA CHANGE ROOM	13	1.57E-13	2.99	3.19	6.18	1.67E-13	6.45E-15	2.25E-14
1207	MET LAB EXHAUST	13	5.74E-13	2.19	3.91	6.10	1.65E-13	6.36E-15	2.22E-14
1210	CONV 1-A EX	13	7.87E-13	17.49	40.25	57.74	1.56E-12	6.02E-14	2.10E-13
1201	FURNACE EX LINE 1	13	1.37E-13	3.69	4.13	7.82	2.11E-13	8.16E-15	2.84E-14
1202	FURNACE EX LINE 2	13	1.42E-13	4.86	3.72	8.58	2.32E-13	8.95E-15	3.12E-14
1203	FURNACE EX LINE 3	13	1.28E-13	3.59	3.78	7.37	1.99E-13	7.69E-15	2.68E-14
1204	FURNACE EX LINE 4	13	1.27E-13	3.74	3.68	7.42	2.01E-13	7.74E-15	2.70E-14
1205	FURNACE EX LINE 5	13	1.26E-13	3.53	3.71	7.24	1.96E-13	7.55E-15	2.63E-14
1222	CALC COMB GAS LN 1	13	2.22E-13	0.54	0.3	0.84	2.27E-14	8.76E-16	3.06E-15
1224	CALC COMB GAS LN 3	13	2.21E-13	0.34	0.4	0.74	2.00E-14	7.72E-16	2.69E-15
1225	CALC COMB GAS LN 4	13	1.66E-13	0.30	0.28	0.58	1.57E-14	6.05E-16	2.11E-15
1237	ABF HOOD TORIT EX	13	1.35E-13	2.14	1.92	4.06	1.10E-13	4.24E-15	1.48E-14
1211	CONV 1-B EX	13	2.53E-13	0.68	0.44	1.12	3.03E-14	1.17E-15	4.07E-15
1227	CHEM LAB EX #2	14	8.85E-13	5.66	5.28	10.94	2.96E-13	1.14E-14	3.98E-14
1229	HP LAB EX	14	2.14E-13	0.93	1.49	2.42	6.54E-14	2.52E-15	8.80E-15
1232	PELLET COMBINED EX	14	1.58E-13	8.03	7.65	15.68	4.24E-13	1.64E-14	5.70E-14
1233	SOLVENT EXT N EX	14	1.30E-13	3.72	3.96	7.68	2.08E-13	8.01E-15	2.79E-14
1234	SOLVENT EXT S EX	14	5.89E-13	1.94	3.43	5.37	1.45E-13	5.60E-15	1.95E-14
1244	AMMON FUME SCR 1008A	14	3.88E-13	6.73	7.56	14.29	3.86E-13	1.49E-14	5.20E-14
1209	SUPPL INCIN EX	15	2.46E-13	2.13	2.58	4.71	1.27E-13	4.91E-15	1.71E-14
1220	CHEM LAB FILT EX	15	1.86E-13	8.81	11.75	20.56	5.56E-13	2.14E-14	7.48E-14
1236	MAP COMBINED	15	3.22E-13	7.88	10.05	17.93	4.85E-13	1.87E-14	6.52E-14
1245	AMMON FUME SCR 1008B	15	3.76E-13	0.17	0.44	0.61	1.65E-14	6.36E-16	2.22E-15
1240	AC-3	15	1.51E-13	5.48	4.14	9.62	2.60E-13	1.00E-14	3.50E-14
1246	AC-4	15	1.49E-13	5.96	4.06	10.02	2.71E-13	1.05E-14	3.64E-14
1248	ERBIA FURNACE EX	16	1.39E-13	14.84	10.39	25.23	6.82E-13	2.63E-14	9.18E-14
1249	ERBIA SCRUBBER EX	16	1.25E-13	5.41	5.81	11.22	3.03E-13	1.17E-14	4.08E-14
1208	INCINERATOR EX	16	7.32E-13	16.84	13.22	30.06	8.12E-13	3.14E-14	1.09E-13
1242	AC-5	17	1.22E-13	4.90	3.18	8.08	2.18E-13	8.43E-15	2.94E-14
1212	S1030 A	17	2.36E-13	17.95	17.64	35.59	9.62E-13	3.71E-14	1.29E-13
1213	S1030 B	17	6.76E-13	1.61	3	4.61	1.25E-13	4.81E-15	1.68E-14
1238	IFBA EXHAUST	19	1.31E-13	6.08	6.63	12.71	3.44E-13	1.33E-14	4.62E-14
1241	PELLET LINE 6	20	1.40E-13	3.91	4.14	8.05	2.18E-13	8.40E-15	2.93E-14
Total				235.21	293.31	528.52	1.43E-11	5.51E-13	1.92E-12

