



April 25, 2017

10 CFR 50.36a

Serial: BSEP 17-0037

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-71 and DPR-62
Docket Nos. 50-325 and 50-324
Annual Radioactive Effluent Release Report - 2016

Ladies and Gentlemen:

In accordance with 10 CFR 50.36a and Technical Specification (TS) 5.6.3 for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2, Duke Energy Progress, LLC, is submitting the enclosed Radioactive Effluent Release Report for 2016. This report covers the period from January 1, 2016, through December 31, 2016.

TS 5.5.1, "Offsite Dose Calculation Manual (ODCM)," requires changes to the ODCM be submitted as part of, or concurrent with, the Radioactive Effluent Release Report. The ODCM was not revised during this report period.

No regulatory commitments are contained in this submittal. Please refer any questions regarding this submittal to Mr. Lee Grzeck, Manager - Regulatory Affairs, at (910) 457-2487.

Sincerely,

Bryan B. Wooten
Director – Organizational Effectiveness
Brunswick Steam Electric Plant

MAT/mat

Enclosure: Annual Radioactive Effluent Release Report - 2016

cc (with enclosure):

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Annual Radioactive Effluent Release Report - 2016



Brunswick Steam Electric Plant Units 1 and 2

Annual Radioactive Effluent Release Report

January 1, 2016 through December 31, 2016

Dockets 50-325 and 50-324



Introduction

The Annual Radioactive Effluent Release Report is pursuant to Brunswick Steam Electric Plant Technical Specification 5.6.3 and ODCM Specification 7.4.2. The below listed attachments to this report provide the required information. In addition, if a revision to the ODCM has occurred during the report period, it is included pursuant to Brunswick Steam Electric Plant Technical Specification 5.5.1.

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Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 1

Summary of Gaseous and Liquid Effluents

This attachment includes a summary of the quantities of radioactive liquid and gaseous effluents as outlined in Regulatory Guide 1.21, Appendix B.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Summation of All Releases

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
1. Total Release	Ci	5.28E+01	2.45E+01	4.66E+01	5.62E+01	1.80E+02
2. Avg. Release Rate	μCi/sec	6.71E+00	3.12E+00	5.86E+00	7.07E+00	5.70E+00
B. Iodine-131						
1. Total Release	Ci	9.17E-04	6.29E-04	9.73E-04	8.52E-04	3.37E-03
2. Avg. Release Rate	μCi/sec	1.17E-04	7.99E-05	1.22E-04	1.07E-04	1.07E-04
C. Particulates Half-Life ≥ 8 days						
1. Total Release	Ci	3.32E-04	2.35E-04	2.65E-04	2.96E-04	1.13E-03
2. Avg. Release Rate	μCi/sec	4.22E-05	2.99E-05	3.34E-05	3.72E-05	3.57E-05
D. Tritium						
1. Total Release	Ci	1.24E+02	6.60E+01	1.39E+02	1.08E+02	4.37E+02
2. Avg. Release Rate	μCi/sec	1.58E+01	8.39E+00	1.75E+01	1.36E+01	1.38E+01
E. Carbon-14						
1. Total Release	Ci	4.58E+00	5.80E+00	5.98E+00	5.80E+00	2.22E+01
2. Avg. Release Rate	μCi/sec	5.83E-01	7.38E-01	7.52E-01	7.30E-01	7.01E-01
F. Gross Alpha						
1. Total Release	Ci	1.03E-07	0.00E+00	0.00E+00	0.00E+00	1.03E-07
2. Avg. Release Rate	μCi/sec	1.31E-08	0.00E+00	0.00E+00	0.00E+00	3.26E-09

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Elevated Releases - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
Ar-41	Ci	2.83E+00	4.84E+00	1.36E+00	3.78E-01	9.41E+00
Kr-85m	Ci	8.89E-01	2.39E-01	2.61E+00	1.34E+00	5.08E+00
Kr-87	Ci	1.46E+00	4.35E-01	0.00E+00	2.84E-01	2.18E+00
Kr-88	Ci	2.29E+00	5.43E-01	0.00E+00	8.67E-01	3.70E+00
Xe-133	Ci	4.53E-01	1.56E-01	2.82E+00	9.61E+00	1.30E+01
Xe-135m	Ci	0.00E+00	7.40E-01	6.41E-01	3.39E+00	4.77E+00
Xe-135	Ci	4.26E+01	1.59E+01	3.46E+01	3.66E+01	1.30E+02
Xe-138	Ci	0.00E+00	0.00E+00	0.00E+00	1.47E+00	1.47E+00
Total for Period	Ci	5.05E+01	2.29E+01	4.20E+01	5.39E+01	1.69E+02
B. Iodines						
I-131	Ci	6.54E-04	5.61E-04	7.55E-04	6.92E-04	2.66E-03
I-133	Ci	4.28E-03	3.75E-03	5.09E-03	4.42E-03	1.75E-02
I-135	Ci	5.52E-03	5.13E-03	6.83E-03	5.65E-03	2.31E-02
Total for Period	Ci	1.05E-02	9.44E-03	1.27E-02	1.08E-02	4.34E-02
C. Particulates Half-Life ≥ 8 days						
Co-60	Ci	3.98E-06	0.00E+00	0.00E+00	0.00E+00	3.98E-06
Sr-89	Ci	3.80E-05	1.16E-05	1.46E-05	1.43E-05	7.85E-05
Ba-140	Ci	5.57E-05	6.59E-05	8.26E-05	6.84E-05	2.73E-04
La-140	Ci	1.03E-04	1.13E-04	1.36E-04	1.30E-04	4.82E-04
Total for Period	Ci	2.00E-04	1.91E-04	2.33E-04	2.13E-04	8.37E-04
D. Tritium						
H-3	Ci	2.47E+01	2.45E+01	5.67E+01	3.54E+01	1.41E+02
E. Carbon-14						
C-14	Ci	1.83E+00	2.32E+00	2.39E+00	2.32E+00	8.86E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Attachment 1
Summary of Gaseous and Liquid Effluents**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Elevated Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life \geq 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Brunswick Steam Electric Plant Units 1 and 2 do not have batch elevated releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Ground Releases - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
Kr-85m	Ci	0.00E+00	1.85E-01	5.65E-02	5.87E-02	3.00E-01
Xe-133	Ci	9.64E-02	0.00E+00	0.00E+00	0.00E+00	9.64E-02
Xe-135	Ci	1.65E+00	9.15E-01	3.70E+00	1.14E+00	7.41E+00
Xe-138	Ci	5.54E-01	5.54E-01	8.23E-01	1.07E+00	3.00E+00
Total for Period	Ci	2.30E+00	1.65E+00	4.58E+00	2.26E+00	1.08E+01
B. Iodines						
I-131	Ci	2.14E-04	3.85E-06	1.23E-04	2.29E-05	3.64E-04
I-133	Ci	6.34E-04	0.00E+00	1.14E-03	1.37E-04	1.91E-03
I-135	Ci	8.52E-04	0.00E+00	2.12E-03	1.71E-04	3.14E-03
Total for Period	Ci	1.70E-03	3.85E-06	3.39E-03	3.31E-04	5.42E-03
C. Particulates Half-Life ≥ 8 days						
Co-60	Ci	5.62E-07	0.00E+00	0.00E+00	0.00E+00	5.62E-07
La-140	Ci	5.92E-08	0.00E+00	0.00E+00	0.00E+00	5.92E-08
Total for Period	Ci	6.21E-07	0.00E+00	0.00E+00	0.00E+00	6.21E-07
D. Tritium						
H-3	Ci	8.49E+01	3.00E+01	6.50E+01	5.46E+01	2.35E+02
E. Carbon-14						
C-14	Ci	9.17E-01	1.16E+00	1.20E+00	1.16E+00	4.43E+00
F. Gross Alpha						
Total for Period	Ci	1.03E-07	0.00E+00	0.00E+00	0.00E+00	1.03E-07

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Ground Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life \geq 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Brunswick Steam Electric Plant Units 1 and 2 do not have batch ground releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Mixed-Mode Releases - Continuous Mode

