



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-21-21

Subject: SNM-1107/70-1151  
NRC Semi-Annual Discharge Report  
July – December 2020

February 15, 2021

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, 2020, through December 31, 2020, 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 ( $\mu\text{Ci}$ )	Parameter	Total 6-month Measured Concentration	Regulatory Concentration Limit
Gaseous	253	Uranium (analyzed as gross alpha)	$1.6\text{E}^{-16} \mu\text{Ci/mL}$ *	$5\text{ E}^{-14} \mu\text{Ci/mL}$
Liquid Effluent <sup>#</sup>	1,402	U-234	$1.2\text{E}^{-08} \mu\text{Ci/mL}$	$3\text{ E}^{-07} \mu\text{Ci/mL}$
	67	U-235		
	244	U-238		
	2,866	Tc-99	$2.1\text{E}^{-08} \mu\text{Ci/mL}$	$6\text{ E}^{-05} \mu\text{Ci/mL}$

\*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 (85.25% U-234, 3.28% U-235, and 11.48% 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 2020 was  $6.63\text{ E}^{+10}$  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-21-13, "2020 Annual Assessment of Public Dose due to Liquid and Gaseous Effluents" is attached.

Sincerely,



Jeff Ferguson  
Manager, Environment, Health and Safety

Attachment:

LTR-EHS-21-13, "2020 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 8, 2021

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

From: David Wagoner  
 Ext: 1919  
 Fax: 803.695.4158

Your ref:  
 Our ref: LTR-EHS-21-13

Subject: **2020 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 #1212 (S1030A), 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 47 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 2020:

- 436.2  $\mu\text{Ci}$  of Uranium in gaseous effluent
- 3,769  $\mu\text{Ci}$  of Uranium in liquid effluent
- 5,801  $\mu\text{Ci}$  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 2020 resulted in a potential whole body dose of 0.16 mrem, 0.007 mrem to the bone, and 1.54 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.** 2020 Annual Dose to the Public from Liquid and Gaseous Effluents

	<b>Whole Body Dose (mrem)</b>	<b>Organ Dose - Bone (mrem)</b>	<b>Organ Dose - Lung (mrem)</b>
<b>Gaseous Effluents</b>			
Direct inhalation*	0.16	5.83E-03	1.54
<b>Liquid Effluents</b>			
Potable Water	9.06E-05	1.32E-03	-
Aquatic Food (Fish)	5.48E-06	7.62E-05	-
Shoreline Deposition	3.43E-09	-	-
<i>Total (mrem)</i>	<i>0.16</i>	<i>7.23E-03</i>	<i>1.54</i>

\* Assumes 80 % residence time

There were no changes in source material and no release points were added during 2020. One release point (location #1228 - Chem lab exhaust #3) was re-routed to the primary ventilation system servicing the chemical lab (location #1220 - chem lab filtered exh). Since location #1220 is continuously monitored, sample location #1228 was removed from service in the second half of 2020. Two release points were modified; the stack height was increased from 12m to 14m on the line

4 calciner combustion gas stack (location #1225) and the stack height was increased from 16m to 17m on the chemistry lab exhaust #2 stack (location #1227). There were no impacts to the sampling systems due to these stack modifications. The attachments below illustrate the method used to calculate each result listed in Table 1.

- Attachment 1: 2020 Gaseous Effluent Discharges
- Attachment 2: Lung/Bone Organ Dose due to Gaseous Effluent
- Attachment 3: 2020 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: 2020 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**  
**2020 Gaseous Effluent Discharges**

