VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 27, 2017

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. 17-147
NAPS/JHL
Docket Nos. 50-338/339
72-16
72-56
License Nos. NPF-4/7
SNM-2507

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
NORTH ANNA POWER STATION UNIT NOS. 1 AND 2
INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI)
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

Enclosed is the 2016 Annual Radioactive Effluent Release Report. This report is provided pursuant to North Anna Units 1 and 2 Technical Specification 5.6.3 [10 CFR 50.36a] and North Anna Independent Spent Fuel Storage Installation Technical Specification 5.5.2c [10 CFR 72.44(d)(3)].

If you have any questions or require additional information, please contact Mr. Donald R. Taylor at (540) 894-2100.

Very truly yours,

N. Larry Lane
Site Vice President

Enclosure

Commitments made in this letter: None

cc: U. S. Nuclear Regulatory Commission
Region II
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, Georgia 30303-1257

Director, Division of Spent Fuel Management
Office of Nuclear Material Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

NRC Senior Resident Inspector
North Anna Power Station

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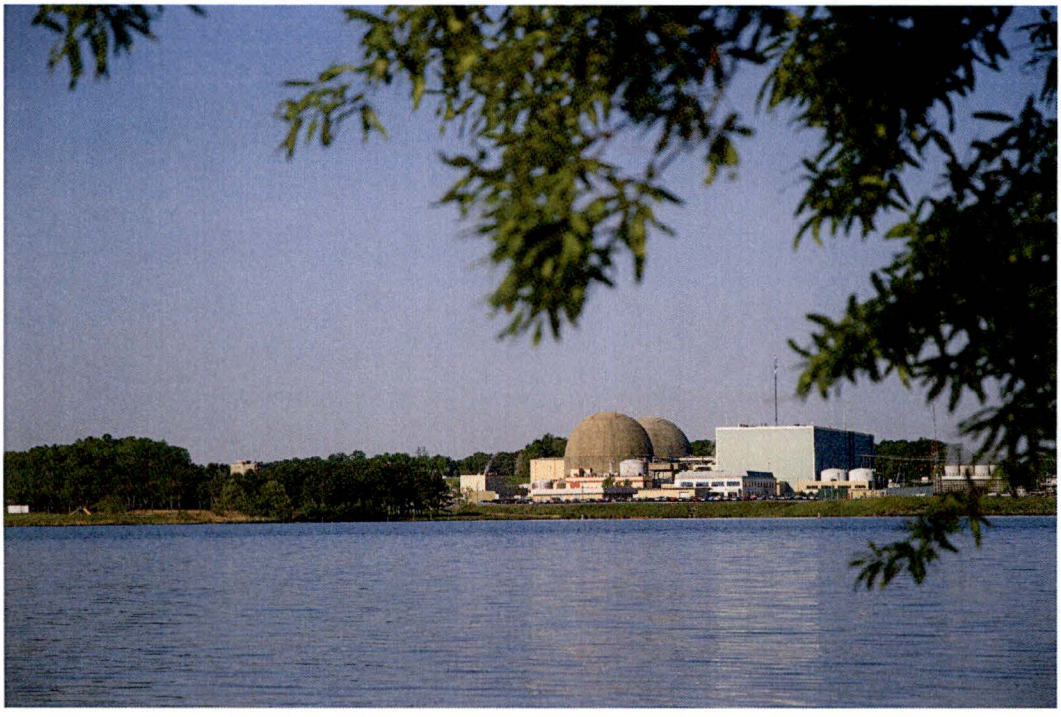
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

NORTH ANNA POWER STATION

(JANUARY 01, 2016 TO DECEMBER 31, 2016)



PREPARED BY: _____

Bradley T. Pleasants, Jr.
Supervisor Radiological
Analysis and Instrumentation

REVIEWED BY: Barbara J. Thompson

Barbara J. Thompson
Superintendent
Health Physics
Technical Services

APPROVED BY: George R. Simmons

George R. Simmons
Manager
Radiological Protection and Chemistry

FORWARD

This report is submitted in accordance with North Anna Unit 1 and 2 Technical Specification 5.6.3 and North Anna Independent Spent Fuel Storage Installation (ISFSI) Technical Specification 5.5.2.c and 10CFR72.44(d)(3).

