

JAFP-19-0046
April 30, 2019

United States Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

James A. FitzPatrick Nuclear Power Plant
Renewed Facility Operating License No. DPR-59
NRC Docket No. 50-333

SUBJECT: 2018 Annual Radioactive Effluent Release Report

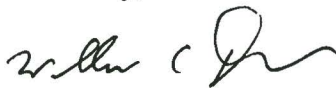
Dear Sir or Madam:

This letter transmits the James A. FitzPatrick Nuclear Power Plant's (JAF) Annual Radioactive Effluent Release Report for the period of January 1, 2018 through December 31, 2018. The enclosure is submitted in accordance with 10 CFR 50.36a and the Reporting Requirements of Technical Specifications Section 5.6.3 and Technical Requirements Manual Appendix H, Offsite Dose Calculation Manual (ODCM), Part 1 Section 6.2, Radioactive Effluent Release Report.

This report (Enclosure 1) includes, as an Addendum, an Assessment of the Radiation Doses to the Public due to the radioactive liquid and gaseous effluents released during the 2018 calendar year. The format used for the effluent data is outlined in Appendix B of Regulatory Guide 1.21, Revision 1. Distribution is in accordance with Regulatory Guide 10.1, Revision 4.

There are no new regulatory commitments contained in this letter. If you have any questions concerning the enclosed report, please contact Mr. Brian Cummings, Chemistry Manager, at (315) 349-6331.

Sincerely,



William C. Drews
Regulatory Assurance Manager

WCD/BC/mh

Enclosure 1: Annual Radioactive Effluent Release Report, January 1 – December 31, 2018

cc: next page

cc:
NRC Regional Administrator, Region I
NRC Resident Inspector
NRC Project Manager

Supervisor, Town of Scriba
Route 8, Box 382
Oswego, NY 13126

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Enclosure 1

Annual Radioactive Effluent Release Report

January 1 – December 31, 2018

(39 Pages)

EXELON FITZPATRICK, LLC
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY 1, 2018 - DECEMBER 31, 2018

DOCKET NO. 50-333

LICENSE NO. DPR-59

EXELON FITZPATRICK, LLC
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
JANUARY 2018 - DECEMBER 2018

SUPPLEMENTAL INFORMATION

FACILITY: JAFNPP LICENSEE: EXELON FITZPATRICK, LLC

1. Offsite Dose Calculation Manual Part 1 Radiological Effluent Controls

a. Fission and Activation Gases:

(1) The dose rate at or beyond the site boundary due to radioactive materials released from the plant in gaseous effluent shall be limited as follows:

(a) Less than or equal to 500 mrem/year to the whole body and less than or equal to 3000 mrem/year to the skin from noble gases.

(2) The air dose to areas at or beyond the site boundary from noble gases released from the plant in gaseous effluent shall be limited:

(a) During any calendar quarter, to less than or equal to 5 mrad from gamma radiation, and less than or equal to 10 mrad from beta radiation; and,

(b) During any calendar year, to less than or equal to 10 mrad from gamma radiation and less than or equal to 20 mrad from beta radiation.

b. Tritium, Iodines and Particulates, Half Lives > 8 days:

(1) The dose to a member of the public at or beyond the site boundary from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days released from the plant in gaseous effluent shall be limited:

(a) During any calendar quarter to less than or equal to 7.5 mrem to any organ; and,

(b) During any calendar year to less than or equal to 15 mrem to any organ.

(c) Less than 0.1% of the limits of ODCM Part 1, Section 3.4 Specification 3.4.1.c.1.a and 3.4.1.c.1.b as a result of burning contaminated oil.

(2) The dose rate at or beyond the site boundary due to radioactive materials released from the plant in gaseous effluents shall be limited as follows:

(a) Less than or equal to 1500 mrem/year to any organ from Iodine-131, Iodine-133, Tritium and for radioactive materials in particulate form with half-lives greater than 8 days (inhalation pathway only).

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SUPPLEMENTAL INFORMATION (continued)

c. Liquid Effluents:

- (1) The concentration of radioactive materials released to the unrestricted areas shall not exceed ten times the values specified in 10 CFR 20.1001-20.2402, Appendix B, Table 2, column 2. For dissolved or entrained noble gases the concentration shall be limited to 2.00E-04 $\mu\text{Ci/ml}$.
- (2) The dose to a member of the public from radioactive materials released from the plant in liquid effluents to unrestricted areas shall be limited as follows:
 - (a) During any calendar quarter, limited to less than or equal to 1.5 mrem to the whole body and to less than or equal to 5 mrem to any organ; and,
 - (b) During any calendar year, limited to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

2. 10X Effluent Concentrations

a. Fission and activation gases:	(None specified)			
b. Iodines:	(None specified)			
c. Particulates, half-lives >8 days:	(None specified)			
d. Liquid effluents:	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
(1) Fission and activation products (mixture EC) ($\mu\text{Ci/ml}$)	None	None	None	None
(2) Tritium ($\mu\text{Ci/ml}$)	1.00E-02	1.00E-02	1.00E-02	1.00E-02
(3) Dissolved and entrained gases ($\mu\text{Ci/ml}$)	2.00E-04	2.00E-04	2.00E-04	2.00E-04

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SUPPLEMENTAL INFORMATION (continued)

3. Average Energy (None specified)

4. Measurements and Approximations of Total Radioactivity

- a. Fission and Activation Gases: Continuous monitor on each release path calibrated to a marinelli grab sample analyzed by gamma spectroscopy; bubbler grab sample analyzed for Tritium.
- b. Iodines: Gamma spectral analysis of charcoal cartridge and particulate filter on each release path.
- c. Particulates: Gamma spectral analysis of each particulate filter and charcoal cartridge for each release path. A four week per quarter composite of particulate filters for each release path for Strontium-89 and Strontium-90. One week per month particulate filter for each release path for gross alpha.
- d. Liquid Effluents: Gamma spectral analysis of each batch discharged, except composite analysis for Strontium-89, Strontium-90, Iron-55, Tritium, and Alpha.
- e. Solid Waste: Gamma spectral analysis of a representative sample of each waste shipment. Scaling factors established from offsite composite sample analyses to estimate concentration of non-gamma emitters. Low activity trash shipments curie content is estimated by dose rate measurement and application of appropriate scaling factors.
- f. Error Estimation Method: Overall error for sampling and analysis estimated by combining individual errors using error propagation methods. This process is composed of determinate and undeterminate errors.