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Iodines						
I-131	Ci	4.92E-05	6.41E-05	9.54E-05	1.37E-04	3.46E-04
I-133	Ci	4.10E-04	5.39E-04	6.65E-04	1.19E-03	2.80E-03
I-135	Ci	0.00E+00	0.00E+00	0.00E+00	1.55E-04	1.55E-04
Total for Period	Ci	4.59E-04	6.03E-04	7.60E-04	1.48E-03	3.30E-03
C. Particulates Half-Life ≥ 8 days						
Cr-51	Ci	4.73E-05	0.00E+00	0.00E+00	0.00E+00	4.73E-05
Mn-54	Ci	8.05E-06	0.00E+00	0.00E+00	0.00E+00	8.05E-06
Fe-59	Ci	1.96E-06	0.00E+00	0.00E+00	0.00E+00	1.96E-06
Co-58	Ci	6.88E-06	4.50E-06	1.32E-06	4.42E-06	1.71E-05
Co-60	Ci	6.40E-05	3.98E-05	3.09E-05	7.84E-05	2.13E-04
Zn-65	Ci	1.10E-06	0.00E+00	0.00E+00	0.00E+00	1.10E-06
Zr-95	Ci	7.29E-07	0.00E+00	0.00E+00	0.00E+00	7.29E-07
Nb-95	Ci	6.77E-07	0.00E+00	0.00E+00	0.00E+00	6.77E-07
Total for Period	Ci	1.31E-04	4.43E-05	3.23E-05	8.28E-05	2.90E-04
D. Tritium						
H-3	Ci	1.44E+01	1.15E+01	1.77E+01	1.83E+01	6.19E+01
E. Carbon-14						
C-14	Ci	1.83E+00	2.32E+00	2.39E+00	2.32E+00	8.86E+00
F. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Attachment 1
Summary of Gaseous and Liquid Effluents**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Gaseous Effluents - Mixed-Mode Releases - Batch Mode *

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Gases						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
B. Iodines						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
C. Particulates Half-Life \geq 8 days						
N/A	Ci	-	-	-	-	-
Total for Period	Ci	-	-	-	-	-
D. Tritium						
N/A	Ci	-	-	-	-	-
E. Carbon-14						
N/A	Ci	-	-	-	-	-
F. Gross Alpha						
Total for Period	Ci	-	-	-	-	-

* Brunswick Steam Electric Plant Units 1 and 2 do not have batch mixed-mode releases.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Liquid Effluents - Summation of All Releases - Discharge Canal

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products *						
1. Total Release	Ci	5.83E-04	1.26E-03	2.69E-03	2.37E-03	6.90E-03
2. Avg. Diluted Conc.	µCi/ml	1.66E-12	2.58E-12	5.11E-12	5.05E-12	3.76E-12
B. Tritium						
1. Total Release	Ci	7.73E+01	7.01E+01	1.04E+02	1.03E+02	3.54E+02
2. Avg. Diluted Conc.	µCi/ml	2.20E-07	1.44E-07	1.97E-07	2.20E-07	1.93E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	3.78E-04	4.26E-04	4.77E-04	7.04E-04	1.99E-03
2. Avg. Diluted Conc.	µCi/ml	1.08E-12	8.72E-13	9.06E-13	1.50E-12	1.08E-12
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	2.25E+08	6.59E+07	1.44E+08	1.04E+08	5.39E+08
2. Batch Releases	liters	2.57E+06	3.39E+06	4.87E+06	3.69E+06	1.45E+07
F. Volume of Dilution Water						
1. All Releases	liters	3.51E+11	4.89E+11	5.27E+11	4.70E+11	1.84E+12

* Excludes tritium, dissolved and entrained noble gases, and gross alpha.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Liquid Effluents - Summation of All Releases - Marsh Area

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products *						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
1. Total Release	Ci	5.51E-02	2.74E-02	2.47E-02	7.40E-02	1.81E-01
2. Avg. Diluted Conc.	µCi/ml	1.09E-06	5.41E-07	4.81E-07	1.44E-06	8.88E-07
C. Dissolved & Entrained Gases						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2. Avg. Diluted Conc.	µCi/ml	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
E. Volume of Liquid Waste						
1. Continuous Releases	liters	5.07E+07	5.07E+07	5.13E+07	5.13E+07	2.04E+08
2. Batch Releases	liters	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
F. Volume of Dilution Water						
1. All Releases	liters	5.07E+07	5.07E+07	5.13E+07	5.13E+07	2.04E+08

* Excludes tritium, dissolved and entrained noble gases, and gross alpha.

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Liquid Effluents - Continuous Mode - Discharge Canal

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	1.47E-02	1.77E-02	9.13E-03	4.71E-03	4.62E-02
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Liquid Effluents - Continuous Mode - Marsh Area

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	5.51E-02	2.74E-02	2.47E-02	7.40E-02	1.81E-01
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Attachment 1
Summary of Gaseous and Liquid Effluents

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Liquid Effluents - Batch Mode - Discharge Canal

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
Mn-54	Ci	1.78E-06	0.00E+00	0.00E+00	0.00E+00	1.78E-06
Co-60	Ci	1.61E-04	1.58E-04	5.03E-04	1.00E-04	9.22E-04
Zn-65	Ci	1.14E-05	0.00E+00	0.00E+00	0.00E+00	1.14E-05
Sr-87m	Ci	0.00E+00	0.00E+00	0.00E+00	2.65E-06	2.65E-06
Y-91m	Ci	3.53E-07	0.00E+00	0.00E+00	0.00E+00	3.53E-07
Te-131m	Ci	7.87E-07	0.00E+00	0.00E+00	0.00E+00	7.87E-07
I-131	Ci	2.13E-04	3.85E-04	4.40E-04	6.58E-04	1.70E-03
I-132	Ci	0.00E+00	0.00E+00	9.40E-06	0.00E+00	9.40E-06
I-133	Ci	1.86E-04	7.09E-04	1.09E-03	1.29E-03	3.28E-03
I-134	Ci	0.00E+00	0.00E+00	5.59E-04	0.00E+00	5.59E-04
I-135	Ci	2.44E-06	9.09E-06	7.68E-05	3.20E-04	4.08E-04
Cs-134	Ci	0.00E+00	0.00E+00	0.00E+00	1.88E-06	1.88E-06
Cs-137	Ci	6.11E-06	2.46E-06	6.74E-06	1.60E-06	1.69E-05
Total for Period	Ci	5.83E-04	1.26E-03	2.69E-03	2.37E-03	6.90E-03
B. Tritium						
H-3	Ci	7.73E+01	7.01E+01	1.04E+02	1.03E+02	3.54E+02
C. Dissolved & Entrained Gases						
Kr-89	Ci	0.00E+00	0.00E+00	0.00E+00	5.10E-05	5.10E-05
Xe-133	Ci	8.79E-05	1.08E-04	9.63E-05	2.71E-04	5.63E-04
Xe-135m	Ci	0.00E+00	0.00E+00	4.88E-06	4.09E-06	8.97E-06
Xe-135	Ci	2.90E-04	3.18E-04	3.76E-04	3.78E-04	1.36E-03
Total for Period	Ci	3.78E-04	4.26E-04	4.77E-04	7.04E-04	1.99E-03
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Attachment 1
Summary of Gaseous and Liquid Effluents**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Liquid Effluents - Batch Mode - Marsh Area

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Fission and Activation Products						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
B. Tritium						
H-3	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C. Dissolved & Entrained Gases						
None	Ci	-	-	-	-	-
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
D. Gross Alpha						
Total for Period	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Attachment 2
Supplemental Information**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 2

Supplemental Information

This attachment includes supplemental information to the gaseous and liquid effluents report.

Attachment 2 Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

I. Regulatory Limits - Per Unit

A. Noble Gases - Air Dose

1. Calendar Quarter Gamma Dose	= 5	mRAD
2. Calendar Quarter Beta Dose	= 10	mRAD
3. Calendar Year Gamma Dose	= 10	mRAD
4. Calendar Year Beta Dose	= 20	mRAD

B. Liquid Effluents - Dose

1. Calendar Quarter Total Body Dose	= 1.5	mREM
2. Calendar Quarter Organ Dose	= 5	mREM
3. Calendar Year Total Body Dose	= 3	mREM
4. Calendar Year Organ Dose	= 10	mREM

C. Gaseous Effluents - Iodine-131 & 133, Tritium, and Particulates with Half-lives > 8 days

1. Calendar Quarter Organ Dose	= 7.5	mREM
2. Calendar Year Organ Dose	= 15	mREM

II. Maximum Permissible Effluent Concentrations

A. Gaseous Effluents

- Information found in Offsite Dose Calculation Manual

B. Liquid Effluents

- Information found in 10 CFR Part 20, Appendix B, Table 2, Column 2

III. Average Energy

(not applicable)

IV. Measurements and Approximations of Total Radioactivity

Analyses of specific radionuclides in selected or composited samples as described in the ODCM are used to determine the radionuclide composition of the effluent. A summary description of the method used for estimating overall errors associated with radioactivity measurements is provided as part of this attachment.