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

FOR THE

NORTH ANNA POWER STATION

JANUARY 01, 2016 TO DECEMBER 31, 2016

INDEX

1.0 EXECUTIVE SUMMARY

The Annual Radioactive Effluent Release Report describes the radioactive effluent control program conducted at the North Anna Power Station and the Independent Spent Fuel Storage Installation (ISFSI) during the 2016 calendar year. This document summarizes the quantities of radioactive liquid and gaseous effluents and solid waste released from the North Anna Power Station and ISFSI in accordance with Regulatory Guide 1.21 during the period of January 1 through December 31, 2016, and includes an assessment of radiation doses to the maximum exposed member of the public due to radioactive liquid and gaseous effluents. There were no releases from the ISFSI during 2016.

There were no unplanned releases, meeting the reporting criteria of Section 6.7.2.a.3 of the Offsite Dose Calculation Manual during this reporting period. Also there were no spills or leaks meeting the voluntary communication criteria of the NEI Ground Water Protection Initiative. This will be discussed in Attachment 6.

10 CFR 50, Appendix I dose calculations were performed on the 2016 effluent release data in accordance with the Offsite Dose Calculation Manual. The results of these pathway dose calculations indicate the following:

a. The total body dose due to liquid effluents was 7.67E-1 mrem, which is 12.82% of the dose limit and the critical organ dose due to liquid effluents was 7.67E-1 mrem, which is 3.84% of the dose limit.

b. The air dose due to noble gases was 1.70E-4 mrad gamma, which is 8.50E-4% of the annual gamma dose limit, and 1.07E-4 mrad beta, which is 2.68E-4% of the annual beta dose limit.

c. The critical organ dose for I-131, I-133, H-3, and particulates with half-lives greater than 8 days including C-14 was 1.18 mrem, which is 3.93% of the annual dose limit. The bases of C-14 calculations are described in Attachment 9.

d. The critical organ dose for I-131, I-133, H-3, and particulates with half-lives greater than 8 days not including C-14 was 3.09E-2 mrem, which is 1.03E-1% of the annual dose limit.

There were no major changes to either the radioactive liquid waste treatment system, or to the gaseous, and solid waste treatment systems during this reporting period.

There were no revisions to the Offsite Dose Calculation Manual during this reporting period.

Based on the levels of radioactivity observed during this reporting period and the dose calculations performed, the operations of the North Anna Nuclear Power Station Units 1 and 2 and ISFSI have resulted in negligible dose consequences to the maximum exposed member of the public in unrestricted areas.

2.0 PURPOSE AND SCOPE

The Radioactive Effluent Release Report includes, in Attachment 1, a summary of the quantities of radioactive liquid and gaseous effluents and solid waste as outlined in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants", Revision 1, June 1974, with data summarized on a quarterly basis for Table 1 and 2 and on an annual basis on Table 3. The report submitted before May 1st of each year 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 during the previous calendar year. The report also includes a list of unplanned releases during the reporting period in Attachment 6.

As required by Technical Specification, any changes to the Offsite Dose Calculation Manual (ODCM) for the time period covered by this report are included in Attachment 3.

Major changes to radioactive liquid, gaseous and solid waste treatment systems are reported in Attachment 4, as required by the ODCM, Section 6.7.2.a.4. Information to support the reason(s) for the change(s) and a summary of the 10 CFR 50.59 evaluation are included.

As required by the ODCM, Sections 6.2.2.b.2 and 6.3.2.b.3, a list and explanation for the inoperability of radioactive liquid and/or gaseous effluent monitoring instrumentation is provided in Attachment 5 of this report.

3.0 DISCUSSION

The basis for the calculation of percent of Technical Specification for the critical organ in Table 1A of Attachment 1 is the ODCM, section 6.3.1, which requires that the dose rate for iodine-131 and iodine-133, for tritium, and for all radionuclides in particulate form with half-lives greater than 8 days shall be less than or equal to 1500 mrem/yr to the critical organ at or beyond the site boundary. The critical organ is the child's bone if C-14 is included and child's thyroid if C-14 is not included both via the inhalation pathway.

The basis for the calculation of percent of Technical Specification for the total body and skin in Table 1A of Attachment 1 is the ODCM, section 6.3.1, which requires that the dose rate for noble gases to areas at or beyond the site boundary shall be less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin.

The basis for the calculation of the percent of Technical Specification in Table 2A in Attachment 1 is the ODCM, section 6.2.1, which states that the concentrations of radioactive material released in liquid effluents to unrestricted areas shall be limited to 10 times the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the concentration shall be limited to 2.0E-4 uCi/ml.