Determinate - Pump flowrates, volume measurements and analysis collection yields

Undeterminate - Random counting error estimated using accepted statistical calculations

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SUPPLEMENTAL INFORMATION (continued)

5. Batch Releases

a. <u>Liquid: Canal</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
(1) Number of batch releases:	2.00E+00	5.00E+00	4.00E+00	1.80E+01
(2) Total time period for batch release: (min)	8.20E+01	2.60E+01	2.74E+02	1.00E+03
(3) Maximum time period for batch release: (min)	7.20E+01	1.20E+01	1.62E+02	1.48E+02
(4) Average time period for batch release: (min)	4.10E+01	5.20E+00	6.85E+01	5.56E+01
(5) Minimum time period for batch release: (min)	1.00E+01	1.00E+00	1.00E+00	5.00E+00
(6) Total Activity Released (Ci)	6.80E-05	1.07E-04	2.26E-01	8.25E-01
(7) Total Volume Released (liters)	4.81E+03	9.84E+03	7.99E+04	3.74E+05
b. <u>Liquid: Non-Canal</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
(1) Number of batch releases:	1.00E+02	6.60E+01	7.70E+01	3.33E+02
(2) Total time period for batch release: (min)	1.16E+02	8.10E+01	3.96E+02	9.36E+02
(3) Maximum time period for batch release: (min)	7.00E+00	6.00E+00	8.00E+00	1.50E+01
(4) Average time period for batch release: (min)	1.16E+00	1.23E+00	5.14E+00	2.81E+00
(5) Minimum time period for batch release: (min)	1.00E+00	1.00E+00	1.00E+00	1.00E+00
(6) Total Activity Released (Ci)	0.00E+00	4.16E-05	2.62E-04	0.00E+00
(7) Total Volume Released (liters)	4.39E+04	3.07E+04	1.50E+05	3.33E+05

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c. <u>Gaseous</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
(1) Number of batch releases:	0.00E+00	0.00E+00	2.00E+00	0.00E+00
(2) Total time period for batch release: (min)	0.00E+00	0.00E+00	2.03E+04	0.00E+00
(3) Maximum time period for batch release: (min)	0.00E+00	0.00E+00	1.03E+04	0.00E+00
(4) Average time period for batch release: (min)	0.00E+00	0.00E+00	1.01E+04	0.00E+00
(5) Minimum time period for batch release: (min)	0.00E+00	0.00E+00	9.94E+03	0.00E+00
(6) Total Activity Released (Ci)	0.00E+00	0.00E+00	2.49E-09	0.00E+00
(7) Total Volume Released (cf)	0.00E+00	0.00E+00	4.06E+05	0.00E+00

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SUPPLEMENTAL INFORMATION (continued)

6. Continuous Releases

a. <u>Liquid: Non-Canal</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
(1) Number of releases:	1.30E+01	1.30E+01	1.30E+01	1.30E+01
(2) Total Activity Released (Ci)	1.00E-02	1.01E-02	1.38E-02	1.02E-02
(3) Total Volume Released (liters)	5.87E+06	4.51E+06	3.98E+06	5.88E+06
b. <u>Liquid: Canal</u>	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
(1) Number of releases:	0	0	0	0
(2) Total Activity Released (Ci)	N/A	N/A	N/A	N/A

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**TABLE 1A
 GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES**

	<u>UNIT</u>	<u>QTR 1</u>	<u>QTR 2</u>	<u>QTR 3</u>	<u>QTR 4</u>	<u>EST TOTAL ERROR %</u>
A. FISSION AND ACTIVATION GASES						
1. Total Release	Ci	2.00E+02	2.44E+02	2.55E+02	2.69E+01	≤2.50E+01
2. Average release rate for period	μCi/sec	2.57E+01	3.11E+01	3.20E+01	3.38E+00	
3. Percentage ODCM Limit	%	*	*	*	*	
B. IODINE-131						
1. Total Iodine-131	Ci	7.62E-05	1.45E-04	4.93E-04	4.50E-04	≤2.50E+01
2. Average release rate for period	μCi/sec	9.34E-06	1.84E-05	6.20E-05	5.72E-05	
3. Percentage ODCM Limit	%	*	*	*	*	
C. PARTICULATES						
1. Particulates with half-lives >8 days	Ci	ND	5.87E-06	1.19E-04	3.20E-06	≤3.60E+01
2. Average release rate for period	μCi/sec	ND	7.46E-07	1.49E-05	4.02E-07	
3. Percentage ODCM Limit	%	*	*	*	*	
4. Gross alpha radioactivity	Ci	1.36E-07	2.37E-07	2.03E-07	4.51E-07	≤2.50E+01
D. TRITIUM						
1. Total Release	Ci	4.22E+00	2.91E+00	4.40E+00	1.67E+00	≤2.50E+01
2. Average release rate for period	μCi/sec	5.42E-01	3.71E-01	5.53E-01	2.10E-01	
3. Percentage ODCM Limit	%	*	*	*	*	
E. CARBON-14 (See Attachment 8)						
*F. PERCENT OF APPLICABLE ODCM LIMITS						
FISSION AND ACTIVATION GASES	<u>UNIT</u>	<u>QTR 1</u>	<u>QTR 2</u>	<u>QTR 3</u>	<u>QTR 4</u>	
1. Quarterly gamma air dose limit	%	4.72E-02	6.51E-02	6.90E-02	1.39E-02	
2. Quarterly beta air dose limit	%	3.66E-03	4.64E-03	1.09E-02	1.31E-03	
3. Yearly gamma air dose limit	%	2.36E-02	5.61E-02	9.06E-02	9.76E-02	
4. Yearly beta air dose limit	%	1.83E-03	4.15E-03	9.59E-03	1.03E-02	
5. Whole body dose rate limit	%	1.83E-03	2.50E-03	2.60E-03	5.32E-04	
6. Skin dose rate limit	%	3.90E-04	5.28E-04	6.08E-04	1.17E-04	
HALOGENS, TRITIUM AND PARTICULATES WITH HALF-LIVES >8 DAYS						
7. Quarterly dose limit (organ)	%	1.76E-02	2.90E-02	7.62E-02	2.23E-02	
8. Yearly dose limit (organ)	%	8.78E-03	2.33E-02	6.14E-02	7.25E-02	
9. Organ dose rate limit	%	3.37E-04	5.62E-04	1.48E-03	4.36E-04	