V. Batch Releases

A. Liquid Effluents

		Jan - Jun	Jul - Dec
1. Total Number of Batch Releases	=	100	123
2. Total Time (min) for Batch Releases	=	2.35E+05	1.91E+05
3. Maximum Time (min) for a Batch Release	=	3.01E+04	4.14E+04
4. Average Time (min) for Batch Releases	=	2.35E+03	1.56E+03
5. Minimum Time (min) for a Batch Release	=	7.00E+00	1.00E+01
6. Average Dilution Water Flow During Release (gpm)	=	6.70E+05	8.04E+05

B. Gaseous Effluents

		Jan - Jun	Jul - Dec
1. Total Number of Batch Releases	=	N/A	N/A
2. Total Time (min) for Batch Releases	=	N/A	N/A
3. Maximum Time (min) for a Batch Release	=	N/A	N/A
4. Average Time (min) for Batch Releases	=	N/A	N/A
5. Minimum Time (min) for a Batch Release	=	N/A	N/A

VI. Abnormal Releases

See Attachment 5, Unplanned Offsite Releases.

Attachment 2 Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Carbon-14

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC recommends U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide" in gaseous effluents, and if so, report the amount of C-14 released. Improvements over the years in effluent management practices and fuel performance have resulted in a decrease in gaseous radionuclide (non-C-14) concentrations, and a change in the distribution of gaseous radionuclides released to the environment. As a result, many sites show C-14 has become a "principal radionuclide" for the gaseous effluent pathway, as defined in Regulatory Guide 1.21, Rev. 2. Although committed to Regulatory Guide 1.21, Rev. 1, the Brunswick Steam Electric Plant 2016 ARERR contains estimates of C-14 radioactivity released in 2016, and estimates of public dose resulting from the C-14 effluent.

Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste is not required (Ref. Reg. Guide 1.21, Rev. 2). The quantity of gaseous C-14 released to the environment can be estimated by use of a C-14 source term scaling factor based on power generation (Ref. Reg. Guide 1.21, Rev. 2). The Brunswick Steam Electric Plant Updated Final Safety Analysis Report (UFSAR) states the C-14 release rate from a BWR is approximately 9.5 Ci/yr per unit assuming 80% plant capacity factor, or 292 Effective Full Power Days (EFPD). Since Brunswick Steam Electric Plant has two reactors, the total release rate would be 19.0 Ci/yr. This value was scaled using actual EFPD of 319.70 for Unit 1 and 361.28 for Unit 2 in 2016 to give a total release rate of 2.22E+01 Ci/yr.

Public dose estimates from airborne C-14 are performed using dose models in Regulatory Guide 1.109. The dose models and assumptions used are documented in the Brunswick Steam Electric Plant ODCM 3.3.3, Carbon-14. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released from Brunswick Steam Electric Plant in 2016 is well below the 10CFR50, Appendix I, ALARA design objective (i.e., 15 mrem/yr per unit).

Based on the 2016 Land Use Census, the critical receptor is located in the south sector at 1.7 miles with a garden. There are no meat or milk pathways within 5 miles. Regulatory Guide 1.109 methodology was used to determine the dose to this critical receptor. The bone dose for 2016 was 2.04E+00 mrem and the total body dose was 4.09E-01 mrem.

	<u>Units</u>	<u>Year</u>
1. C-14 Activity Released	Ci	2.22E+01
2. C-14 Total Body Dose	mREM	4.09E-01
3. C-14 Organ Dose	mREM	2.04E+00

Receptor Location **1.7 miles S**

Critical Age **CHILD**

Critical Organ **BONE**

Attachment 2 Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Discussion of liquid release from the BSEP Sewage Treatment Plant

In accordance with the Brunswick Steam Electric Plant (BSEP) National Pollutant Discharge Elimination System (NPDES) Permit Number NC0007064 the decant from the BSEP Sewage Treatment Plant is released to Outfall Number 004. Outfall Number 004 discharges to the discharge canal which is a designated release point. The BSEP sewage decant is sampled monthly for gamma and tritium analysis. On December 11, 2013 the monthly effluent sample contained tritium, there was no detectable gamma activity. Condition Report (CR) 651320 was generated and daily sampling was initiated for effluent accountability. Inputs to the system were sampled and it was discovered that tritiated groundwater is leaking into the Number 6 lift station. The source of tritium is from pre-existing groundwater contamination in the general area surrounding the Number 6 lift station. Regulatory Affairs confirmed this was not reportable per NEI 07-07 groundwater reporting. Approximately $1.29\text{E}+06$ gallons containing $4.62\text{E}-02$ curies of tritium was released in 2016 to the discharge canal.

Discussion of liquid releases from the Storm Drain Collector Basin (SDCB)

During periods of heavy rain, the contents of the SDCB may be released to the discharge canal in accordance with regulatory requirements to protect plant personnel and equipment. The SDCB was released directly to the discharge canal on 21 occasions in 2016 due to heavy rains. Approximately $6.74\text{E}+06$ gallons containing $3.55\text{E}-01$ curies of tritium were released. There was no detectable gamma radioactivity.

Discussion of liquid releases from the Storm Drain Stabilization Pond (SDSP) Infiltration

On August 22, 2014 water was found flowing from the Storm Drain Stabilization Facility (SDSF) outfall pipe into the intake canal when a permitted release was not in progress. The water was analyzed and found to contain tritium. Condition Report 704775 was generated and daily sampling was initiated for effluent accountability. Subsequent investigation determined the water was infiltrating through the side of the first collection box in the drainage line located near the SDSP discharge weir. The pipe was repaired by installing a fiberglass liner inside the existing outfall pipe and sealing the original pipe/liner interface. This repair was completed in 2015. No releases from this pathway occurred in 2016 due to the successful repair.

Discussion of liquid releases from the Storm Drain Stabilization Facility (SDSF)

The SDSF collects rainwater, water from miscellaneous low volume drains on plant site, water from the Groundwater Extraction System, and water from the Unit 1 CST Remediation Facility. Treatment consists of filtration and evaporation. When sufficient water has accumulated in the pond it is released into the intake canal where it is drawn into the plant circulating and service water system and eventually released into the discharge canal. There were 14 SDSF releases in 2016. Approximately $8.95\text{E}+07$ gallons containing $5.33\text{E}+00$ curies of tritium were released from the SDSF. There was no detectable gamma radioactivity.

Discussion of water evaporation from the Storm Drain Stabilization Pond (SDSP)

It was calculated that $5.96\text{E}+07$ gallons of tritiated water was released via evaporation from the SDSP in 2016. This yields $2.19\text{E}-01$ curies of tritium released to the atmosphere as a ground release. The nearest resident to the pond is in the northwest sector at approximately 0.3 miles. The maximum exposed individuals at that location received a calculated dose of $6.70\text{E}-05$ mrem via the inhalation pathway in 2016. Only inhalation dose was determined because the exposed individuals do not have a garden and also do not have any milk or meat animals at this location.

Attachment 2 Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Discussion of water evaporation from the Storm Drain Stabilization Facility (SDSF)

It was calculated that $4.93\text{E}+06$ gallons of tritiated water was released via evaporation from the SDFS in 2016. This yields $3.68\text{E}-01$ curies of tritium released to the atmosphere as a ground release. The nearest resident to the pond is in the north northwest sector at approximately 0.5 miles. The maximum exposed individuals at that location received a calculated dose of $2.37\text{E}-04$ mrem via the inhalation pathway in 2016. Only inhalation dose was determined because the exposed individuals do not have a garden and also do not have any milk or meat animals at this location.

Discussion of liquid releases from the Marsh to Nancy's Creek

Samples are routinely analyzed from the marsh areas that drain into Nancy's Creek during falling tides. The marsh areas are all on company owned property. The marsh land is under the influence of high and low tides and releases to Nancy's Creek, which is offsite. This constitutes a release point for evaluation. The sampling program consists of weekly sampling and analysis at eight locations. All gamma analyses performed in 2016 were less than the Lower Limit of Detection (LLD). Some tritium analyses were greater than the LLD. The average tritium concentration each month, two high tides per day, the area of the marsh at high tide, the days in the month, and a conservative factor of 2 were used to calculate the amount of tritium released each month. In 2016, it was calculated that $5.39\text{E}+07$ gallons were released to Nancy's Creek containing $1.81\text{E}-01$ curies of tritium. This yielded a Total Body dose of $2.20\text{E}-03$ mrem to an adult from eating fish and invertebrate (shrimp, crabs, etc.).