Sampling Station	Location Description	Stack Height (m)	Gross Alpha Concentration* (uCi/mL)	Total uCi		Release Rate (Ci/s)		
				1st Half (Jan-Jun)	2nd Half (July-Dec)	Released	U234	U235
1207	MET LAB EXHAUST	10	2.61E-13	1.67	2.90	4.57	1.24E-13	4.75E-15
1239	MAINT WELD EX	11	1.77E-13	2.47	2.78	5.25	1.42E-13	5.46E-15
1243	AC-8	11	8.22E-14	4.73	5.03	9.76	2.64E-13	1.02E-14
1222	CALC COMB GAS LN 1	12	2.56E-13	0.52	0.80	1.32	3.57E-14	1.37E-15
1223	CALC COMB GAS LN 2	12	2.35E-13	0.41	0.81	1.22	3.30E-14	1.27E-15
1224	CALC COMB GAS LN 3	12	1.40E-13	0.36	0.36	0.72	1.95E-14	7.49E-16
1226	CALC COMB GAS LN 5	12	1.86E-13	0.52	0.44	0.96	2.60E-14	9.98E-16
1228	CHEM LAB EX #3	12	6.65E-14	0.39	0.00	0.39	1.05E-14	4.06E-16
1237	ABF HOOD TORIT EX	12	9.10E-14	1.90	2.16	4.06	1.10E-13	4.22E-15
1241	PELLET LINE 6	12	8.24E-14	3.52	3.68	7.20	1.95E-13	7.49E-15
1247	HOT OIL RM EX	12	2.37E-13	9.11	19.96	29.07	7.86E-13	3.02E-14
1201	FURNACE EX LINE 1	13	8.29E-14	3.52	3.72	7.24	1.96E-13	7.53E-15
1202	FURNACE EX LINE 2	13	8.09E-14	3.49	3.58	7.07	1.91E-13	7.35E-15
1203	FURNACE EX LINE 3	13	1.14E-13	4.19	5.81	10.00	2.70E-13	1.04E-14
1204	FURNACE EX LINE 4	13	8.00E-14	3.48	3.51	6.99	1.89E-13	7.27E-15
1205	FURNACE EX LINE 5	13	8.09E-14	3.48	3.59	7.07	1.91E-13	7.35E-15
1206	NEW DECON ROOM	13	9.11E-14	2.35	2.35	4.70	1.27E-13	4.89E-15
1208	INCINERATOR EX	13	5.74E-13	8.13	26.08	34.21	9.25E-13	3.56E-14
1209	SUPPL INCIN EX	13	1.44E-13	1.76	2.50	4.26	1.15E-13	4.43E-15
1217	CONV ENCL EX 4-C	13	1.43E-13	9.83	7.66	17.49	4.73E-13	1.82E-14
1218	CONV ENCL EX 4-D	13	2.02E-13	0.00	0.00	0.00	0.00E+00	0.00E+00
1219	CONV EMERG EX 4E	13	2.84E-13	0.62	1.03	1.65	4.46E-14	1.72E-15
1221	DECON ROOM EX	13	4.14E-13	7.19	11.28	18.47	4.99E-13	1.92E-14
1230	DEV LAB EX #1	13	2.17E-13	2.32	4.14	6.46	1.75E-13	6.72E-15
1231	DEV LAB EX #2	13	3.02E-13	3.29	5.68	8.97	2.42E-13	9.33E-15
1232	PELLET COMBINED EX	13	8.48E-14	6.09	6.49	12.58	3.40E-13	1.31E-14
1225	CALC COMB GAS LN 4	14	1.09E-13	0.25	0.31	0.56	1.51E-14	5.82E-16
1229	HP LAB EX	15	8.90E-14	0.80	0.83	1.63	4.41E-14	1.70E-15
1236	MAP COMBINED	15	2.78E-13	0.00	0.00	0.00	0.00E+00	0.00E+00
1240	AC-3	15	8.28E-14	4.90	4.93	9.83	2.66E-13	1.02E-14
1246	AC-4	15	9.54E-14	4.98	6.68	11.66	3.15E-13	1.21E-14
1251	WATERGLASS SCR S1190	15	2.02E-13	5.63	9.38	15.01	4.06E-13	1.56E-14
1210	CONV 1-A EX	16	2.73E-13	6.73	29.10	35.83	9.69E-13	3.73E-14
1211	CONV 1-B EX	16	1.66E-13	0.00	0.00	0.00	0.00E+00	0.00E+00
1212	S1030 A	16	1.59E-13	20.21	15.66	35.87	9.70E-13	3.73E-14
1213	S1030 B	16	2.83E-13	1.16	2.04	3.20	8.65E-14	3.33E-15
1233	SOLVENT EXT N EX	16	8.26E-14	3.63	3.79	7.42	2.01E-13	7.72E-15
1234	SOLVENT EXT S EX	16	2.40E-13	1.56	2.04	3.60	9.73E-14	3.74E-15
1220	CHEM LAB FILT EX	17	9.57E-14	7.44	9.28	16.72	4.52E-13	1.74E-14
1227	CHEM LAB EX #2	17	7.27E-13	5.88	7.46	13.34	3.61E-13	1.39E-14
1242	AC-5	17	9.18E-14	4.78	6.13	10.91	2.95E-13	1.13E-14
1244	AMMON FUME SCR 1008A	17	1.15E-13	2.61	4.21	6.82	1.84E-13	7.09E-15
1245	AMMON FUME SCR 1008B	17	1.90E-13	0.00	0.00	0.00	0.00E+00	0.00E+00
1238	IFBA EXHAUST	18	8.42E-14	6.14	6.36	12.50	3.38E-13	1.30E-14
1248	ERBIA FURNACE EX	18	8.90E-14	12.52	10.33	22.85	6.18E-13	2.38E-14
1249	ERBIA SCRUBBER EX	18	8.18E-14	5.48	5.67	11.15	3.01E-13	1.16E-14
1250	ERBIA CHANGE ROOM	18	9.37E-14	2.79	2.81	5.60	1.51E-13	5.82E-15
<b>Total</b>				<b>182.83</b>	<b>253.35</b>	<b>436.18</b>	<b>1.18E-11</b>	<b>4.54E-13</b>
*Concentration LLD is 8E-14 uCi/mL								