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TABLE 1B
GASEOUS EFFLUENTS - ELEVATED RELEASE

CONTINUOUS MODE

NUCLIDES RELEASED

1. <u>Fission Gases</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>
Argon-41	Ci	3.64E+00	4.48E+00	4.02E+00	3.21E+00
Krypton-85	Ci	ND	ND	ND	ND
Krypton-85m	Ci	4.50E+01	5.42E+01	4.07E+01	1.70E+00
Krypton-87	Ci	9.77E-01	2.06E+00	4.55E+00	2.28E+00
Krypton-88	Ci	3.70E+01	5.16E+01	5.23E+01	2.86E+00
Krypton-89	Ci	ND	ND	ND	ND
Xenon-133	Ci	1.13E+02	1.31E+02	1.15E+02	2.67E-01
Xenon-133m	Ci	ND	ND	ND	ND
Xenon-135	Ci	3.47E-01	3.65E-01	ND	2.51E+00
Xenon-135m	Ci	1.54E-01	3.17E-01	ND	2.44E+00
Xenon-137	Ci	ND	ND	ND	ND
Xenon-138	Ci	ND	2.01E-02	ND	9.36E+00
TOTAL	Ci	2.00E+02	2.44E+02	2.17E+2	2.46E+01
2. <u>Iodines</u>					
Iodine-131	Ci	8.91E-06	2.09E-05	5.40E-05	4.26E-04
Iodine-132	Ci	ND	ND	ND	3.01E-05
Iodine-133	Ci	2.61E-05	4.97E-05	7.26E-05	1.94E-03
Iodine-134	Ci	ND	ND	ND	5.89E-03
Iodine-135	Ci	ND	ND	ND	5.86E-03
TOTAL	Ci	3.50E-05	7.06E-05	1.27E-04	1.42E-02
3. <u>Particulates</u>					
Barium-140	Ci	ND	ND	ND	ND
Cobalt-60	Ci	ND	ND	4.95E-06	ND
Cesium-137	Ci	ND	ND	ND	ND
Manganese-54	Ci	ND	8.87E-07	5.25E-06	1.34E-06
Strontium-89	Ci	ND	4.11E-06	1.17E-05	1.85E-06
Zinc-65	Ci	ND	8.69E-07	5.35E-06	ND
Chromium-51	Ci	ND	ND	5.56E-06	ND
Iron-59	Ci	ND	ND	1.02E-06	ND
Cobalt-58	Ci	ND	ND	1.11E-06	ND
TOTAL	Ci	ND	5.87E-06	3.49E-05	3.20E-06
4. <u>Tritium</u>					
Hydrogen-3	Ci	3.90E-01	2.77E-01	7.08E-01	2.83E-01

Note: There were no batch releases for this report period.

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TABLE 1C
GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

CONTINUOUS MODE

NUCLIDES RELEASED

1. <u>Fission Gases</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>
Argon-41	Ci	ND	ND	ND	ND
Krypton-85	Ci	ND	ND	ND	ND
Krypton-85m	Ci	ND	ND	ND	ND
Krypton-87	Ci	ND	ND	ND	ND
Krypton-88	Ci	ND	ND	ND	ND
Xenon-133	Ci	1.06E-02	1.21E-02	3.80E+01	2.23E+00
Xenon-133m	Ci	ND	ND	ND	ND
Xenon-135	Ci	7.93E-03	7.27E-03	ND	ND
Xenon-135m	Ci	3.59E-04	4.40E-04	ND	ND
Xenon-137	Ci	ND	ND	ND	ND
Xenon-138	Ci	ND	ND	ND	ND
TOTAL	Ci	1.89E-02	1.98E-02	3.80E+01	2.23E+00
2. <u>Iodines</u>					
Iodine-131	Ci	6.73E-05	1.24E-04	4.39E-04	2.42E-05
Iodine-132	Ci	ND	ND	ND	ND
Iodine-133	Ci	3.71E-04	5.88E-04	4.90E-04	1.63E-05
Iodine-134	Ci	ND	ND	ND	ND
Iodine-135	Ci	ND	ND	ND	ND
TOTAL	Ci	4.39E-04	7.12E-04	9.29E-04	4.05E-05
3. <u>Particulates</u>					
Chromium-51	Ci	ND	ND	6.23E-06	ND
Cobalt-58	Ci	ND	ND	ND	ND
Cobalt-60	Ci	ND	ND	6.47E-06	ND
Manganese-54	Ci	ND	ND	1.09E-05	ND
Iron-59	Ci	ND	ND	ND	ND
Strontium-89	Ci	ND	ND	ND	ND
Zinc-65	Ci	ND	ND	6.03E-05	ND
TOTAL	Ci	ND	ND	8.38E-05	ND
4. <u>Tritium</u>					
Hydrogen-3	Ci	3.83E+00	2.64E+00	3.69E+00	1.33E+00