Discussion of liquid releases from the Storm Drain Stabilization Pond (SDSP)

The SDSP collects rainwater as its only input source. Treatment from this location consists of sedimentation, evaporation, and transpiration. When sufficient water has accumulated in the pond, it is released into the intake canal where it is drawn into the circulating and service water system and eventually released into the discharge canal. There were 7 SDSP releases in 2016. Approximately $4.49\text{E}+07$ gallons were released in 2016 containing $0.00\text{E}+00$ curies of tritium. There was no detectable gamma radioactivity.

Attachment 2 Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Overall Estimate of Error for Effluent Radioactivity Release Reported

The estimated percentage of overall error for Gaseous effluent release data at Brunswick Steam Electric Plant is listed below. These values were derived by taking the square root of the sum of the squares of the discrete individual estimates of error.

- | | | |
|---------------------------------|---|-------|
| 1. Fission and Activation Gases | = | ± 25% |
| 2. Particulates and Iodine | = | ± 25% |
| 3. Tritium | = | ± 15% |

The estimated percentage of overall error for Liquid effluent release data at Brunswick Steam Electric Plant is listed below. These values were derived by taking the square root of the sum of the squares of the discrete individual estimates of error.

- | | | |
|---|---|-------|
| 1. Fission and Activation Products and
Dissolved and Entrained Noble Gases | = | ± 17% |
| 2. Tritium | = | ± 23% |
| 3. Gross Alpha | = | ± 32% |

Overall Estimate of Error for Solid Waste Radioactivity Reported

The estimated percentage of overall error for Solid Waste data at Brunswick Steam Electric Plant has been determined to be ± 10%.

Attachment 2
Supplemental Information

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Summary of Changes in Land Use Census Affecting Effluent Dose Calculations

The 2016 Land Use Census was performed June 27-29, 2016. The results were certified and made available for use on July 21, 2016. The following are changes to residences, gardens, and milk animals from the previous year.

Residences

No changes to nearest residence in each sector.

Gardens

The garden in the N sector at 1.1 miles was replaced by a garden at 1.0 miles.
The garden in the S sector at 1.8 miles was replaced by a garden at 1.7 miles.
The garden in the SSW sector at 1.9 miles was replaced by a garden at 1.7 miles.
The garden in the SW sector at 1.4 miles was no longer present and replaced by a garden at 2.2 miles.
The garden in the WNW sector at 1.1 miles changed addresses but remains at 1.1 miles.

Milk Animals

No milk animal was present within 5 miles in each sector.

Environmental Monitoring Locations

No changes to environmental monitoring locations in each sector.

Attachment 3
Solid Radioactive Waste Disposal

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 3

Solid Radioactive Waste Disposal

This attachment includes a summary of the solid waste shipped off-site for burial and/or disposal, including:

- Container volume
- Total Curie content
- Principal Radionuclides
- Source/Type of waste
- Solidification agent or absorbent
- Type of shipping container
- Number of shipments
- Other relevant information as necessary

Attachment 3 Solid Radioactive Waste Disposal

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m ³)	Total Activity (Curies)
1. <u>Waste from Liquid Systems</u>							
a. Spent Resins, Filters, Sludges (dewatered)	11	11	A	Type A GDP	N/A	54.1	5.94E+01
b. Spent Resins, Filters, Sludges (dewatered)	4	4	B	Type B	N/A	7.22	3.19E+02
c. Solidified (cement) Acids, Oily Water	0	-	-	-	-	-	-
2. <u>Dry Solid Waste</u>							
a. Dry Active Waste (compacted & non-compacted)	52	52	A	Type A GDP	N/A	2230	9.85E-01
b. Irradiated Components	3	3	C	Type B	N/A	4.73	3.14E+04
c. Other Waste (oil/sludge)	7	7	A	Type A GDP	N/A	95.5	4.64E-01
3. <u>Total Solid Waste</u>	77	77	-	-	-	2391.55	3.18E+04

NOTE: Total Activity determined by estimate. Solid Waste listed above shipped for processing to various waste processing services or directly shipped to licensed disposal facility.

Attachment 3 Solid Radioactive Waste Disposal

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Type of Waste Shipped	Radionuclide	% Abundance
1. <u>Waste from Liquid Systems</u>		
a. Spent Resins, Filters, Sludges (dewatered)	Fe-55	1.65E+01%
	Mn-54	3.28E+00%
	Co-58	1.59E+00%
<i>Class A & B combined</i>	Co-60	6.67E+01%
	Ni-63	4.35E+00%
	Zn-65	3.53E+00%
	Cs-137	1.99E+00%
b. Solidified (cement) Acids, Oily Water	N/A	N/A
2. <u>Dry Solid Waste</u>		
a. Dry Active Waste (compacted & non- compacted)	H-3	1.84E+00%
	Fe-55	3.95E+01%
	Mn-54	2.40E+00%
	Co-60	4.68E+01%
	Ni-63	4.58E+00%
	Cs-137	1.45E+00%
b. Irradiated Components	Fe-55	3.06E+01%
	Co-60	6.04E+01%
	Ni-63	6.81E+00%
	Ta-182	1.47E+00%
c. Other Waste (oil/sludge)	H-3	2.78E+00%
	Mn-54	1.60E+00%
	Fe-55	4.25E+01%
	Co-60	4.40E+01%
	Ni-63	5.08E+00%
	Cs-137	2.00E+00%

**Attachment 4
Meteorological Data**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 4

Meteorological Data

This attachment includes a summary of meteorological joint frequency distributions of wind speed, wind direction, and atmospheric stability (hours of occurrence).

Attachment 4 Meteorological Data

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Ground Releases

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.51-7.50	1	1	2	5	9	13	8	0	3	1	1	1	1	3	1	0
	7.51-12.50	1	1	3	17	20	4	1	1	1	10	51	15	0	0	0	3
	12.51-18.50	0	0	0	2	0	0	0	0	0	0	22	4	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.75-3.50	0	0	2	0	1	0	0	0	0	0	0	1	0	2	0	1
	3.51-7.50	9	9	8	7	9	6	11	8	1	1	3	7	9	7	8	4
	7.51-12.50	1	11	6	17	11	4	0	2	6	24	76	37	0	0	1	6
	12.51-18.50	0	0	1	2	0	0	0	0	0	0	17	6	0	0	0	1
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0.75-3.50	1	3	1	0	0	0	2	1	0	0	0	3	4	3	1	2
	3.51-7.50	18	20	14	25	11	18	19	9	4	4	9	18	11	14	9	8
	7.51-12.50	10	30	17	17	12	2	2	5	2	22	52	58	0	0	2	10
	12.51-18.50	0	0	0	2	0	0	0	0	0	0	16	6	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.75-3.50	16	12	17	15	7	8	14	7	6	3	7	17	31	23	25	27
	3.51-7.50	159	245	116	144	54	51	51	29	35	35	133	192	66	41	50	138
	7.51-12.50	43	150	58	70	35	1	1	0	6	36	289	318	9	0	31	40
	12.51-18.50	7	5	1	1	4	2	1	4	1	15	23	20	0	0	0	7
	18.51-25.00	0	0	0	0	0	1	0	4	0	0	0	1	0	0	0	2
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Ground Releases

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.75-3.50	89	60	27	26	14	23	16	12	18	10	17	53	62	62	46	47
	3.51-7.50	122	130	21	53	14	13	25	35	45	24	95	178	34	8	30	56
	7.51-12.50	1	11	2	3	1	0	0	2	23	38	70	56	0	1	1	14
	12.51-18.50	0	0	0	0	0	0	0	0	4	8	9	1	0	0	0	1
	18.51-25.00	3	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.75-3.50	143	48	11	6	2	3	4	3	13	5	18	41	49	40	57	85
	3.51-7.50	30	5	1	0	0	0	0	1	8	2	13	18	0	0	9	10
	7.51-12.50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.75-3.50	106	19	2	1	3	1	0	1	4	3	8	22	43	46	46	94
	3.51-7.50	2	0	0	1	0	0	0	0	0	0	1	1	1	0	2	5
	7.51-12.50	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	12.51-18.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18.51-25.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Attachment 4 Meteorological Data