## Attachment 2

	1st half (Jan-Jun)	2nd half (Jul-Dec)	Total	EPA				
STACK IDENTIFICATION	uCi Uranium	uCi Uranium	uCi released	Comply Run Results				
S-1030A	20.21	15.66	35.87	Dose (mrem/yr)	1.90E-02			
use highest release to calculate X/Q used by COMPLY				Stack height (m)	16			
Dose from comply release quantity	0.01900	mrem		Release Rate (Ci/s)	U-234 9.70E-13	U-235 3.73E-14	U-238 1.31E-13	
	35.87	uCi						
	3.59E-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	85.25%					
U-235	3.32E-05	Sv/Bq	3.28%					
U-238	3.20E-05	Sv/Bq	11.48%					
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)								
	1.60E-05	X/Q						
Estimate Lung Dose using X/Q and semi-annual releases for 2020			Estimate Bone Dose using X/Q and semi-annual releases for 2020					
App E table E-5								
Lung Organ Dose conversion								
EPA FGR 11 p150-151								
U-234	2.98E-04	Sv/Bq	85.25%	1.13E-06	Sv/Bq			
U-235	2.76E-04	Sv/Bq	3.28%	1.05E-06	Sv/Bq			
U-238	2.66E-04	Sv/Bq	11.48%	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	1.0864	mrem/pCi		4.12E-03	mrem/pCi			
release quantity	436.18	uCi		436.18	uCi			
	4.36E-04	Ci		4.36E-04	Ci			
Lung *	1.54	mrem	Bone *	5.83E-03	mrem			
*assume 80% residence			*assume 80% residence					