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Batch Mode

NUCLIDES RELEASED

1. <u>Fission Gases</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>
Argon-41	Ci	ND	ND	ND	ND
Krypton-85	Ci	ND	ND	ND	ND
Krypton-85m	Ci	ND	ND	ND	ND
Krypton-87	Ci	ND	ND	ND	ND
Krypton-88	Ci	ND	ND	ND	ND
Xenon-133	Ci	ND	ND	ND	ND
Xenon-133m	Ci	ND	ND	ND	ND
Xenon-135	Ci	ND	ND	ND	ND
Xenon-135m	Ci	ND	ND	ND	ND
Xenon-137	Ci	ND	ND	ND	ND
Xenon-138	Ci	ND	ND	ND	ND
TOTAL	Ci	ND	ND	ND	ND
2. <u>Iodines</u>					
Iodine-131	Ci	ND	ND	2.06E-09	ND
Iodine-132	Ci	ND	ND	ND	ND
Iodine-133	Ci	ND	ND	ND	ND
Iodine-134	Ci	ND	ND	ND	ND
Iodine-135	Ci	ND	ND	ND	ND
TOTAL	Ci	ND	ND	2.06E-09	ND
3. <u>Particulates</u>					
Chromium-51	Ci	ND	ND	ND	ND
Cobalt-58	Ci	ND	ND	ND	ND
Cobalt-60	Ci	ND	ND	ND	ND
Manganese-54	Ci	ND	ND	4.30E-10	ND
Iron-59	Ci	ND	ND	ND	ND
Strontium-89	Ci	ND	ND	ND	ND
Zinc-65	Ci	ND	ND	ND	ND
TOTAL	Ci	ND	ND	4.30E-10	ND
4. <u>Tritium</u>					
Hydrogen-3	Ci	ND	ND	3.30E-05	ND

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TABLE 2A
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	<u>UNIT</u>	<u>QTR 1</u>	<u>QTR 2</u>	<u>QTR 3</u>	<u>QTR 4</u>	<u>EST TOTAL ERROR %</u>
A. FISSION AND ACTIVATION PRODUCTS						
1. Total Release (not including tritium, gases and alpha)	Ci	ND	ND	ND	2.58E-04	NA
2. Average diluted concentration during period	μCi/ml	ND	ND	ND	1.64E-10	
3. Percentage ODCM Limit	%	NA	NA	NA	NA	
B. TRITIUM						
1. Total Release	Ci	1.01E-02	1.02E-02	2.40E-01	8.35E-01	≤2.50E+01
2. Average diluted concentration during period (Note 1)	μCi/ml	7.38E-08	2.31E-07	9.90E-06	5.33E-07	
3. Percentage ODCM Limit	%	*	*	*	*	
C. DISSOLVED AND ENTRAINED GASES						
1. Total Release	Ci	ND	ND	ND	ND	NA
2. Average diluted concentration during period	μCi/ml	ND	ND	ND	ND	
3. Percentage ODCM Limit	%	NA	NA	NA	NA	
D. GROSS ALPHA RADIOACTIVITY						
1. Total Release	Ci	ND	ND	4.08E-06	5.89E-06	≤4.20E+01
E. VOLUME OF WASTE RELEASED (PRIOR TO DILUTION)						
	liters	5.91E+06	4.54E+06	4.21E+06	6.58E+06	
F. VOLUME OF DILUTION WATER USED DURING PERIOD						
	liters	1.31E+08	3.99E+07	2.02E+07	1.56E+09	
*G. PERCENT OF APPLICABLE ODCM LIMITS						
1. Quarterly Whole Body Dose	%	2.82E-05	3.93E-05	3.60E-04	3.84E-04	
2. Quarterly Organ Dose	%	8.65E-06	1.18E-05	1.08E-04	2.11E-04	
3. Annual Whole Body Dose	%	1.41E-05	1.96E-05	1.80E-04	1.92E-04	
4. Annual Organ Dose	%	4.24E-06	5.89E-06	5.39E-05	1.05E-04	

Note 1: Concentration includes summation from diluted and undiluted values from Canal and Non-Canal releases (Table 2B).

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TABLE 2B
LIQUID EFFLUENTS CANAL

BATCH MODE

<u>NUCLIDES RELEASED</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>
1. <u>Fission and Activation Products</u>					
Mn-54	Ci	ND	ND	ND	6.93E-5
C0-60	Ci	ND	ND	ND	4.29E-5
Zn-65	Ci	ND	ND	ND	1.46E-4
2. <u>Tritium</u>					
Hydrogen-3	Ci	6.80E-5	1.07E-04	2.26E-01	8.25E-01
3. <u>Dissolved and Entrained Gases</u>					
ND	Ci	ND	ND	ND	ND

TABLE 2B
LIQUID EFFLUENTS CANAL

CONTINUOUS MODE

<u>NUCLIDES RELEASED</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>
1. <u>Fission and Activation Products</u>					
ND	Ci	ND	ND	ND	ND
2. <u>Tritium</u>					
Hydrogen-3	Ci	ND	ND	ND	ND
3. <u>Dissolved and Entrained Gases</u>					
ND	Ci	ND	ND	ND	ND

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**TABLE 2B (SUPPLEMENT)
 LIQUID EFFLUENTS NON-CANAL**

<u>CONTINUOUS MODE</u>					
<u>NUCLIDES RELEASED</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>
1. <u>Fission and Activation Products</u>					
ND	Ci	ND	ND	ND	ND
2. <u>Tritium</u>					
Hydrogen-3	Ci	1.00E-02	1.01E-02	1.38E-02	1.02E-02
3. <u>Dissolved and Entrained Gases</u>					
ND	Ci	ND	ND	ND	ND

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**TABLE 2B (SUPPLEMENT)
 LIQUID EFFLUENTS NON-CANAL**

<u>NUCLIDES RELEASED</u>	<u>UNIT</u>	<u>BATCH MODE</u>				
		<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>	
1. <u>Fission and Activation Products</u>						
ND	Ci	ND	ND	ND	ND	
2. <u>Tritium</u>						
Hydrogen-3	Ci	ND	4.16E-05	2.62E-04	ND	
3. <u>Dissolved and Entrained Gases</u>						
ND	Ci	ND	ND	ND	ND	

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TABLE 2B (continued)
ABNORMAL RELEASE
LIQUID EFFLUENTS CANAL

<u>CONTINUOUS MODE</u>						
<u>NUCLIDES RELEASED</u>	<u>UNIT</u>	<u>QUARTER 1</u>	<u>QUARTER 2</u>	<u>QUARTER 3</u>	<u>QUARTER 4</u>	
1. <u>Fission and Activation Products</u>						
ND	Ci	ND	ND	ND	ND	
2. <u>Tritium</u>						
ND	Ci	ND	ND	ND	ND	
3. <u>Dissolved and Entrained Gases</u>						
ND	Ci	ND	ND	ND	ND	