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Elevated Releases

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3.51-7.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7.51-12.50	0	0	0	2	0	0	1	2	0	0	0	2	0	0	0	0
	12.51-18.50	0	0	0	2	0	0	0	0	0	0	15	4	0	0	1	4
	18.51-25.00	0	0	0	3	0	0	0	0	0	0	7	0	0	0	0	0
	25+	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
B	0.75-3.50	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
	3.51-7.50	1	1	0	1	1	0	1	1	0	0	0	5	0	0	0	
	7.51-12.50	3	2	7	4	8	5	3	3	3	5	4	7	4	4	0	2
	12.51-18.50	3	1	1	8	3	0	0	0	2	1	21	11	1	2	6	6
	18.51-25.00	0	0	1	1	0	0	0	0	0	1	14	1	0	0	1	2
	25+	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0.75-3.50	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
	3.51-7.50	2	2	1	3	2	10	3	3	3	0	1	3	3	1	1	2
	7.51-12.50	6	9	11	18	16	2	7	6	3	5	13	14	7	8	0	8
	12.51-18.50	9	8	9	9	7	0	0	1	1	4	14	23	1	2	7	7
	18.51-25.00	4	4	0	2	0	0	0	0	0	0	11	5	0	0	2	4
	25+	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
D	0.75-3.50	2	1	2	2	2	2	4	2	2	2	1	2	5	1	0	1
	3.51-7.50	14	18	6	14	19	9	8	13	12	7	13	17	16	6	12	12
	7.51-12.50	47	77	45	39	27	10	6	5	7	24	44	101	43	16	18	48
	12.51-18.50	63	151	82	98	20	1	3	1	5	33	114	131	32	44	37	61
	18.51-25.00	22	39	7	22	4	0	0	0	5	16	94	55	1	12	27	13
	25+	10	10	1	4	0	0	0	0	9	7	8	1	0	0	2	2

Attachment 4 Meteorological Data

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Elevated Releases

Stability Class	Wind Speed (mph)	Hours of Occurrence															
		Sector															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
E	0.75-3.50	0	0	0	0	0	0	1	0	3	0	0	0	1	0	0	0
	3.51-7.50	2	1	6	2	2	1	3	5	6	3	3	5	10	3	5	2
	7.51-12.50	8	14	14	21	14	8	5	9	16	19	12	42	55	14	15	12
	12.51-18.50	67	98	32	24	8	6	8	8	3	14	46	87	21	29	19	28
	18.51-25.00	7	19	5	6	3	1	4	11	15	52	54	49	3	9	33	23
	25+	0	0	0	1	1	0	0	3	18	20	16	4	0	0	5	4
F	0.75-3.50	0	0	0	0	0	1	1	1	0	1	0	0	0	2	1	0
	3.51-7.50	1	2	0	1	3	3	1	4	2	2	3	4	14	6	3	1
	7.51-12.50	12	9	7	15	8	5	5	2	9	13	7	17	21	12	6	9
	12.51-18.50	16	24	19	19	2	1	1	1	5	14	15	29	7	15	13	8
	18.51-25.00	10	9	6	0	0	0	0	1	2	2	9	9	0	13	14	25
	25+	0	0	0	1	0	0	0	0	3	0	0	0	0	1	2	0
G	0.75-3.50	2	4	3	0	1	0	0	2	2	4	4	2	3	3	3	3
	3.51-7.50	6	9	2	7	5	4	4	1	6	7	4	11	8	4	6	12
	7.51-12.50	13	20	15	18	13	11	14	14	12	8	8	27	16	13	18	11
	12.51-18.50	15	32	22	13	1	0	5	3	8	10	7	31	14	22	16	11
	18.51-25.00	5	8	5	2	0	0	0	2	1	0	0	1	1	14	5	9
	25+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2

**Attachment 5
Unplanned Offsite Releases**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 5

Unplanned Offsite Releases

This attachment includes a summary of the unplanned offsite releases of gaseous and liquid radioactive effluents.

Attachment 5
Unplanned Offsite Releases

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Brunswick Steam Electric Plant did not experience any unplanned offsite gaseous or liquid effluent releases in 2016.

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 6

Assessment of Radiation Dose from Radioactive Effluents to Members of the Public
(includes fuel cycle dose calculation results)

This attachment includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents released from the site for each calendar quarter for the calendar year of the report as well as the total dose for the calendar year.

This attachment also includes an assessment of radiation doses to the maximum exposed member of the public from all uranium fuel cycle sources within 8 km of the site for the calendar year of this report to show conformance with 40 CFR Part 190.

Methods for calculating the dose contribution from liquid and gaseous effluents are given in the Offsite Dose Calculation Manual (ODCM).

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Gaseous Effluents Dose Summary

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Noble Gases						
1. Maximum Beta Air	mRAD	1.43E-03	1.06E-03	2.60E-03	1.64E-03	6.73E-03
(a) Limit	mRAD	2.00E+01	2.00E+01	2.00E+01	2.00E+01	4.00E+01
(b) % of Limit		7.16E-03	5.31E-03	1.30E-02	8.20E-03	1.68E-02
2. Maximum Gamma Air	mRAD	2.27E-03	1.77E-03	3.20E-03	2.81E-03	1.00E-02
(a) Limit	mRAD	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		2.27E-02	1.77E-02	3.20E-02	2.81E-02	5.02E-02

Receptor Location **0.7 miles ENE**

B. Iodine, H-3, & Particulates

1. Maximum Organ Dose	mREM	1.18E-02	6.14E-03	1.13E-02	9.52E-03	3.88E-02
(a) Limit	mREM	1.50E+01	1.50E+01	1.50E+01	1.50E+01	3.00E+01
(b) % of Limit		7.84E-02	4.10E-02	7.56E-02	6.34E-02	1.29E-01

Receptor Location **4.75 miles NE**

Critical Age **INFANT**

Critical Organ **THYROID**

Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Liquid Effluents Dose Summary

	<u>Units</u>	<u>Qtr 1</u>	<u>Qtr 2</u>	<u>Qtr 3</u>	<u>Qtr 4</u>	<u>Year</u>
A. Batch & Continuous Mode						
1. Maximum Organ Dose	mREM	4.77E-05	4.38E-05	8.51E-05	7.53E-05	2.52E-04
(a) Limit	mREM	1.00E+01	1.00E+01	1.00E+01	1.00E+01	2.00E+01
(b) % of Limit		4.77E-04	4.38E-04	8.51E-04	7.53E-04	1.26E-03
2. Maximum Total Body Dose	mREM	3.13E-05	1.93E-05	3.72E-05	2.63E-05	1.14E-04
(a) Limit	mREM	3.00E+00	3.00E+00	3.00E+00	3.00E+00	6.00E+00
(b) % of Limit		1.04E-03	6.43E-04	1.24E-03	8.78E-04	1.90E-03

Critical Age **ADULT**

Critical Organ **THYROID**

**Attachment 6
Assessment of Radiation Dose from Radioactive Effluents to Members of the Public**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

40 CFR Part 190 Uranium Fuel Cycle Dose Calculation Results

In accordance with the requirements of 40 CFR Part 190, the annual dose commitment to any member of the general public shall be calculated to assure that doses are limited to 25 millirems to the total body or any organ with the exception of the thyroid which is limited to 75 millirems. The fuel cycle dose assessment for Brunswick Steam Electric Plant includes liquid and gaseous effluent dose contributions from Brunswick Steam Electric Plant and direct and air-scatter dose from the onsite ISFSI and Turbine Buildings. No other uranium fuel cycle facility contributes significantly to the maximum exposed individual. Also included is dose from Carbon-14, evaporation of tritium from both the SDSP and SDSF, and marsh releases containing tritium to Nancy's Creek (Ref. Attachment 2, Supplemental Information, of this report for further information). The combined dose to a maximum exposed individual from effluent releases and direct and air-scatter dose is below 40 CFR Part 190 limits as shown by the following summary.

Note: The 40 CFR Part 190 effluent dose analysis to the maximum exposed individual from liquid and gas releases does not include the dose from noble gases (i.e., total body and skin) due to the low significance compared to other dose pathways.