2020

## Attachment 3 - 2020 LIQUID EFFLUENT RADIOACTIVITY DISCHARGES

	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																						
Month	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	3667.702	3,667,702	20.2	1.15	3.34	24.7	0.00	24.7	280.4	16.0	46.4	0.0	1.7	0.5	0.7	25.4	23.6	6.5	9.7	352.6																			
February	3511.279	3,511,279	24.2	0.888	4.61	29.7	6.89	36.6	321.6	11.8	61.3	91.6	1.9	0.4	0.8	20.6	25.1	5.5	11.0	273.8																			
March	3273.403	3,273,403	21.3	0.935	4.01	26.2	23.5	49.7	263.9	11.6	49.7	291.2	1.8	0.4	0.8	22.6	22.1	5.3	9.6	280.0																			
April	2800.576	2,800,576	23.9	0.953	4.10	29.0	71.3	100.3	253.3	10.1	43.5	755.8	1.2	0.3	0.5	3.8	12.2	2.7	5.0	39.9																			
May	2999.495	2,999,495	22.5	1.05	3.59	27.1	63.2	90.3	255.4	11.9	40.8	717.5	1.6	0.4	0.6	5.0	18.3	4.5	7.4	56.3																			
June	3050.455	3,050,455	26.7	1.31	4.82	32.8	93.5	126.3	308.3	15.1	55.7	1079.5	1.8	0.4	0.8	4.2	20.3	5.1	8.7	48.3																			
July	2449.251	2,449,251	28.9	1.55	4.82	35.3	81.6	116.9	267.9	14.4	44.7	756.5	1.5	0.4	0.6	3.7	13.6	3.6	5.6	34.2																			
August	3986.655	3,986,655	13.8	0.241	2.94	17.0	49.3	66.3	208.2	3.6	44.4	743.9	1.5	0.3	0.7	3.5	21.9	3.8	10.4	53.0																			
September	2672.651	2,672,651	19.5	1.03	3.27	23.8	40.4	64.2	197.3	10.4	33.1	408.7	1.6	0.4	0.7	3.9	15.9	4.3	6.6	39.5																			
October	2678.814	2,678,814	21.4	1.03	3.73	26.2	29.8	56.0	217.0	10.4	37.8	302.2	1.8	0.5	0.8	3.0	18.6	4.7	7.8	30.7																			
November	2746.831	2,746,831	27.9	1.28	4.32	33.5	27.7	61.2	290.1	13.3	44.9	288.0	2.2	0.5	0.9	3.0	22.9	5.6	9.1	31.0																			
December	2969.596	2,969,596	19.7	1.30	3.48	24.5	32.6	57.1	221.4	14.6	39.1	366.4	1.6	0.5	0.7	3.7	18.2	5.3	7.7	41.3																			
Total	36806.708	36,806,708							3084.9	143.3	541.2	5801.2					233	57	99	1280																			
Liters (L)			<b>1.39E+08</b>																																				
Milliliters (ml)			1.39E+11																																				

## LIQUID DISCHARGES

Radionuclide	LLD (uCi/ml)	Quantity Released (uCi)	Error	Average Concentration Released (uCi/ml)
<b>U234</b>	6.00E-10	3084.9	+/- 233	2.21E-08
<b>U235</b>	6.00E-10	143.3	+/- 57	1.03E-09
<b>U238</b>	6.00E-10	541.2	+/- 99	3.88E-09
<b>Total U</b>		<b>3769.4</b>		<b>2.71E-08</b>
<b>Tc-99</b>	6.00E-10	5801.2	+/- 1280	4.16E-08
<b>Total</b>		<b>9570.6</b>		<b>6.87E-08</b>