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TABLE 3A
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)

1. <u>Type of Waste</u>	<u>UNIT</u>	<u>CLASS A</u>	<u>CLASS B</u>	<u>CLASS C</u>	<u>EST. TOTAL ERROR %</u>
a. Spent resins, filter sludges, evaporator bottoms, etc.	m ³	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
b. Dry compressible waste, contaminated equipment, etc.	m ³	1.27E+03	0.00E+00	0.00E+00	1.00E+01
	Ci	1.84E+00	0.00E+00	0.00E+00	1.00E+01
c. Irradiated components, control rods, etc.	m ³	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00
d. Other: Dry compressible waste, contaminated equipment, spent resins for volume reduction.	m ³	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00

2. Estimate of Major Nuclide Composition (by type of waste)

a. Spent resins, filter sludges, evaporator bottoms, etc.

b. Dry compressible waste, contaminated equipment, etc.

<u>Isotope</u>	<u>Percent</u>	<u>Curies</u>	
Fe-55	8.12E+01	1.50E+00	E
Co-60	9.08E+00	1.67E-01	E
Cs-137	7.90E-01	1.45E-02	E
Mn-54	5.02E+00	9.26E-02	E
Ni-63	1.75E+00	3.22E-02	E
Zn-65	1.45E+00	2.67E-02	E
Fe-59	4.70E-01	8.70E-03	E
Co-58	1.30E-01	2.35E-03	E

(E- Estimated M- Measured)

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TABLE 3A (continued)
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

c. Irradiated components, control rods, etc.
None

d. Other: Dry compressible waste, contaminated equipment, spent resins, contaminated oil, glycol and water for volume reduction.
(E- Estimated M- Measured)

Percentage of nuclides and total activities are based on a combination of direct measurements and scaling for non-gamma emitting nuclides.

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TABLE 3A (continued)
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

3. Solid Waste Disposition

<u>No. of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
25	Trucks	*Energy Solutions Oak Ridge, TN
3	Trucks	*Energy Solutions Kingston, TN

B. IRRADIATED FUEL SHIPMENTS (Disposition)

<u>No. of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
None	-----	-----

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TABLE 3B
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. NRC CLASS A

<u>SOURCE OF WASTE</u>	<u>PROCESSING EMPLOYED</u>	<u>CONTAINER VOLUME</u>	<u>TYPE OF CONTAINER</u>	<u>NUMBER OF CONTAINERS</u>
Dry compressible Waste (DAW), Contaminated Equipment, etc.	Non-compacted	1280 ft ³ (36.2m ³)	STC	43
Dry compressible Waste (DAW), Contaminated Equipment, etc.	Non-compacted	96 ft ³ (2.7m ³)	STC	10
Dry compressible Waste (DAW), Contaminated Equipment, etc.	Non-compacted	2560 ft ³ (72.4m ³)	STC	1

B. NRC CLASS B

<u>SOURCE OF WASTE</u>	<u>PROCESSING EMPLOYED</u>	<u>CONTAINER VOLUME</u>	<u>TYPE OF CONTAINER</u>	<u>NUMBER OF CONTAINERS</u>
None				

C. NRC CLASS C

<u>SOURCE OF WASTE</u>	<u>PROCESSING EMPLOYED</u>	<u>CONTAINER VOLUME</u>	<u>TYPE OF CONTAINER</u>	<u>NUMBER OF CONTAINERS</u>
None				

HIC-High Integrity Container, STC-Strong Tight Container

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ATTACHMENT NO. 1

CHANGES TO THE OFFSITE DOSE CALCULATION MANUAL (ODCM)

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls (REC) Section 6.2.3, changes made to the Offsite Dose Calculation Manual (ODCM) during the reporting period shall be included in the Annual Radioactive Effluent Release Report.

The latest revision of the ODCM (Rev. 14) became effective during calendar year 2016. A copy of this revision is attached. There were no changes to the ODCM in 2018.

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ATTACHMENT NO. 2

SUMMARY OF CHANGES TO THE PROCESS CONTROL PROGRAM

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls Section 6.2.3, changes made to the Process Control Program (PCP) during the reporting period shall be included in the Annual Radioactive Effluent Release Report.

RW-AA-600 Rev. 2, Guidelines for Tracking Processed Liners (issued 11/30/18), supersedes EN-RW-102.

RP-AA-600-1009 Rev. 3, Shipment of Category 2 Quantities of Radioactive Material or Waste (Category 2 RAMQC), (issued 11/6/18)

RP-AA-600-1009 Rev. 2, Shipment of Category 2 Quantities of Radioactive Material or Waste (Category 2 RAMQC), (issued 2/1/18), supersedes EN-RW-106.

ATTACHMENT NO. 3

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**SUMMARY OF CHANGES TO THE ENVIRONMENTAL
MONITORING AND DOSE CALCULATION LOCATIONS**

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1, Radiological Effluent Controls Section 6.2.3 a listing of new locations for dose calculation and/or environmental monitoring identified by the land use census shall be included in the Annual Radioactive Effluent Release Report.

During the reporting period, no changes in Dose Calculation Receptor Locations and/or the Environmental Monitoring were required based on the results of the land use census.

ATTACHMENT NO. 4

EXELON FITZPATRICK, LLC
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**DEVIATIONS FROM THE REQUIRED
ENVIRONMENTAL SAMPLING SCHEDULE**

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1, Radiological Effluent Controls Section 6.2.7, the cause for the unavailability of any environmental samples required during the report period shall be included in the Annual Radioactive Effluent Release Report.

The following reports samples that were a deviation from the requirements of ODCM Part 1, Table 5.1-1. ODCM Part Section 5.1.1.c.1 allows for deviations from the program due to hazardous conditions, seasonal unavailability, theft, uncooperative residents, or to a malfunction of automatic sampling equipment.