40 CFR Part 190 Effluent Dose Summary			
A. Gaseous Effluent Dose			
1. Location	4.75 miles NE		
2. Critical Age	INFANT		
3. Critical Organ	THYROID		
4. Organ Dose (mREM)	3.88E-02		
5. Total Body Dose (mREM)	8.84E-03		
B. Liquid Effluent Dose			
1. Location	0.10 miles SW		
2. Critical Age	ADULT		
3. Critical Organ	THYROID		
4. Organ Dose (mREM)	2.52E-04		
5. Total Body Dose (mREM)	1.14E-04		
C. Carbon-14 Dose			
1. Location	1.70 miles S		
2. Critical Age	CHILD		
3. Critical Organ	BONE		
4. Organ Dose (mREM)	2.04E+00		
5. Total Body Dose (mREM)	4.09E-01		
D. SDSP Evaporation H-3 Dose			
1. Location	0.30 miles NW		
2. Critical Age	TEEN		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	6.70E-05		
5. Total Body Dose (mREM)	6.70E-05		
E. SDSF Evaporation H-3 Dose			
1. Location	0.50 miles NNW		
2. Critical Age	TEEN		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	2.37E-04		
5. Total Body Dose (mREM)	2.37E-04		
F. Nancy's Creek Marsh H-3 Dose			
1. Location	Nancy's Creek		
2. Critical Age	ADULT		
3. Critical Organ	N/A		
4. Organ Dose (mREM)	2.20E-03		
5. Total Body Dose (mREM)	2.20E-03		

Attachment 6 Assessment of Radiation Dose from Radioactive Effluents to Members of the Public

Brunswick Steam Electric Plant Units 1 & 2 Period 1/1/2016 - 12/31/2016

Direct and air-scatter radiation dose contributions from the onsite ISFSI and Turbine Buildings are shown in plant operating manual OPLP-36, 10 CFR 72.212 Report, revision 4. The maximum dose rate to the nearest real individual from the ISFSI and Turbine Buildings is conservatively calculated to be less than 14.8 mrem/yr. The below excerpt from plant operating manual OPLP-36, 10 CFR 72.212 Report, revision 4, Attachment 1, is provided to document the method used to calculate the dose from the onsite ISFSI and Turbine Buildings as less than 14.8 mrem/yr to the nearest real individual.

5.2.2 Dose from Normal Operations and Anticipated Occurrences

4. Radiation from Plant Operations

Offsite direct dose measurements are obtained and analyzed in accordance with the Radiological Environmental Monitoring Program (REMP) and submitted annually to the NRC. As part of the REMP, two rings of stations are established for monitoring direction radiation. The inner ring of stations is established in the general area of the site boundary. The outer ring of stations is located at distances of 8 km or greater from the site (Ref. [7.5.16]). Environmental data on external radiation exposure does not indicate a significant higher exposure rate for the inner ring versus the outer ring. This demonstrates that no discernible off-site exposure occurs as a result of plant operations (Ref. [7.6.2], [7.6.3]).

For conservatism, an approach is taken for quantifying the plant contribution to direct dose at the controlled area boundary. The ODCM TLD sample point along either the inner or outer ring of stations with the highest dose reading for each quarter was used as a bounding indicator dose.

...The real dose contribution from direct radiation sources during plant operations at BSEP is taken at 14.8 mrem/year.

Dose contributions from Carbon-14 in gaseous effluents have been determined from ODCM 3.3.3, Carbon-14. The maximum dose rate to the nearest real individual from the release of Carbon-14 in gaseous effluents is conservatively calculated to be less than 2.04E+00 mrem/yr based on 2.22E+01 Curies released in 2016 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Storm Drain Stabilization Pond (SDSP) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.2-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSP is conservatively calculated to be less than 6.70E-05 mrem/yr based on 2.19E-01 Curies released in 2016 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from evaporation of the Storm Drain Stabilization Facility (SDSF) have been determined from ODCM 3.3.2, I-131, I-133, Particulates, and Tritium, equation 3.2-19. The maximum dose rate to the nearest real individual from evaporation of tritium in the SDSF is conservatively calculated to be less than 2.37E-04 mrem/yr based on 3.68E-01 Curies released in 2016 (Ref. Attachment 2, Supplemental Information, of this report).

Dose contributions from marsh releases to Nancy's Creek from ODCM 2.1.5, Marsh Releases. The maximum dose rate to the nearest real individual from marsh releases to Nancy's Creek is conservatively calculated to be less than 2.20E-03 mrem/yr based on 1.81E-01 Curies released in 2016 (Ref. Attachment 2, Supplemental Information, of this report).

Total dose from liquid and gaseous effluents from Brunswick Steam Electric Plant and the additional pathways mentioned above is conservatively estimated to be less than 17 mrem/yr for total body and organ. It is recognized summing dose for different organs and age groups is not entirely accurate. However, the sum of the organ and age specific doses will always be less than the sum of the maximums of each. Therefore, summing the maximum values of each provides the most conservative value to ensure compliance with 40 CFR 190. The dose from all pathways related to operation of Brunswick Steam Electric Plant meets the 40 CFR Part 190 requirements of an annual dose commitment to any member of the general public of less than 25 mrem total body or any organ and 75 mrem to the thyroid.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 7

Information to Support the NEI Ground Water Protection Initiative

This attachment includes a summary of voluntary reports made in accordance with the NEI Ground Water Protection Initiative and a summary of ground water well sample data.

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

The Brunswick Steam Electric Plant groundwater sampling and analysis program is a significant surveillance program. Wells are installed around the Storm Drain Stabilization Pond (SDSP), in the Protected Area (PA), and throughout the Owner Controlled Area (OCA). The wells listed in the ODCM are collected as part of the Radiological Environmental Monitoring Program (REMP) and reported in the Annual Radiological Environmental Operating Report (AREOR). The monitoring wells not described in the ODCM are listed below. The list consists of shallow and intermediate wells in different locations around the OCA and PA. They are used to evaluate groundwater movement and for remediation of the Unit 1 Condensate Storage Tank (CST) leak and the SDSP.

Unit 1 CST Groundwater Wells - The investigation into groundwater impacts resulting from the December 2010 Unit 1 Condensate Storage Tank line leak resulted in the installation of numerous monitoring/recovery wells. Two of these wells (U1CSTREM-07BCH and U1CSTREM-09BCH) are installed in the Castle Hayne aquifer (greater than 70' below ground surface) to investigate and monitor potential impacts to the aquifer. Ten of these wells (U1CSTREM-05, U1CSTREM-02B, U1CSTREM-08/GWM-17, U1CSTREM-09B, U1CSTREM-15/GWM-15, U1CSTREM- 21B, U1CSTREM-22B, U1CSTREM-27B, MW-01B, and MWPA-111B/GWM-01) are installed in the dense sand unit (45' - 70' below ground surface) to investigate and monitor impacts to this flow zone comprised of native material beneath the plant excavation backfill. Three of these dense sand wells are currently being used as recovery wells as part of the groundwater remediation effort (GWM-01, GWM-15, GWM-17). Twenty-four of these wells (U1CSTREM-02C/GWM-01, U1CSTREM-09C, U1CSTREM-10/GWM-04, U1CSTREM-11, U1CSTREM-12, U1CSTREM-13/GWM-13, U1CSTREM-14/GWM-15, U1CSTREM-16/GWM-16, U1CSTREM-18/GWM-18, U1CSTREM-19/GWM-19, U1CSTREM-21C, U1CSTREM-22C/GWM-07, U1CSTREM-23/GWM-11, U1CSTREM-24/GWM-22, U1CSTREM-25/GWM-21, U1CSTREM-26/GWM-06, U1CSTREM-27C/GWM-05, U1CSTREM-28/GWM-03, U1CSTREM-29/GWM-02, U1CSTREM-30/GWM-08, U1CSTREM-31/GWM-09, U1CSTREM-32, U1CSTREM-33/GWM-10, and MWPA-112C/GWM-12) are installed in the plant excavation backfill (up to 45' below ground surface) to investigate and monitor impacts to this flow zone where the leak occurred. Fifteen of these wells are currently used as recovery wells as part of the groundwater remediation effort.

Wells are typically sampled quarterly or semi-annually. Ground water samples are regularly analyzed for tritium and all wells are analyzed for gamma emitters. No gamma emitters, other than naturally occurring radionuclides, were identified in well samples during 2016.

Results from sampling during 2016 are shown in the table below.

No events meeting the criteria for voluntary notification per NEI 07-07, Industry Ground Water Protection Initiative, occurred at Brunswick Steam Electric Plant in 2016.