*Concentration LLD is 8E-14 uCi/ml

Attachment 2
Lung/Bone Organ Dose due to Gaseous Effluents

	1st half (Jan-Jun)	2nd half (Jul-Dec)	Total	EPA				
STACK IDENTIFICATION	uCi Uranium	uCi Uranium	uCi released	Comply Run Results				
Conv 1-A Ex	17.49	40.25	57.74	Dose (mrem/yr)	3.10E-02			
use highest release to calculate X/Q used by COMPLY				Stack height (m)	13			
Dose from comply	0.03100	mrem/yr		Release Rate (Ci/s)	U-234	U-235	U-238	
release quantity	57.74	uCi			1.56E-12	6.02E-14	2.10E-13	
	5.77E-05	Ci						
App E table E-5	8000.00	m3/yr						
Effective Dose conversion								
EPA FGR 11 p150-151								
U-234	3.58E-05	Sv/Bq	85.23%					
U-235	3.32E-05	Sv/Bq	3.29%					
U-238	3.20E-05	Sv/Bq	11.47%					
weighted dose conversion	3.53E-05	Sv/Bq						
conversion factor	3700.00	mrem/pCi= factor* Sv/Bq						
weighted dose conversion	0.1305	mrem/pCi						
				equations				
Dose (mrem) = R(a)*3.17e4*Q*(X/Q)*effective Dose conversion				see RG1.109-25				
Dose (mrem)/(R(a)*3.17e4*Q*effective Dose conversion)=(X/Q)								
	1.62E-05	X/Q						
Estimate Lung Dose using X/Q and semi-annual releases for 2021				Estimate Bone Dose using X/Q and semi-annual releases for 2021				
App E table E-5								
Lung Organ Dose conversion								
EPA FGR 11 p150-151								
U-234	2.98E-04	Sv/Bq	85.23%	1.13E-06	Sv/Bq			
U-235	2.76E-04	Sv/Bq	3.29%	1.05E-06	Sv/Bq			
U-238	2.66E-04	Sv/Bq	11.47%	1.01E-06	Sv/Bq			
weighted dose conversion	2.94E-04	Sv/Bq		1.11E-06	Sv/Bq			
conversion factor	3700.00	mrem/pCi= factor* Sv/Bq		3700.00	mrem/pCi= factor* Sv/Bq			
weighted dose conversion	1.0862	mrem/pCi		4.12E-03	mrem/pCi			
release quantity	528.52	uCi/yr		528.52	uCi/yr			
	5.29E-04	Ci/yr		5.29E-04	Ci/yr			
Lung *	1.89	mrem/yr		7.17E-03	mrem/yr			
	assume 80% residence							