Percent of Technical Specification calculations are based on the total gaseous or liquid effluents released for that respective quarter.

The annual and quarterly doses, as reported in Attachment 2, were calculated according to the methodology presented in the ODCM. The beta and gamma air doses due to noble gases released from the site were calculated at site boundary. The maximum exposed member of the public from the releases of airborne iodine-131 and iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days, including carbon-14 is defined as a child, exposed through the vegetation pathway, with the critical organ being the bone. If carbon-14 is excluded from these calculations, the maximum exposed member of the public from the releases of airborne iodine-131 and iodine-133, tritium and all radionuclides in particulate form with half-lives greater than 8 days is defined as a child, exposed through the vegetation pathway, with the critical organ being the thyroid gland. The maximum exposed member of the public for calculation of total body dose from radioactive materials in liquid effluents released to unrestricted areas is defined as a child, and also as a child for the calculation of critical organ dose, which was determined to be Gastrointestinal- Lower Large Intestine (GI-LLI). The age group is exposed via the drinking water and fish ingestion pathways.

As shown in Attachment 6, there was no unplanned releases meeting the requirements of 6.7.2.a.3 of the ODCM.

The typical Lower Limit of Detection (LLD) capabilities of the radioactive effluent analysis instrumentation are presented in Attachment 7. These LLD values are based upon conservative conditions (i.e., minimum sample volume and maximum delay time prior to analysis). Actual LLD values may be lower. If a radioisotope was not detected when effluent samples were analyzed, then the activity of that radioisotope was reported as Not Detectable (N/D) on Attachment 1 of this report. If an analysis for an isotope was not performed, then the activity was reported as Not Applicable (N/A).

4.0 SUPPLEMENTAL INFORMATION

As required by the ODCM, section 6.6.2, evaluation of the Land Use Census is performed to identify if new location(s) need be added for the radiological environmental monitoring program pursuant to the ODCM. There were no new sampling locations added. There were seven (7) changes made to the land use census in 2016. The nearest garden location in the N sector changed from 1.76 miles to 1.56 miles. The nearest garden location in the NW sector changed from 1.96 miles to 1.28 miles. The nearest garden location in the NNW sector changed from 1.22 miles to 2.54 miles. Physical addresses for the nearest garden locations in the ESE and W sectors changed but distances from station were unchanged. Also, the location of the nearest meat animal in the ENE sector changed from 2.65 miles to 2.49 miles. There are no longer meat animals in the W sector. Meat animals previously in W sector at 4.40 miles distance were no longer present and no other meat animals were found in the W sector within a five mile radius of the station. Finally, the physical address of the nearest resident in the ENE sector changed but the distance from the station was unchanged.

Section 6.6.1.b.4 of the ODCM requires identification of the cause(s) for the unavailability of milk or leafy vegetation samples, and the identification of new locations for obtaining replacement samples. All milk samples were collected as required. Vegetation samples were not collected from stations 14B, 15, 16, 23 and 26 from January through March and December due to seasonal unavailability. All other vegetation samples were obtained.

Attachment 8 contains the results of samples associated with ground water protection sampling undertaken at North Anna to

voluntarily comply with the Nuclear Energy Institute, NEI, Ground Water Protection Initiative. In addition to the well, river, and surface water samples included as part of the Radiological Environmental Monitoring Program, North Anna obtained subsurface water samples from various locations on the site.

Attachment 9 contains an explanation of the bases for the carbon-14 calculations performed to assess doses due to carbon-14. Doses and %TS for gaseous releases are displayed with C-14 included and without for comparison of the values.

ATTACHMENT 1

EFFLUENT RELEASE DATA

(01/16 - 12/16)

This attachment includes a summary of the quantities of radioactive liquid and gaseous effluents and solid waste, as outlined in Regulatory Guide 1.21, Appendix B, except that in accordance with Step 6.7.2.a.1 of the ODCM liquid and gaseous data is summarized on a quarterly basis and solid waste is summarized on an annual basis.