Key to below table.

- | | | |
|-----------------|---|---|
| NS | - | Not scheduled to be sampled, not sampled due to insufficient volume in well, or well inaccessible during outage. |
| pCi/l | - | picocuries per liter. |
| < LLD | - | less than lower limit of detection, typically 250 pCi/l. |
| 20,000 pCi/l | - | the Environmental Protection Agency drinking water standard for tritium. This standard applies only to water used for drinking. |
| 1,000,000 pCi/l | - | the 10 CFR Part 20, Appendix B, Table 2, Column 2, Effluent Concentration Limit for tritium. |

**Attachment 7
Information to Support the NEI Ground Water Protection Initiative**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

Brunswick <u>Shallow</u> Wells for Plant Site						
Well Name	Number of Samples in 2016	Number of Positive H-3 Samples in 2016	Average H-3 Activity (pCi/L)	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
ESS-2C	4	4	9.27E+03	5.74E+03	1.35E+04	27
ESS-3C	2	2	8.54E+02	7.50E+02	9.58E+02	14
ESS-12C	1	1	3.01E+02	3.01E+02	3.01E+02	15
ESS-13C	1	0	< LLD	< LLD	< LLD	25
ESS-16	4	4	1.34E+03	1.15E+03	1.75E+03	27
ESS-17C	4	4	6.90E+03	5.94E+03	7.74E+03	26
ESS-18C	4	4	4.02E+03	4.01E+02	1.24E+04	20
ESS-19C	2	2	1.20E+05	1.02E+05	1.37E+05	20
ESS-20C	4	4	1.65E+04	9.01E+03	2.48E+04	20
ESS-21C	1	1	5.39E+02	5.39E+02	5.39E+02	20
ESS-22C	2	2	2.60E+04	1.52E+04	3.68E+04	20
ESS-23C	2	2	8.47E+04	7.24E+04	9.69E+04	23
ESS-24C	4	4	2.50E+03	2.09E+03	2.68E+03	18
ESS-25C	1	0	< LLD	< LLD	< LLD	22
ESS-26C	2	2	2.05E+04	2.58E+03	3.85E+04	15
ESS-27C	2	2	1.24E+05	1.05E+05	1.43E+05	16
ESS-28C	2	2	3.25E+02	3.18E+02	3.32E+02	23
ESS-29C	2	0	< LLD	< LLD	< LLD	28
ESS-30C	2	1	4.69E+02	4.69E+02	4.69E+02	15
ESS-31C	2	0	< LLD	< LLD	< LLD	15
ESS-38C	1	0	< LLD	< LLD	< LLD	15
ESS-39C	1	0	< LLD	< LLD	< LLD	20
ESS-40C	1	0	< LLD	< LLD	< LLD	30
ESS-41C	1	0	< LLD	< LLD	< LLD	27
ESS-42C	1	0	< LLD	< LLD	< LLD	30
ESS-44C	1	0	< LLD	< LLD	< LLD	15
ESS-45C	1	0	< LLD	< LLD	< LLD	21
ESS-46C	1	0	< LLD	< LLD	< LLD	18
ESS-48C	1	0	< LLD	< LLD	< LLD	18
ESS-49C	1	0	< LLD	< LLD	< LLD	19
ESS-50C	1	0	< LLD	< LLD	< LLD	22
ESS-51C	1	0	< LLD	< LLD	< LLD	22
ESS-54C	1	0	< LLD	< LLD	< LLD	24
ESS-55C	1	0	< LLD	< LLD	< LLD	38
ESS-56C	1	0	< LLD	< LLD	< LLD	32
ESS-58C	1	0	< LLD	< LLD	< LLD	18

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Brunswick <u>Shallow</u> Wells for Plant Site - continued						
Well Name	Number of Samples in 2016	Number of Positive H-3 Samples in 2016	Average H-3 Activity (pCi/L)	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
ESS-59C	1	0	< LLD	< LLD	< LLD	18
ESS-60C	1	0	< LLD	< LLD	< LLD	19
ESS-67C	1	1	7.98E+02	7.98E+02	7.98E+02	25
ESS-68C	1	0	< LLD	< LLD	< LLD	19
ESS-69C	1	0	< LLD	< LLD	< LLD	30
ESS-70C	1	0	< LLD	< LLD	< LLD	18
ESS-71C	1	0	< LLD	< LLD	< LLD	19
ESS-72C	2	0	< LLD	< LLD	< LLD	18
ESS-73C	1	0	< LLD	< LLD	< LLD	15
ESS-74C	1	0	< LLD	< LLD	< LLD	25
ESS-201C	4	4	1.78E+04	6.33E+03	2.38E+04	19
ESS-202C	4	4	3.82E+04	6.34E+03	5.73E+04	19
ESS-203C	4	4	2.29E+03	1.31E+03	2.81E+03	19
ESS-STAB	2	2	2.74E+03	1.37E+03	4.10E+03	31
ESS-NC-4A	2	2	5.77E+03	4.08E+03	7.46E+03	17
MW-1	1	1	7.84E+02	7.84E+02	7.84E+02	24
MW-2	2	0	< LLD	< LLD	< LLD	24
MW-3	2	2	4.43E+02	3.59E+02	5.26E+02	26
MWPA-100C	2	2	9.27E+02	5.44E+02	1.31E+03	30
MWPA-101C	2	2	8.43E+02	5.66E+02	1.12E+03	29
MWPA-102C	2	2	6.78E+02	4.16E+02	9.39E+02	30
MWPA-103C	1	0	< LLD	< LLD	< LLD	30
MWPA-104C	4	4	4.12E+03	2.40E+03	4.83E+03	29
MWPA-105C	2	2	1.12E+03	7.68E+02	1.48E+03	30
MWPA-106C	2	2	5.18E+02	4.49E+02	5.86E+02	29
MWPA-107C	4	4	1.86E+03	1.42E+03	2.07E+03	29
MWPA-108C	4	4	6.65E+02	5.41E+02	7.90E+02	29
MWPA-109C	2	2	8.35E+02	7.15E+02	9.55E+04	29
MWPA-110C	4	4	1.23E+03	1.10E+03	1.45E+03	29
MWPA-113C	3	3	1.20E+03	1.02E+03	1.37E+03	25
MWPA-114C	4	4	1.81E+03	8.96E+02	2.61E+03	30
MWPA-115C	5	5	2.41E+03	1.92E+03	3.37E+03	34
MWPA-116C	2	0	< LLD	< LLD	< LLD	30
MWPA-117C	2	2	6.77E+02	6.37E+02	7.16E+02	30
MWPA-118C	2	2	8.37E+02	7.22E+02	9.51E+02	30

Attachment 7
Information to Support the NEI Ground Water Protection Initiative

Brunswick Steam Electric Plant Units 1 & 2
 Period 1/1/2016 - 12/31/2016

Brunswick <u>Intermediate</u> Wells for Plant Site						
Well Name	Number of Samples in 2016	Number of Positive H-3 Samples in 2016	Average H-3 Activity (pCi/L)	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
ESS-2B	1	0	< LLD	< LLD	< LLD	58
ESS-3B	1	0	< LLD	< LLD	< LLD	52
ESS-18B	4	4	5.06E+02	4.03E+02	6.77E+02	23
ESS-19B	4	4	1.67E+04	1.03E+04	2.15E+04	42
ESS-20B	4	0	< LLD	< LLD	< LLD	43
ESS-22B	4	4	2.12E+03	1.65E+03	2.48E+03	76
ESS-38B	1	0	< LLD	< LLD	< LLD	55
ESS-39B	1	0	< LLD	< LLD	< LLD	55
ESS-51B	1	0	< LLD	< LLD	< LLD	45
ESS-52B	1	0	< LLD	< LLD	< LLD	51
ESS-53B	1	0	< LLD	< LLD	< LLD	76
MWPA-104B	4	4	8.72E+03	7.80E+03	9.40E+03	59
MWPA-107B	4	4	1.18E+04	1.00E+04	1.57E+04	60