Attachment 3 - 2021 LIQUID EFFLUENT RADIOACTIVITY DISCHARGES

Month	Liquid Effluent Discharges		Isotopic Uranium Measured Concentrations				Tc-99 Measured Concentrations	Sum U & Tc-99	Total uCi/month Released (based on monthly GEL discharge samples)				Measurement Uncertainty / Error				Uncertainty / Error					
	Actual kgal/month	Actual gal/month	U234 pCi/L	U235 pCi/L	U238 pCi/L	Total U pCi/L	Tc-99 pCi/L	Total U & Tc-99 pCi/L	U234	U-235	U-238	Tc-99	U234 pCi/L	U235 pCi/L	U238 pCi/L	Tc-99 pCi/L	U234 (uCi)	U-235 (uCi)	U-238 (uCi)	Tc-99 (uCi)		
January	2945.861	2,945,861	34.0	1.77	6.37	42.1	28.0	70.1	379	20	71	312	1.62	0.419	0.699	3.27	18	5	8	36		
February	3711.259	3,711,259	4.44	0.258	4.04	8.74	59.0	67.7	62	4	57	829	0.778	0.224	0.741	4.95	11	3	10	70		
March	3275.019	3,275,019	20.9	0.868	3.29	25.1	36.2	61.3	259	11	41	449	1.20	0.281	0.505	3.75	15	3	6	46		
April	1812.059	1,812,059	19.1	0.493	3.53	23.1	18.6	41.7	131	3	24	128	1.59	0.325	0.711	2.39	11	2	5	16		
May	2544.166	2,544,166	31.1	1.23	5.77	38.1	18.8	56.9	299	12	56	181	1.64	0.386	0.736	3.47	16	4	7	33		
June	3231.978	3,231,978	13.3	0.712	2.59	16.6	8.93	25.5	163	9	32	109	1.58	0.438	0.704	2.17	19	5	9	27		
July	3539.662	3,539,662	14.7	0.912	2.89	18.5	7.28	25.8	197	12	39	98	0.953	0.277	0.429	2.27	13	4	6	30		
August	4536.226	4,536,226	15.1	0.895	2.92	18.9	4.84	23.8	259	15	50	83	1.28	0.355	0.565	2.41	22	6	10	41		
September	3231.769	3,231,769	14.2	0.696	2.57	17.5	24.8	42.3	174	9	31	303	1.40	0.358	0.604	2.67	17	4	7	33		
October	2764.638	2,764,638	13.7	0.591	2.31	16.6	30.2	46.8	143	6	24	316	1.43	0.348	0.596	3.14	15	4	6	33		
November	2225.996	2,225,996	16.3	0.854	2.45	19.6	34.6	54.2	137	7	21	292	0.919	0.241	0.359	3.56	8	2	3	30		
December	2785.661	2,785,661	24.0	1.57	3.59	29.2	20.0	49.2	253	17	38	211	1.62	0.465	0.627	2.20	17	5	7	23		
Total	36604.293	36,604,293								2457	124	483	3310				182	47	84	419		
Liters (L)		1.39E+08								3064												
Milliliters (ml)		1.39E+11								6374												
										uCi Uranium & Tc-99												

LIQUID DISCHARGES

Radionuclide	LLD (uCi/ml)	Quantity Released (uCi)	Error		Average Concentration Released (uCi/ml)
U234	6.00E-10	2457	+/-	182	1.77E-08
U235	6.00E-10	124	+/-	47	8.96E-10
U238	6.00E-10	483	+/-	84	3.49E-09
Total U		3064			2.21E-08
Tc-99	6.00E-10	3310	+/-	419	2.39E-08
Total		6374			6.81E-08