#### **Attachment 4**

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

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

Bone Surface-Ingestion														
<b>730 liters</b>														
Usage by adult/yr	U	10CFR20	$7.3 \times 10^5$ (ml)	which is the annual water intake of "Reference Man."										
31293 mixing - dilution	Dilution at diffuser	M	Congaree Flow	9388	cubic feet/sec									
0.3 cubic ft/sec	Average discharge	F	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	Sv/Bq	Sv/Bq	mRem/pCi	mRem/pCi				
3.74E-03 U-238	mRem/pCi	D-bone	Exposure-to-dose conversion factors for ingestion			U-235	7.66E-08	1.13E-06	2.83E-04	4.18E-03				
2.23E-07 Tc-99	mRem/pCi	D-bone				U-238	7.19E-08	1.05E-06	2.66E-04	3.88E-03				
						Tc-99	6.88E-08	1.01E-06	2.55E-04	3.74E-03				
							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	$\lambda$												
1.12404E-13 U-235	decay const	$\lambda$	Nuclide	T(1/2) yr	T(1/2) hr	$\lambda$								
1.77058E-14 U-238	decay const	$\lambda$	URANIUM234	2.45E+05	2.14E+09	3.24E-10								
3.71407E-10 Tc-99	decay const	$\lambda$	URANIUM235	7.04E+08	6.17E+12	1.12E-13								
			URANIUM238	4.47E+09	3.91E+13	1.77E-14								
0.9999999961 U-234	exp(- $\lambda t_p$ )	TC-99		2.13E+05	1.87E+09	3.71E-10			uCi/ml	milliters	uCi	pCi	mRem	mRem/pCi
1.0000000000 U-235	exp(- $\lambda t_p$ )						U-234	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04	
1.0000000000 U-238	exp(- $\lambda t_p$ )						U-235	3.00E-07	7.30E+05	2.19E-01	2.19E+05	50	2.28E-04	
0.9999999955 Tc-99	exp(- $\lambda t_p$ )						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				
3.085E-03 U-234 release fraction	Cl								Sv/Bq	Rem/Bq	mRem/pCi			
1.433E-04 U-235 release fraction	Cl													
5.412E-04 U-238 release fraction	Cl						adult	5.00E-08	0.005	1.85E-04				
5.801E-03 Tc-99 release fraction	Cl						infant	3.70E-07	0.037	1.37E-03				
							bone-adult	7.90E-07	0.079	2.92E-03				
check U sum	0.00377													
1.29E-05 U-234	release fraction *dose factor*exp(- $\lambda t_p$ )													
5.57E-07 U-235	release fraction *dose factor*exp(- $\lambda t_p$ )													
2.02E-06 U-238	release fraction *dose factor*exp(- $\lambda t_p$ )													
1.30E-09 Tc-99	release fraction *dose factor*exp(- $\lambda t_p$ )													
1.55E-05 all nuclides	sum of nuclides													
85.53473 usage	1100*(usage*dilution)/flow													
<b>1.32E-03 mRem</b>	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 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 Radioanuclide 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			
3.23557E-10 U-234	decay const	$\lambda$	reg guide table E-15								
1.12404E-13 U-235	decay const	$\lambda$	Nuclide	T(1/2) yr	T(1/2) hr	$\lambda$					
1.77058E-14 U-238	decay const	$\lambda$	URANIUM234	2.45E+05	2.14E+09	3.24E-10			for comparison only		
3.71407E-10 Tc-99	decay const	$\lambda$	URANIUM235	7.04E+08	6.17E+12	1.12E-13					
			URANIUM238	4.47E+09	3.91E+13	1.77E-14			Part 20 table 2	soluble forms	
0.99999999223 U-234	exp(- $\lambda$ t-p)	TC-99		2.13E+05	1.87E+09	3.71E-10			Dose Conversion		
1.00000000000 U-235	exp(- $\lambda$ t-p)								uCi/ml	milliters	
1.00000000000 U-238	exp(- $\lambda$ t-p)								uCi	pCi	mRem
0.99999999109 Tc-99	exp(- $\lambda$ t-p)										mRem/pCi
Activity Released											
3.085E-03 U-234 release fraction	Ci								ICRP 69	Comparison	
1.433E-04 U-235 release fraction	Ci										
5.412E-04 U-238 release fraction	Ci								Sv/Bq	Rem/Bq	mRem/pCi
5.801E-03 Tc-99 release fraction	Ci										
check U sum	0.00377								adult	5.00E-08	0.005
									infant	3.70E-07	0.037
									bone-adult	7.90E-07	0.079
											1.85E-04
											1.37E-03
											2.92E-03
1.75E-06 U-234	release fraction *bioaccumulation factor*dose factor*exp(- $\lambda$ *tp)			2	UC-11						
7.62E-08 U-235	release fraction *bioaccumulation factor*dose factor*exp(- $\lambda$ *tp)			2	Methodology for Calculation of Radiation Doses						
2.76E-07 U-238	release fraction *bioaccumulation factor*dose factor*exp(- $\lambda$ *tp)			2	in the Enviros from Nuclear Fuel						
1.27E-07 Tc-99	release fraction *bioaccumulation factor*dose factor*exp(- $\lambda$ *tp)			15	Cycle Facilities						
2.23E-06 all nuclides	sum of nuclides										
2.46059 usage	1100*(usage*dilution)/flow										
<b>5.48E-06 mRem</b>	see regulatory guide 1.109 page 1.109-2 and 1.109-3 for formula and definition of terms.										