**Attachment 7
Information to Support the NEI Ground Water Protection Initiative**

**Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016**

Brunswick <u>Unit 1</u> CST Groundwater Wells						
Well Name	Number of Samples in 2016	Number of Positive H-3 Samples in 2016	Average H-3 Activity (pCi/L)	Minimum H-3 Activity (pCi/L)	Maximum H-3 Activity (pCi/L)	Depth of Well (ft)
GWM-01	72	57	3.97E+03	< LLD	7.83E+03	61
GWM-02	85	85	2.24E+04	1.75E+04	3.28E+04	45
GMW-06	7	7	1.06E+03	6.58E+02	1.30E+03	45
GWM-08	82	81	6.93E+03	< LLD	1.38E+04	45
GWM-09	80	32	1.67E+03	< LLD	2.94E+03	46
GWM-10	84	84	1.02E+04	4.87E+03	1.54E+04	45
GWM-11	82	82	8.09E+03	3.76E+03	1.22E+04	45
GWM-12	65	64	8.62E+03	< LLD	1.76E+04	33
GMW-13	77	77	6.20E+04	3.98E+03	3.13E+05	44
GWM-14	65	65	9.68E+04	1.80E+04	3.08E+05	44
GMW-15	66	66	1.73E+04	9.62E+03	5.48E+04	59
GWM-16	67	67	2.18E+05	8.37E+03	2.76E+05	40
GMW-17	66	16	2.51E+03	< LLD	3.12E+03	68
GWM-18	72	72	3.43E+05	2.17E+04	5.33E+05	29
GMW-19	57	57	3.86E+04	1.86E+04	5.21E+04	40
GMW-20	66	66	1.60E+04	3.89E+03	2.84E+04	45
GMW-21	70	70	2.43E+04	1.01E+04	5.03E+04	45
GWM-22	92	92	2.23E+04	1.57E+04	3.02E+04	29
MW-1	13	8	8.23E+02	< LLD	1.68E+03	24
MW-1B	12	9	1.40E+03	< LLD	3.86E+03	45
U1CSTREM-02B	10	2	5.02E+02	< LLD	6.66E+02	68
U1CSTREM-05B	10	6	4.14E+02	< LLD	5.37E+02	65
U1CSTREM-07BCH	12	8	1.45E+03	< LLD	4.33E+03	85
U1CSTREM-09B	11	8	3.03E+03	< LLD	3.97E+03	68
U1CSTREM-09BCH	11	6	7.71E+02	< LLD	1.35E+03	85
U1CSTREM-09C	11	10	4.25E+03	< LLD	7.02E+03	45
U1CSTREM-10C	11	8	9.17E+02	< LLD	2.96E+03	45
U1CSTREM-11C	12	1	3.19E+02	< LLD	3.19E+02	40
U1CSTREM-12C	10	5	6.75E+03	< LLD	2.72E+04	34
U1CSTREM-21B	11	7	1.65E+03	< LLD	2.11E+03	69
U1CSTREM-21C	11	8	2.71E+03	< LLD	3.66E+03	45
U1CSTREM-22B	11	0	< LLD	< LLD	< LLD	69
U1CSTREM-27B	11	4	5.27E+02	< LLD	6.00E+02	68
U1CSTREM-27C	10	7	1.40E+03	< LLD	3.08E+03	45
U1CSTREM-28C	11	11	9.76E+03	9.64E+02	2.42E+04	45
U1CSTREM-32C	11	7	9.79E+02	8.13E+02	1.15E+03	45

**Attachment 8
Inoperable Equipment**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 8

Inoperable Equipment

This attachment includes an explanation of inoperable instruments related to effluent monitoring in excess of allowed time defined by licensing bases and an explanation of liquid hold-up tanks exceeding 10 Curies total activity (excluding tritium and dissolved or entrained noble gases).

Attachment 8 Inoperable Equipment

Brunswick Steam Electric Plant Units 1 & 2 Period 1/1/2016 - 12/31/2016

Brunswick Steam Electric Plant experienced three (3) instances of inoperable equipment relevant to effluent monitoring in excess of ODCM Specification 7.3.0 limits during 2016. Details of each are described below.

Brunswick Steam Electric Plant experienced no Liquid Hold-Up Tank exceeding the 10 Curie limit of ODCMS 7.3.6 during 2016.

ODCM # from Table 7.3.2-1	Title	Completion Time	Description
5	Main Condenser Off-Gas Treatment System Explosive Gas Monitoring System - Hydrogen Monitor	30 Days	Off-gas H2/O2 analyzer 1-OG-AIT-4324 was made inoperable for EC 88820 on 2/2/16 at 08:13 per LCO O-1-16-00095. 1-OG-AIT-4324 was not restored by 3/3/16 at 08:13 due to work for analyzer modification per EC 88820. Reference NCR 02023181.

ODCM # from Table 7.3.2-1	Title	Completion Time	Description
5	Main Condenser Off-Gas Treatment System Explosive Gas Monitoring System - Hydrogen Monitor	30 Days	Off-gas H2/O2 analyzer 1-OG-AIT-4284 was declared inoperable due to failing 1MST-RGE21Q on 3/24/16 At 18:00 per LCO O-1-16-00245. 1-OG-AIT-4284 was not restored by 4/23/16 at 18:00. Reference NCR 02023191.

ODCM # from Table 7.3.2-1	Title	Completion Time	Description
5	Main Condenser Off-Gas Treatment System Explosive Gas Monitoring System - Hydrogen Monitor	30 Days	Unit 2 Off Gas H2/O2 Analyzer 2-OG-AIT-4284 was taken out of service and made inoperable on 7/18/16 at 0819. 2-OG-AIT-4284 was not restored by 8/17/16 at 0819 due to work for analyzer modification per EC 88820. Reference NCR 02054350.

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 9

Summary of Changes to the Offsite Dose Calculation Manual

This attachment includes a summary of changes to the ODCM and Radiological Effluent Controls.

Attachment 9
Summary of Changes to the Offsite Dose Calculation Manual

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ODCM Revision 37

The Brunswick Steam Electric Plant ODCM was not revised in 2016. The most recent revision is 37.

Attachment 10
Summary of Changes to the Process Control Program

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 10

Summary of Changes to the Process Control Program

This attachment includes a summary of changes to the PCP.

Attachment 10
Summary of Changes to the Process Control Program

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

The Brunswick Steam Electric Plant PCP was not revised in 2016. The most recent revision is 5.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 11

Summary of Major Modifications to the Radioactive Waste Treatment Systems

This attachment includes a description of major modifications to the radioactive waste treatment systems that are anticipated to affect effluent releases.

Attachment 11
Summary of Major Modifications to the Radioactive Waste Treatment Systems

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

No major modifications to Brunswick Steam Electric Plant liquid, gaseous, solid, or mobile radioactive waste treatment systems occurred in 2016.

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

ATTACHMENT 12

Errata to a Previous Year's ARERR

This attachment includes any amended pages from a previous year's ARERR.

Attachment 12
Errata to a Previous Year's ARERR

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

The following contains amended pages to the Brunswick Steam Electric Plant 2015 ARERR. Amended pages are identified with "Amendment #" on page. Specific changes are identified with change bars in right margin.

The Brunswick Steam Electric Plant 2015 ARERR Amendment #1 requires the following change from Attachment 3 Page 3-2:

Brunswick Steam Electric Plant 2015 ARERR as submitted:

3. <u>Total Solid Waste</u>	81	-	-	-	-	3750	3.50E+01
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Brunswick Steam Electric Plant 2015 ARERR Amendment #1 as revised:

3. <u>Total Solid Waste</u>	81	-	-	-	-	3741.2	3.50E+01
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**Attachment 12
Errata to a Previous Year's ARERR**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2016 - 12/31/2016

**Attachment 3
Solid Radioactive Waste Disposal**

Brunswick Steam Electric Plant Units 1 & 2
Period 1/1/2015 - 12/31/2015

Type of Waste Shipped	Number of Shipments	Number of Containers	Waste Class	Container Type	Solidification Agent	Burial Volume (m ³)	Total Activity (Curies)
1. <u>Waste from Liquid Systems</u>							
a. Spent Resins, Filters, Sludges (dewatered)	8	-	A	Type A GDP	N/A	21.2	3.26E+01
b. Solidified (cement) Acids, Oily Water	0	-	-	-	-	-	-
2. <u>Dry Solid Waste</u>							
a. Dry Active Waste (compacted & non-compacted)	73	-	A	Type A GDP	N/A	3720	2.34E+00
b. Irradiated Components	0	-	-	-	-	-	-
3. <u>Total Solid Waste</u>	81	-	-	-	-	3741.2	3.50E+01

NOTE: Total Activity determined by estimate. Solid Waste listed above shipped for processing to various waste processing services or directly shipped to licensed disposal facility. No Waste Class B or Waste Class C shipments were made in 2015.