A. ODCM Program Deviations

The following are deviations from the program specified by the ODCM:

IR# 0477893 9/13/18-9/27/18

Unmonitored Path lovol in Turbine Building had detectable amounts of Iodine-131 and Manganese-54. During Refueling outage 23 Turbine Lovol had trace amounts of Iodine-131 $2.27E-13$ uCi/cc, and Mn-54 $7.342E-14$ uCi/cc. Both concentrations were < 1% effluent concentration limits in 10CFR Part 20.

Air Sampling Station Operability Assessment

The ODCM required air sampling program consists of 5 individual sampling locations. The collective operable time period for the air monitoring stations was 43,705.2 hours out of a possible 43,800 hours. The air sampling availability factor for the report period was 99.8%. Issue reports (IRs) were generated for each event. Air sampling equipment found inoperable was returned to service. Identification of locations for obtaining replacement samples was not required.

IR 4124687, 04/09/18, G-Onsite, loss of power
IR 4125118, 04/10/18, G-Offsite, loss of power
IR 4160337, 07/31/18, F-Offsite, pump breaker tripped

ATTACHMENT NO. 5

EXELON FITZPATRICK, LLC
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ANNUAL SUMMARY OF HOURLY METEOROLOGICAL DATA

The James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1, Radiological Effluent Controls Section 6.2 and 6.2.2 states in part: The Annual Radioactive Effluent Release Report submitted prior to May 1 of each year may include an annual summary of meteorological data collected over the previous year. If the meteorological data is not included, the licensee shall retain it on file and provide it to the U.S. Nuclear Regulatory Commission upon request.

In accordance with the aforementioned ODCM requirement, meteorological data is not included in this report. It is retained on file and is available upon request.

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ATTACHMENT NO. 6

**MAJOR MODIFICATIONS TO RADIOACTIVE LIQUID,
GASEOUS AND SOLID WASTE TREATMENT SYSTEMS**

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls Section 7.0, Major Modifications to Radioactive Waste Treatment Systems (liquid, gaseous and solid) shall be reported in the Annual Radioactive Effluent Release Report for the period in which the modification is completed and made operational.

There were no major modifications to any liquid, gaseous, or solid radioactive waste treatment systems.

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ATTACHMENT NO. 7

ONSITE GROUNDWATER MONITORING

In response to the Nuclear Energy Institute (NEI) Groundwater Protection Initiative, JAF instituted a groundwater monitoring program in 2007. FitzPatrick's Groundwater Monitoring Well Program consists of twenty-two wells which are sampled quarterly.

Groundwater Monitoring Well samples collected in 2018 were analyzed quarterly for tritium, annually for gamma emitting radionuclides and annually for gross beta, provided sample was of sufficient volume. The detection limits were in accordance with the Offsite Dose Calculation Manual (ODCM) Part 1, Table 5.1-3 and results are reported in the tables on pages 27 and 28.

All sample results were <LLD for gamma emitting nuclides and tritium. Analysis results for gross beta ranged from <LLD, a minimum positive indication of 4.85 pCi/L for MW-2B sampled on 7/9/18, and a maximum concentration of 75.1 pCi/L for MW-4B sampled on 10/29/18. No drinking water pathway exists at the James A. FitzPatrick site under normal operating conditions due to the direction and distance of the nearest water intake (Oswego, 8.5 miles west of the JAF discharge). There is no potential to influence any offsite drinking well.

In conclusion, there were no plant related isotopes detected in groundwater monitoring wells during 2018 that are attributable to James A. FitzPatrick, and all concentrations were below any reporting criteria.

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ATTACHMENT NO. 7 (continued)

ONSITE GROUNDWATER MONITORING

A) Gamma Isotopic Monitoring & Gross Beta

For 2018, the 22 monitoring wells were sampled annually for gamma emitting radionuclides. Samples results were below the required lower limits of detection in accordance with the Offsite Dose Calculation Manual (ODCM) Part 1, Table 5.1-3 as provided below.

Radionuclide	LLD Value (pCi/L)
Gross Beta	4
Tritium (H-3)	3000
Manganese-54	15
Cobalt-58	15
Iron-59	30
Cobalt-60	15

Radionuclide	LLD Value (pCi/L)
Zinc-65	30
Zirconium /Niobium-95	15
Iodine-131	15
Cesium-134	15
Cesium-137	18
Barium/Lanthanum-140	15

There were no plant related gamma emitting nuclides detected in 2018 samples. For 2018, 20 monitoring wells were sampled for gross beta. Gross Beta results are listed in the table below.

Gross Beta Summary

Well Name	# Samples in 2018	# Positive Samples in 2018	Minimum Positive Concentration	Maximum Positive Concentration
MW-1A	1	1	8.17	8.17
MW-1B	1	1	35.9	35.9
MW-2A	1	1	13.5	13.5
MW-2B	1	1	4.85	4.85
MW-3A	1	1	16.3	16.3
MW-3B	1	1	18.3	18.3
MW-4A	1	1	9.42	9.42
MW-4B	2	2	65.7	75.1
MW-5	1	0	-	-
MW-6	1	1	12.8	12.8

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MW-7	1	1	12.9	12.9
Well Name	# Samples in 2018	# Positive Samples in 2018	Minimum Positive Concentration	Maximum Positive Concentration
MW-8	1	1	10.5	10.5
MW-9	1	0	-	-
MW-10A	1	1	9.01	9.01
MW-10B	1	1	30.9	30.9
MW-13	1	1	23.8	23.8
MW-14	1	1	10.3	10.3
MW-15	1	1	16.8	16.8
MW-16	1	1	8.03	8.03
MW-19	1	0	-	-

Note 1: All results are in pCi/L.

Note 2: Gross Beta analysis not required for MW-20 and MW-21 per EN-AA-408-4000 and EN-JF-408-4160.