TABLE 1A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF ALL GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

	UNITS	1 ST QUARTER	2 ND QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Gases				
1. Total Release	Curies	8.11E-01	3.43E-02	1.80E+1
2. Average Release Rate For Period	µCi/sec	1.03E-01	4.37E-03	
B. Iodines:				
1. Total Iodine-131 Release	Curies	4.09E-05	0.00E+00	2.80E+1
2. Average Release Rate For Period	µCi/sec	5.20E-06	0.00E+00	
C. Particulate ($T_{1/2}$ > 8 days):				
1. Total Particulate ($T_{1/2}$ > 8 days) Release	Curies	1.36E-05	0.00E+00	2.80E+1
2. Average Release Rate For Period	µCi/sec	1.73E-06	0.00E+00	
3. Gross Alpha Radioactivity Release	Curies	1.44E-07	8.65E-08	
D. Tritium:				
1. Total Release	Curies	5.19E+00	6.11E+00	3.10E+1
2. Average Release Rate For Period	µCi/sec	6.59E-01	7.77E-01	
E. Carbon-14				
1. Total Release	Curies	2.48E+01	1.05E+00	
2. Average Release Rate For Period	µCi/sec	3.15E+00	1.34E-01	
F. Percentage Of Technical Specification Limits				
1. Total Body Dose Rate	%	6.41E-05	1.12E-07	
2. Skin Dose Rate	%	3.02E-05	1.23E-06	
3. Critical Organ Dose Rate (with C-14)	%	1.66E-02	9.24E-04	
Critical Organ Dose Rate (without C-14)	%	4.90E-04	5.39E-04	

TABLE 1A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF ALL GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

	UNITS	3 RD QUARTER	4 TH QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Gases				
1. Total Release	Curies	6.77E-02	2.28E-02	1.80E+1
2. Average Release Rate For Period	µCi/sec	8.52E-03	2.87E-03	
B. Iodines:				
1. Total Iodine-131 Release	Curies	0.00E+00	0.00E+00	2.80E+1
2. Average Release Rate For Period	µCi/sec	0.00E+00	0.00E+00	
C. Particulate ($T_{1/2}$ > 8 days):				
1. Total Particulate ($T_{1/2}$ > 8 days) Release	Curies	7.93E-07	3.25E-06	2.80E+1
2. Average Release Rate For Period	µCi/sec	9.98E-08	4.09E-07	
3. Gross Alpha Radioactivity Release	Curies	2.11E-07	3.10E-07	
D. Tritium:				
1. Total Release	Curies	1.02E+01	1.96E+01	3.10E+1
2. Average Release Rate For Period	µCi/sec	1.28E+00	2.47E+00	
F. Carbon-14				
1. Total Release	Curies	2.08E+00	7.01E-01	
2. Average Release Rate For Period	µCi/sec	2.62E-01	8.82E-02	
F. Percentage Of Technical Specification Limits				
1. Total Body Dose Rate	%	2.18E-06	1.10E-07	
2. Skin Dose Rate	%	1.54E-06	8.56E-07	
3. Critical Organ Dose Rate (with C-14)	%	2.10E-03	1.92E-03	
Critical Organ Dose Rate (without C-14)	%	8.76E-04	1.64E-03	

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	N/D	N/D
Krypton - 85m	Ci	N/D	N/D	N/D	N/D
Krypton - 87	Ci	N/D	N/D	N/D	N/D
Krypton - 88	Ci	N/D	N/D	N/D	N/D
Xenon - 131m	Ci	N/D	N/D	N/D	N/D
Xenon - 133	Ci	2.43E-01	7.61E-03	1.92E-01	4.78E-03
Xenon - 133m	Ci	N/D	N/D	2.44E-03	N/D
Xenon - 135	Ci	4.10E-03	N/D	1.13E-01	5.76E-03
Xenon - 135m	Ci	N/D	N/D	N/D	N/D
Xenon - 137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)		N/D	N/D	N/D	N/D
Argon - 41	Ci	7.77E-03	1.62E-02	1.55E-01	N/D
Total For Period	Ci	2.55E-01	2.38E-02	4.63E-01	1.05E-02
Iodines:					
Iodine - 130	Ci	N/D	N/D	N/D	N/D
Iodine - 131	Ci	8.50E-09	N/D	N/D	N/D
Iodine - 132	Ci	N/D	N/D	N/D	N/D
Iodine - 133	Ci	N/D	N/D	N/D	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	8.50E-09	N/D	N/D	N/D
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	N/D	N/D
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	N/D	N/D	N/D	N/D
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D
Cesium - 136	Ci	N/D	N/D	N/D	N/D
Cesium - 137	Ci	N/D	N/D	N/D	N/D