Attachment 7

**Attachment 8**  
**Whole Body Dose from Liquid Effluent Pathways - Shoreline Deposits**

			<b>Whole Body</b>											
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 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								
				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	$\lambda$				Nuclide		T(1/2) yr	T(1/2) hr	$\lambda$	T(1/2) day		
1.12404E-13	U-235	decay const	$\lambda$				URANIUM234		2.45E+05	2.14E+09	3.24E-10	8.90E+07		
1.77058E-14	U-238	decay const	$\lambda$				URANIUM235		7.04E+08	6.17E+12	1.12E-13	2.56E+11		
3.71407E-10	Tc-99	decay const	$\lambda$				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(- $\lambda$ t-p)*[1-exp(- $\lambda$ t-b)]												
0.0000000147	U-235	exp(- $\lambda$ t-p)*[1-exp(- $\lambda$ t-b)]												
0.0000000023	U-238	exp(- $\lambda$ t-p)*[1-exp(- $\lambda$ t-b)]												
0.0000486679	Tc-99	exp(- $\lambda$ t-p)*[1-exp(- $\lambda$ t-b)]												
Activity Released														
3.085E-03	U-234 release fraction	Ci												
1.433E-04	U-235 release fraction	Ci												
5.412E-04	U-238 release fraction	Ci												
5.801E-03	Tc-99 release fraction	Ci												
check U sum		0.00377												
1.15E-10	U-234	release fraction *dose factor*exp(- $\lambda$ t-p)*1-exp(- $\lambda$ t-b)*t-i												
1.07E-09	U-235	release fraction *dose factor*exp(- $\lambda$ t-p)*1-exp(- $\lambda$ t-b)*t-i												
1.50E-11	U-238	release fraction *dose factor*exp(- $\lambda$ t-p)*1-exp(- $\lambda$ t-b)*t-i												
2.27E-11	Tc-99	release fraction *dose factor*exp(- $\lambda$ t-p)*1-exp(- $\lambda$ t-b)*t-i												
1.22E-09	all nuclides	sum of nuclides												
2.812101	usage	11000*(usage*dilution*shore width factor)/flow												
3.43E-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**

### **2020 Isotopic Fractions**

**Based on the plant nominal enrichment for 2020**

<b>Nuclide</b>	<b>Average wt%</b>	<b>Specific Activity Ci/g</b>	<b>Weighted Activity</b>	<b>% Activity</b>
<b>U-234</b>	0.04	6.220E-03	2.388E-06	85.25
<b>U-235</b>	4.25	2.160E-06	9.180E-08	3.28
<b>U-238</b>	95.70	3.360E-07	3.216E-07	11.48
<b>Total</b>	100.0		2.802E-06	100.00

# Attachment 10 - Comply Results

COMPLY: V1.7.

2/ 8/2021 8:45

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  
803.647.1919

Prepared for:

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

2020 Semi-Annual Dose to Public due to Gaseous Effluents

-----  
SCREENING LEVEL 2  
-----

DATA ENTERED:  
-----

RELEASE RATES FOR STACK 1.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 1.240E-13
U-235	Y 4.750E-15
U-238	Y 1.660E-14

RELEASE RATES FOR STACK 2.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 4.060E-13
U-235	Y 1.560E-14
U-238	Y 5.460E-14

RELEASE RATES FOR STACK 3.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 1.210E-12
U-235	Y 4.670E-14
U-238	Y 1.640E-13

RELEASE RATES FOR STACK 4.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 3.980E-12
U-235	Y 1.530E-13
U-238	Y 5.360E-13

RELEASE RATES FOR STACK 5.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 1.510E-14
U-235	Y 5.820E-16
U-238	Y 2.040E-15

RELEASE RATES FOR STACK 6.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 1.030E-12
U-235	Y 3.970E-14
U-238	Y 1.390E-13

RELEASE RATES FOR STACK 7.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 2.320E-12
U-235	Y 8.940E-14
U-238	Y 3.130E-13

RELEASE RATES FOR STACK 8.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 1.290E-12
U-235	Y 4.970E-14
U-238	Y 1.740E-13

RELEASE RATES FOR STACK 9.

Nuclide	Release Rate (curies/SECOND)
U-234	Y 1.410E-12
U-235	Y 5.420E-14
U-238	Y 1.900E-13

SITE DATA FOR STACK 1.

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 2.

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 3.

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 4.

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 5.

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 6.

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 7.

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 8.

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 9.

Release height 18 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: 0.2 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/ 8/2021 9:33

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  
803.647.1919

Prepared for:

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

S1030A

-----  
SCREENING LEVEL 2  
-----

DATA ENTERED:  
-----

Nuclide	Release Rate (curies/SECOND)
U-234	Y 9.700E-13
U-235	Y 3.730E-14
U-238	Y 1.310E-13

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.

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: 1.9E-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 \*\*\*\*\*