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ATTACHMENT NO. 7 (continued)

ONSITE GROUNDWATER MONITORING

B) Tritium Summary

Well Name	# Samples in 2018	# Positive Samples in 2018	Minimum Positive Concentration	Maximum Positive Concentration
MW-1A	4	0	-	-
MW-1B	4	0	-	-
MW-2A	4	0	-	-
MW-2B	4	0	-	-
MW-3A	4	0	-	-
MW-3B	4	0	-	-
MW-4A	4	0	-	-
MW-4B	4*	0	-	-
MW-5	4	0	-	-
MW-6	4	0	-	-
MW-7	4	0	-	-
MW-8	4	0	-	-
MW-9	4	0	-	-
MW-10A	4	0	-	-
MW-10B	4	0	-	-
MW-13	4	0	-	-
MW-14	4	0	-	-
MW-15	4	0	-	-
MW-16	4	0	-	-
MW-19	4	0	-	-
MW-20	4	0	-	-
MW-21	4	0	-	-

Note 1: All results are in pCi/L.

Note 2: A total of 88 samples were analyzed for H-3 in 2018, all results were <LLD in accordance with the ODCM limits in Table 5.1-3.

Note 3: *MW-4B did not provide sufficient volume for tritium analysis in third quarter, sampling occurred twice in fourth quarter.

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ATTACHMENT NO. 8

GASEOUS EFFLUENTS – CARBON-14

- a) **Date:** January 01, 2018 – December 31, 2018
- b) **Location:** Elevated Release – Main Stack
- c) **Duration:** 365 Days
- d) **Flow rate:** N/A
- e) **Volume Released:** N/A
- f) **Nuclides Released:** Carbon-14
- g) **Curies Released⁽¹⁾:**
- | <u>UNIT</u> | <u>QTR 1</u> | <u>QTR 2</u> | <u>QTR 3</u> | <u>QTR 4</u> |
|-------------|--------------|--------------|--------------|--------------|
| Ci | 2.63E+00 | 2.55E+00 | 1.88E+00 | 2.47E+00 |
| μCi/sec | 3.40E-01 | 3.40E-01 | 3.40E-01 | 3.40E-01 |
- h) **Resultant Doses:** See Addendum 1—Assessment of Radiation Doses to the Public January-December 2018 Table 1, Section D
- i) **Dose Calculations:** Doses were calculated in accordance with the Offsite Dose Calculation Manual (ODCM) Part 2, Section 4.4.1

⁽¹⁾Curies released calculated using the methodology in EPRI Technical Report 1021106
“Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents”.

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ATTACHMENT NO. 9

**EVENTS LEADING TO CONDITIONS WHICH RESULTED IN EXCEEDING
RADIOACTIVITY LIMITS.**

In accordance with the James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls Section 6.2.9, the report shall contain the events leading to the conditions which resulted in exceeding the radioactivity limits for the specified outdoor radioactive radwaste tanks specified in the Technical Requirements Manual, TRM 3.7.E

The radioactivity limits for the specified outdoor radioactive radwaste tanks were not exceeded.

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ADDENDUM 1

**ASSESSMENT OF RADIATION DOSES TO THE PUBLIC
JANUARY - DECEMBER 2018**

1. INTRODUCTION

The James A. FitzPatrick Nuclear Power Plant Offsite Dose Calculation Manual (ODCM), Part 1 Radiological Effluent Controls, requires an assessment of the radiation doses to the likely most exposed member of the public due to radioactive liquid and gaseous effluents. This assessment of doses to the likely most exposed member of the public is based on accepted methodologies found in the Offsite Dose Calculation Manual (ODCM).

2. DOSE LIMITS

A. DOSE FROM LIQUID EFFLUENTS (ODCM, Part 1, Section 2.3)

Applicability

Applies to doses from radioactive material in liquid effluents.

Objective

To ensure that the dose limitations of 10 CFR 50, Appendix I, are met.

Specifications

The dose to a member of the public from radioactive materials released from the plant in liquid effluents to Unrestricted Areas shall be limited as follows:

1. During any calendar quarter, limited to less than or equal to 1.5 mrem to the whole body and to less than or equal to 5 mrem to any organ.
2. During any calendar year, limited to less than or equal to 3 mrem to the whole body and to less than or equal to 10 mrem to any organ.

B. GASEOUS DOSE RATES (ODCM, Part 1, Section 3.2)

Applicability

Applies to the radiation dose from radioactive material in gaseous effluents.

Objective

To ensure that the dose rates at or beyond the site boundary from gaseous effluents do not exceed the annual dose limits of 10 CFR 20 for Unrestricted Areas.

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ADDENDUM 1 (continued)

Specifications

The dose rate at or beyond the Site Boundary due to radioactive materials released from the plant in gaseous effluents shall be limited as follows:

1. Less than or equal to 500 mrem/year to the whole body and less than or equal to 3000 mrem/year to the skin from noble gases; and,
2. Less than or equal to 1500 mrem/year to any organ from Iodine-131, Iodine-133, Tritium and for radioactive materials in particulate form with half-lives greater than 8 days (inhalation pathway only).

C. AIR DOSE, NOBLE GASES (ODCM, Part 1, Section 3.3)

Applicability

Applies to the air dose due to noble gases in gaseous effluents.

Objective

To ensure that the noble gas dose limitations of 10 CFR 50, Appendix I, are met.

Specifications

The air dose to areas at or beyond the Site Boundary from noble gases released from the plant in gaseous effluents shall be limited:

1. During any calendar quarter, to less than or equal to 5 mrad from gamma radiation, and less than or equal to 10 mrad from beta radiation; and,
2. During any calendar year, to less than or equal to 10 mrad from gamma radiation and less than or equal to 20 mrad from beta radiation.

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ADDENDUM 1 (continued)

D. DOSE DUE TO IODINE-131, IODINE-133, TRITIUM AND RADIONUCLIDES IN PARTICULATE FORM (ODCM, Part 1, Section 3.4)

Applicability

Applies to the cumulative dose from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents.

Objective

To ensure that the dose limitations of 10 CFR 50, Appendix I, are met.

Specifications

The dose to a member of the public at or beyond the Site Boundary from Iodine-131, Iodine-133, Tritium, and radionuclides in particulate form with half-lives greater than 8 days released from the plant in gaseous effluents shall be limited:

- a. During any calendar quarter to less than or equal to 7.5 mrem to any organ; and,
- b. During any calendar year to less than or equal to 15 mrem to any organ.
- c. Less than 0.1% of the limits of ODCM Part 1, Section 3.4, Specifications 3.4.1.c.1.a and 3.4.1.c.1.b as a result of burning contaminated oil.