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Particulates: (cont.)					
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Ag-110m	Ci	N/D	N/D	N/D	N/D
Total for Period (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	N/D	N/D
GROSS ALPHA:	Ci	N/D	N/D	N/D	N/D
TRITIUM:	Ci	3.00E-01	9.33E-02	3.21E-02	1.16E-04
CARBON-14	Ci	7.82E+00	7.30E-01	1.42E+01	3.22E-01

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	N/D	N/D
Krypton - 85m	Ci	N/D	N/D	N/D	N/D
Krypton - 87	Ci	N/D	N/D	3.83E-06	N/D
Krypton - 88	Ci	N/D	N/D	N/D	N/D
Xenon - 131m	Ci	N/D	N/D	N/D	N/D
Xenon - 133	Ci	9.47E-03	N/D	3.91E-02	1.00E-02
Xenon - 133m	Ci	N/D	N/D	N/D	N/D
Xenon - 135	Ci	N/D	N/D	1.22E-05	9.39E-05
Xenon - 135m	Ci	N/D	N/D	N/D	N/D
Xenon - 137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	1.44E-05	N/D
Other (Specify)		N/D	N/D	N/D	N/D
Argon - 41	Ci	1.09E-02	4.18E-05	2.03E-03	1.24E-02
Total For Period	Ci	2.04E-02	4.18E-05	4.11E-02	2.25E-02
Iodines:					
Iodine - 130	Ci	N/D	N/D	N/D	N/D
Iodine - 131	Ci	N/D	N/D	N/D	N/D
Iodine - 132	Ci	N/D	N/D	N/D	N/D
Iodine - 133	Ci	N/D	N/D	N/D	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	N/D	N/D
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	N/D	N/D
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	N/D	N/D	N/D	N/D
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 85	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Silver-110m	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D
Cesium - 137	Ci	N/D	N/D	N/D	N/D

TABLE 1B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
MIXED MODE GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Particulates: (cont.)					
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Total for Period (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	N/D	N/D
GROSS ALPHA:	Ci	N/D	N/D	N/D	N/D
TRITIUM:	Ci	2.59E-01	1.09E+00	2.96E-02	8.67E-05
CARBON-14	Ci	6.26E-01	1.28E-03	1.26E+00	6.90E-01

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	N/D	N/D
Krypton - 85m	Ci	N/D	N/D	1.49E-04	N/D
Krypton - 87	Ci	N/D	N/D	8.79E-05	N/D
Krypton - 88	Ci	N/D	N/D	2.04E-04	N/D
Xenon - 131m	Ci	N/D	N/D	N/D	N/D
Xenon - 133	Ci	N/D	N/D	6.35E-02	1.11E-05
Xenon - 133m	Ci	N/D	N/D	4.50E-04	N/D
Xenon - 135	Ci	N/D	N/D	2.86E-03	N/D
Xenon - 135m	Ci	N/D	N/D	6.96E-06	N/D
Xenon - 137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Argon - 41	Ci	N/D	N/D	2.56E-02	N/D
Total For Period	Ci	N/D	N/D	9.28E-02	1.11E-05
Iodines:					
Iodine - 130	Ci	N/D	N/D	N/D	N/D
Iodine - 131	Ci	4.09E-05	N/D	N/D	N/D
Iodine - 132	Ci	1.00E-04	N/D	2.19E-04	N/D
Iodine - 133	Ci	N/D	N/D	N/D	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	1.41E-04	N/D	2.19E-04	N/D
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	N/D	N/D
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	3.15E-06	N/D	3.27E-06	N/D
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Particulates: (cont.)					
Cesium - 137	Ci	N/D	N/D	N/D	N/D
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Ruthenium-103 (T1/2 > 8 days)	Ci	1.54E-06	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Niobium-95	Ci	N/D	N/D	N/D	N/D
Zirconium-95	Ci	N/D	N/D	N/D	N/D
Tellurium-131m (T1/2 < 8 days)	Ci	N/D	N/D	3.05E-05	N/D
Yttrium-91m (T1/2 < 8 days)	Ci	N/D	N/D	1.87E-07	N/D
Chromium-51	Ci	N/D	N/D	5.63E-06	N/D
Total for Period (T1/2 > 8 days)	Ci	4.70E-06	N/D	8.89E-06	N/D
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	3.06E-05	N/D
Total For Period	Ci	4.70E-06	0.00E+00	3.95E-05	0.00E+00
GROSS ALPHA:	Ci	1.44E-07	8.65E-08	N/D	N/D
TRITIUM:	Ci	1.75E+00	5.92E+00	3.11E+00	9.69E-02
CARBON-14	Ci	N/D	N/D	2.85E+00	3.41E-04