**Attachment 4
Whole Body Dose from Liquid Effluent Pathways - Potable Water**

Whole Body-Ingestion															
730	liters	Usage by adult/yr	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								
					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					
2.55E-04	U-238	mRem/pCi	D	Exposure-to-dose conversion factors for ingestion		U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03					
1.46E-06	Tc-99	mRem/pCi	D			U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03					
						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										
3.2357E-10	U-234	decay const	λ												
1.12404E-13	U-235	decay const	λ	Nuclide	T(1/2) yr	T(1/2) hr	λ								
1.77058E-14	U-238	decay const	λ	URANIUM234	2.45E+05	2.14E+09	3.24E-10								
3.71407E-10	Tc-99	decay const	λ	URANIUM235	7.04E+08	6.17E+12	1.12E-13		for comparison only						
				URANIUM238	4.47E+09	3.91E+13	1.77E-14								
0.9999999961	U-234	exp(-λt-p)		TC-99	2.13E+05	1.87E+09	3.71E-10		Part 20 table 2						
1.0000000000	U-235	exp(-λt-p)							Dose Conversion soluble forms						
1.0000000000	U-238	exp(-λt-p)							uCi/ml	milliliters	uCi	pCi	mRem	mRem/pCi	
0.9999999955	Tc-99	exp(-λt-p)							U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
									U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
									U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
									Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07	50	1.14E-06
Activity Released															
2.457E-03	U-234 release fraction	Ci							ICRP 69	Comparison					
1.240E-04	U-235 release fraction	Ci													
4.830E-04	U-238 release fraction	Ci													
3.310E-03	Tc-99 release fraction	Ci													
check U sum	0.00306								adult	5.00E-08	0.005	1.85E-04			
									infant	3.70E-07	0.037	1.37E-03			
									bone-adult	7.90E-07	0.079	2.92E-03			
6.96E-07	U-234	release fraction *dose factor*exp(-λ*tp)													
3.30E-08	U-235	release fraction *dose factor*exp(-λ*tp)													
1.23E-07	U-238	release fraction *dose factor*exp(-λ*tp)													
4.84E-09	Tc-99	release fraction *dose factor*exp(-λ*tp)													
8.57E-07	all nuclides	sum of nuclides													
85.53473	usage	1100*(usage*dilution)/flow													
7.33E-05	mRem	see regulatory guide 1.109-2 and 1.109-3 for formula and definition of terms.													

Attachment 5
Dose to the Bone Surface from Liquid Effluent Pathways - Potable Water

Bone Surface-Ingestion																
730	liters	Usage by adult/yr	U	10CFR20	7.3 x 10 ⁵ (ml) which is the annual water intake of "Reference Man."											
31293	mixing - dilution	Dilution at difuser	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 Radioanuclide Intake.....			effective	bone	effective	bone						
3.88E-03	U-235	mRem/pCi	D-bone	FRG no 11	1988		U-234	7.66E-08	1.13E-06	2.83E-04	4.18E-03					
3.74E-03	U-238	mRem/pCi	D-bone	Exposure-to-dose conversion factors for ingestion			U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03					
2.23E-07	Tc-99	mRem/pCi	D-bone				U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03					
							Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07					
12	hrs	transit time	t-p	reg guide table E-15												
3.23557E-10	U-234	decay const	λ													
1.12404E-13	U-235	decay const	λ	Nuclide	T(1/2) yr	T(1/2) hr	λ									
1.77058E-14	U-238	decay const	λ	URANIUM234	2.45E+05	2.14E+09	3.24E-10	Part 20 table 2								
3.71407E-10	Tc-99	decay const	λ	URANIUM235	7.04E+08	6.17E+12	1.12E-13	Dose Conversion		soluble forms						
				URANIUM238	4.47E+09	3.91E+13	1.77E-14									
0.9999999961	U-234	exp(-λt-p)		TC-99	2.13E+05	1.87E+09	3.71E-10			uCi/ml	milliliters	uCi	pCi	mRem	mRem/pCi	
1.0000000000	U-235	exp(-λt-p)								U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
1.0000000000	U-238	exp(-λt-p)								U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
0.9999999955	Tc-99	exp(-λt-p)								U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
										Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07	50	1.14E-06
Activity Released																
										ICRP 69	Comparison					
2.457E-03	U-234 release fraction	Ci									Sv/Bq	Rem/Bq	mRem/pCi			
1.240E-04	U-235 release fraction	Ci														
4.830E-04	U-238 release fraction	Ci								adult	5.00E-08	0.005	1.85E-04			
3.310E-03	Tc-99 release fraction	Ci								infant	3.70E-07	0.037	1.37E-03			
										bone-adult	7.90E-07	0.079	2.92E-03			
check U sum 0.00306																
1.03E-05	U-234	release fraction *dose factor*exp(-λ*tp)														
4.82E-07	U-235	release fraction *dose factor*exp(-λ*tp)														
1.80E-06	U-238	release fraction *dose factor*exp(-λ*tp)														
7.40E-10	Tc-99	release fraction *dose factor*exp(-λ*tp)														
1.26E-05	all nuclides	sum of nuclides														
85.53473	usage	1100*(usage*dilution)/flow														
1.07E-03	mRem	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.														