E. TOTAL DOSE FROM URANIUM FUEL CYCLE (ODCM, Part 1, Section 4.0)

Applicability

Applies to radiation dose from releases of radioactivity and radiation from uranium fuel cycle sources.

Objective

1. To assure that the requirements of 40 CFR 190 are met.
2. To assure that the requirements of 10 CFR 72.104 are met in accordance with Section 3.2.3, Required Action A.2, Certificate of Compliance 1014 Appendix A, Technical Specifications for the Hi-Storm 100 Cask System.

Specifications

The dose or dose commitment to any member of the public, due to releases of radioactivity and radiation, from uranium fuel cycle sources shall be limited as follows:

1. Less than or equal to 25 mrem/year to the whole body; and,
2. Less than or equal to 25 mrem/year to any organ except the thyroid which shall be limited to less than or equal to 75 mrem/year.

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ADDENDUM 1 (continued)

3. DOSE ASSESSMENT

A. METHODOLOGY

The assessment of radiation doses to the public due to radioactive liquid and gaseous effluents is performed in accordance with the ODCM. The ODCM is based on methodologies and models suggested by the Guidance Manual For "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants" (NUREG-0133) and "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I" (Regulatory Guide 1.109).

B. ASSUMPTIONS

Dose calculations are performed using formulas and constants defined in the ODCM. Specific radioactive release activities used in the dose calculations are listed in the Annual Radioactive Effluent Release Report (1.21 Report) for the period of January 1, 2018 to December 31, 2018. Historical meteorological data was used to generate tables of average dispersion factors. Locations of interest were identified from the 2018 land use census. These tables are available upon request.

C. ASSESSMENT RESULTS SUMMARY

The calculated doses to the public due to radioactive effluents are listed in Table 1. The calculated doses are small fractions of their respective dose limits.

4. 40 CFR 190 DOSE ASSESSMENT

A. METHODOLOGY

Evaluation to demonstrate compliance with the 40 CFR 190 dose limits must be performed when the doses calculated for 10 CFR 50 compliance exceed twice their respective limits. When additional dose assessment is required to demonstrate compliance with 40 CFR 190 it is performed in accordance with the ODCM.

B. RESULTS SUMMARY

The cumulative dose contribution from liquid and gaseous effluents for this report period were calculated and are listed in Table 1. The cumulative dose contribution from direct radiation from the reactor unit and from radwaste storage tanks is measured by environmental thermoluminescent dosimeters for the report period. This data is contained in the Annual Environmental Operating Report. The calculated doses from liquid and gaseous effluents are less than twice their respective 10 CFR 50 limits; therefore, additional calculations are not necessary to demonstrate compliance with 40 CFR 190 dose limits.

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ADDENDUM 1 (continued)

**TABLE 1
 ANNUAL DOSE ASSESSMENT 2018**

A. LIQUIDS

<u>QUARTER</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>ANNUAL</u>
	(a)	(a)	(a)	(c)	(c)
Organ (mrem)	4.24E-07	5.89E-07	5.39E-06	1.05E-05	1.69E-05
% of Limit	8.48E-06	1.18E-05	1.08E-04	2.11E-04	1.69E-04
	(b)	(b)	(b)	(b)	(b)
Whole Body (mrem)	4.24E-07	5.89E-07	5.39E-06	5.77E-06	1.22E-05
% of Limit	2.82E-05	3.93E-05	3.60E-04	3.84E-04	4.06E-04

- (a) Dose to the Child Liver.
 - (b) Dose to the Child Whole Body.
 - (c) Dose to the Adult Liver.
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ADDENDUM 1 (continued)

**TABLE 1 (cont)
 ANNUAL DOSE ASSESSMENT 2018**

B. NOBLE GASES

<u>QUARTER</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>ANNUAL</u>
Total Body (mrem/yr)	1.46E-02	2.61E-02	2.77E-02	2.51E-02	2.77E-02
% of Limit	2.92E-03	5.22E-03	5.54E-03	5.02E-03	5.54E-03
Skin (mrem/yr)	1.86E-02	3.30E-02	3.48E-02	3.27E-02	3.48E-02
% of Limit	6.20E-04	1.10E-03	1.16E-03	1.09E-03	1.16E-03
Gamma (mrad)	2.36E-03	3.25E-03	3.45E-03	6.96E-04	9.76E-03
% of Limit	4.72E-02	6.51E-02	6.90E-02	1.39E-02	9.76E-02
Beta (mrad)	3.66E-04	4.64E-04	1.09E-03	1.31E-04	2.05E-04
% of Limit	3.66E-03	4.64E-03	1.09E-02	1.31E-03	1.03E-02

C. IODINES AND PARTICULATES

<u>QUARTER</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>ANNUAL</u>
	(a)	(a)	(a)	(a)	(a)
Organ (mrem)	1.89E-03	4.92E-03	5.12E-03	1.50E-03	1.34E-02
% of Limit	2.52E-02	6.56E-02	6.83E-02	2.00E-02	8.93E-02
	(a)	(a)	(a)	(a)	(a)
Organ Dose Rate (mrem/yr)	1.21E-04	2.01E-04	3.47E-04	3.84E-04	3.84E-04
% of Limit	8.07E-06	1.34E-05	2.31E-05	2.56E-05	2.56E-05

(a) Dose to the Child Thyroid.

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ADDENDUM 1 (continued)

**TABLE 1 (cont)
 ANNUAL DOSE ASSESSMENT 2018**

D. CARBON 14

<u>QUARTER</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>ANNUAL</u>
	(a)	(a)	(a)	(a)	(a)
Organ (mrem)	8.40E-03	8.15E-03	6.00E-03	7.86E-03	3.04E-02
% of Limit	1.12E-01	1.09E-01	8.00E-02	1.05E-01	2.03E-01
					(a)
Organ Dose Rate (mrem/yr)	NA	NA	NA	NA	3.04E-02
% of Limit	NA	NA	NA	NA	2.03E-03

(a) Dose to the Child Bone.