**Attachment 6
Whole Body Dose from Liquid Effluent Pathways - Aquatic Foods**

Whole Body																
21	Kg	Usage by adult/yr	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	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						
2.55E-04	U-238	mRem/pCi	D	Exposure-to-dose conversion factors for ingestion		U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03						
1.46E-06	Tc-99	mRem/pCi	D			U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03						
24	hrs	transit time	t-p			Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07						
reg guide 1 table E-15																
3.23557E-10	U-234	decay const	λ													
1.12404E-13	U-235	decay const	λ	Nuclide	T(1/2) yr	T(1/2) hr	λ									
1.77058E-14	U-238	decay const	λ	URANIUM234	2.45E+05	2.14E+09	3.24E-10									
3.71407E-10	Tc-99	decay const	λ	URANIUM235	7.04E+08	6.17E+12	1.12E-13									
				URANIUM238	4.47E+09	3.91E+13	1.77E-14									
0.99999999223	U-234	exp(-λt-p)		TC-99	2.13E+05	1.87E+09	3.71E-10									
1.00000000000	U-235	exp(-λt-p)														
1.00000000000	U-238	exp(-λt-p)														
0.99999999109	Tc-99	exp(-λt-p)														
Activity Released										Part 20 table 2				soluble forms		
										Dose Conversion						
										uCi/ml	milliliters	uCi	pCi	mRem	mRem/pCi	
										U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
										U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
										U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04
										Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07	50	1.14E-06
										ICRP 69 Comparison						
2.457E-03	U-234 release fraction	Ci														
1.240E-04	U-235 release fraction	Ci														
4.830E-04	U-238 release fraction	Ci														
3.310E-03	Tc-99 release fraction	Ci														
check U sum										0.00306						
										bioaccumulation factor		BNWL-2075				
1.39E-06	U-234	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)					2									
6.60E-08	U-235	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)					2									
2.46E-07	U-238	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)					2									
7.26E-08	Tc-99	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)					15									
1.78E-06	all nuclides	sum of nuclides														
2.46059	usage	1100*(usage*dilution)/flow														
4.37E-06	mRem	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.														

**Attachment 7
Dose to the Bone Surface from Liquid Effluent Pathways - Aquatic Foods**

Bone Surface																
21 Kg	Usage by adult/yr	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	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	effective	bone	effective	bone						
4.18E-03	U-234	mRem/pCi	D	EPA Limiting Values of Radioisotope Intake.....			Sv/Bq	Sv/Bq	mRem/pCi	mRem/pCi						
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					
3.74E-03	U-238	mRem/pCi	D	Exposure-to-dose conversion factors for ingestion			U-235	7.19E-08	1.05E-06	2.66E-04	3.88E-03					
2.23E-07	Tc-99	mRem/pCi	D				U-238	6.88E-08	1.01E-06	2.55E-04	3.74E-03					
							Tc-99	3.95E-10	6.04E-11	1.46E-06	2.23E-07					
24	hrs	transit time	t-p	reg guide 1.109 table E-15												
3.23557E-10	U-234	decay const	λ								for comparison only					
1.12404E-13	U-235	decay const	λ	Nuclide	T(1/2) yr	T(1/2) hr	λ									
1.77058E-14	U-238	decay const	λ	URANIUM234	2.45E+05	2.14E+09	3.24E-10									
3.71407E-10	Tc-99	decay const	λ	URANIUM235	7.04E+08	6.17E+12	1.12E-13	Part 20 table 2		soluble forms						
				URANIUM238	4.47E+09	3.91E+13	1.77E-14	Dose Conversion								
0.99999999223	U-234	exp(-λt-p)		Tc-99	2.13E+05	1.87E+09	3.71E-10		uCi/ml	milliliters	uCi	pCi	mRem	mRem/pCi		
1.00000000000	U-235	exp(-λt-p)							U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04	
1.00000000000	U-238	exp(-λt-p)							U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04	
0.99999999109	Tc-99	exp(-λt-p)							U-238	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04	
									Tc-99	6.00E-05	7.30E+05	4.38E+01	4.38E+07	50	1.14E-06	
Activity Released										ICRP 69 Comparison						
2.457E-03	U-234 release fra	Ci								Sv/Bq	Rem/Bq	mRem/pCi				
1.240E-04	U-235 release fra	Ci								adult	5.00E-08	0.005	1.85E-04			
4.830E-04	U-238 release fra	Ci								infant	3.70E-07	0.037	1.37E-03			
3.310E-03	Tc-99 release fra	Ci								bone-adult	7.90E-07	0.079	2.92E-03			
check U sum	0.00306															
				bioaccumulation factor	BNWL-2075											
2.05E-05	U-234	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)		2	UC-11											
9.63E-07	U-235	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)		2	Methodology for Calculation of Radiation Doses											
3.61E-06	U-238	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)		2	in the Environs from Nuclear Fuel											
1.11E-08	Tc-99	release fraction *bioaccumulation factor*dose factor*exp(-λ*tp)		15	Cycle Facilities											
2.51E-05	all nuclides	sum of nuclides														
2.46059	usage	1100*(usage*dilution)/flow														
6.18E-05	mRem	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.														

Attachment 8

Whole Body Dose from Liquid Effluent Pathways - Shoreline Deposits

Whole Body														
12	hr	Usage by adult/yr	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		9388	cubic feet/sec		see Nureg-1118 Environmental Assessment for renewam ...SNM-1107 May					
				Effluent Flow		3.00E-01	cubic feet/sec							
				Sv/s:Bq/m^2		mrem/hr:pCi/m^2								
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								
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 ...										
131040	hrs	xposure time of sedime	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				
1.77058E-14	U-238	decay const	λ			URANIUM235	7.04E+08	6.17E+12	1.12E-13	2.56E+11				
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)]												
0.0000000023	U-238	exp(-λt-p)*[1-exp(-λt-b)]												
0.0000486679	Tc-99	exp(-λt-p)*[1-exp(-λt-b)]												
Activity Released														
2.457E-03	U-234 release fraction	Ci												
1.240E-04	U-235 release fraction	Ci												
4.830E-04	U-238 release fraction	Ci												
3.310E-03	Tc-99 release fraction	Ci												
check U sum 0.00306														
9.14E-11	U-234	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i												
9.22E-10	U-235	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i												
1.34E-11	U-238	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i												
1.30E-11	Tc-99	release fraction *dose factor*exp(-λt-p)*1-exp(-λt-b)*t-i												
1.04E-09	all nuclides	sum of nuclides												
2.812101	usage	11000*(usage*dilution*shore width factor)/flow												
2.92E-09	mRem	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.												
see regulatory guide 1.109 page 1.109-40 table A-2,Shore width..														

Attachment 9 2021 Isotopic Fractions

Based on the plant nominal enrichment for 2021

Nuclide	Average wt%	Specific Activity Ci/g	Weighted Activity	% Activity
U-234	0.04	6.220E-03	2.388E-06	85.23
U-235	4.27	2.160E-06	9.223E-08	3.29
U-238	95.70	3.360E-07	3.216E-07	11.47
Total	100.0		2.802E-06	100.00

Attachment 10 - Comply Results

COMPLY: V1.7.

2/18/2022 3:51

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

REPORT ON COMPLIANCE WITH
THE CLEAN AIR ACT LIMITS FOR RADIONUCLIDE EMISSIONS
FROM THE COMPLY CODE - V1.7.

Prepared by:

Westinghouse Electric Co
Columbia Fuel Fabrication Facility
5801 Bluff Rd. Hopkins, SC 29061

David Wagoner
803.465.5088

Prepared for:

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Washington, DC 20460

2021 Annual Assessment of Dose to a Member of the Public

SCREENING LEVEL 2

DATA ENTERED:

RELEASE RATES FOR STACK 1.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	2.310E-13
U-235	Y	8.920E-15
U-238	Y	3.110E-14

RELEASE RATES FOR STACK 2.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	3.010E-13
U-235	Y	1.160E-14
U-238	Y	4.060E-14

RELEASE RATES FOR STACK 3.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	2.560E-12
U-235	Y	9.890E-14
U-238	Y	3.450E-13

RELEASE RATES FOR STACK 4.

Nuclide		Release Rate (curies/SECOND)
---------	--	---------------------------------

U-234	Y	5.890E-13
U-235	Y	2.280E-14
U-238	Y	7.930E-14

RELEASE RATES FOR STACK 5.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	3.700E-12
U-235	Y	1.430E-13
U-238	Y	4.980E-13

RELEASE RATES FOR STACK 6.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	1.520E-12
U-235	Y	5.880E-14
U-238	Y	2.050E-13

RELEASE RATES FOR STACK 7.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	1.710E-12
U-235	Y	6.620E-14
U-238	Y	2.310E-13

RELEASE RATES FOR STACK 8.

Nuclide		Release Rate (curies/SECOND)
U-234	Y	1.800E-12
U-235	Y	6.940E-14
U-238	Y	2.420E-13

RELEASE RATES FOR STACK 9.

Nuclide		Release Rate (curies/SECOND)
---------	--	---------------------------------

U-234	Y	1.300E-12
U-235	Y	5.040E-14
U-238	Y	1.760E-13

RELEASE RATES FOR STACK 10.

Nuclide		Release Rate (curies/SECOND)
-----		-----
U-234	Y	3.440E-13
U-235	Y	1.330E-14
U-238	Y	4.620E-14

RELEASE RATES FOR STACK 11.

Nuclide		Release Rate (curies/SECOND)
-----		-----
U-234	Y	2.180E-13
U-235	Y	8.400E-15
U-238	Y	2.930E-14

SITE DATA FOR STACK 1.

Release height 9 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 2.

Release height 10 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 3.

Release height 11 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 4.

Release height 12 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 5.

Release height 13 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 6.

Release height 14 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 7.

Release height 15 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 8.

Release height 16 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 9.

Release height 17 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 10.

Release height 19 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

SITE DATA FOR STACK 11.

Release height 20 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

Building (width) is unusually WIDE.
Receptor is unusually FAR.

RESULTS:

Effective dose equivalent: 0.3 mrem/yr.

*** Comply at level 2.

This facility is in COMPLIANCE.

It may or may not be EXEMPT from reporting to the EPA.

You may contact your regional EPA office for more information.

***** END OF COMPLIANCE REPORT *****

COMPLY: V1.7.

2/18/2022 4:06

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

REPORT ON COMPLIANCE WITH
THE CLEAN AIR ACT LIMITS FOR RADIONUCLIDE EMISSIONS
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Prepared for:

U.S. Environmental Protection Agency
Office of Radiation and Indoor Air
Washington, DC 20460

Conv. 1-A Ex

SCREENING LEVEL 2

DATA ENTERED:

Nuclide		Release Rate (curies/SECOND)
U-234	Y	1.560E-12
U-235	Y	6.020E-14
U-238	Y	2.100E-13

Release height 13 meters.

Building height 9 meters.

The source and receptor are not on the same building.

Distance from the source to the receptor is 595 meters.

Building width 137 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

Building (width) is unusually WIDE.
Receptor is unusually FAR.

RESULTS:

Effective dose equivalent: 3.1E-02 mrem/yr.

*** Comply at level 2.

This facility is in COMPLIANCE.

It may or may not be EXEMPT from reporting to the EPA.

You may contact your regional EPA office for more information.

***** END OF COMPLIANCE REPORT *****