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Fission & Activation Gases:					
Krypton - 85	Ci	N/D	N/D	N/D	N/D
Krypton - 85m	Ci	N/D	N/D	1.03E-05	N/D
Krypton - 87	Ci	N/D	N/D	N/D	N/D
Krypton - 88	Ci	N/D	N/D	1.74E-06	N/D
Xenon - 131m	Ci	N/D	N/D	N/D	N/D
Xenon - 133	Ci	N/D	N/D	4.68E-03	2.95E-04
Xenon - 133m	Ci	N/D	N/D	1.35E-04	N/D
Xenon - 135	Ci	N/D	N/D	9.26E-04	N/D
Xenon - 135m	Ci	N/D	N/D	N/D	N/D
Xenon-137	Ci	N/D	N/D	N/D	N/D
Xenon - 138	Ci	N/D	N/D	N/D	N/D
Other (Specify)	Ci				
Argon - 41	Ci	N/D	N/D	4.91E-04	N/D
Total For Period	Ci	N/D	N/D	6.24E-03	2.95E-04
Iodines:					
Iodine - 130	Ci	N/D	N/D	5.71E-08	N/D
Iodine - 131	Ci	N/D	N/D	N/D	N/D
Iodine - 132	Ci	N/D	N/D	N/D	N/D
Iodine - 133	Ci	N/D	N/D	N/D	N/D
Iodine - 134	Ci	N/D	N/D	N/D	N/D
Iodine - 135	Ci	N/D	N/D	N/D	N/D
Total For Period	Ci	N/D	N/D	5.71E-08	N/D
Particulates:					
Manganese - 54	Ci	N/D	N/D	N/D	N/D
Cobalt - 58	Ci	N/D	N/D	N/D	7.75E-07
Iron - 59	Ci	N/D	N/D	N/D	N/D
Cobalt - 60	Ci	N/D	N/D	7.93E-07	1.50E-06
Zinc - 65	Ci	N/D	N/D	N/D	N/D
Strontium - 89	Ci	N/D	N/D	N/D	N/D
Strontium - 90	Ci	N/D	N/D	N/D	N/D
Cesium - 134	Ci	N/D	N/D	N/D	N/D

TABLE 1C
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
GROUND LEVEL GASEOUS EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Particulates: (cont.)					
Cesium - 137	Ci	N/D	N/D	N/D	1.42E-07
Barium - Lanthanum - 140	Ci	N/D	N/D	N/D	N/D
Cerium - 141	Ci	N/D	N/D	N/D	N/D
Cerium - 144	Ci	N/D	N/D	N/D	N/D
Other (Specify)					
Strontium-91 (T1/2 < 8 days)	Ci	N/D	N/D	5.00E-07	N/D
Rubidium-88 (T1/2 < 8 days)	Ci	N/D	N/D	2.77E-07	N/D
Niobium-95 (T1/2 > 8 days)	Ci	N/D	N/D	4.70E-11	8.32E-07
Ru-103 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/D
Rhodium-105 (T1/2 < 8 days)	Ci	N/D	N/D	N/D	6.86E-11
Ruthenium-105 (T1/2 < 8 days)	Ci	N/D	N/D	N/D	4.89E-10
Total for Period (T1/2 > 8 days)	Ci	N/D	N/D	7.93E-07	3.25E-06
Total for Period (T1/2 < 8 days)	Ci	N/D	N/D	7.77E-07	5.58E-10
Total For Period	Ci	0.00E+00	0.00E+00	1.57E-06	3.25E-06
GROSS ALPHA:	Ci	2.11E-07	3.10E-07	N/D	N/D
TRITIUM:	Ci	6.72E+00	1.78E+01	3.16E+00	7.05E-01
CARBON-14	Ci	N/D	N/D	1.91E-01	9.05E-03

TABLE 2A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT - SUMMATION OF ALL RELEASES FOR (01/16 - 12/16)

	UNITS	1 ST QUARTER	2 ND QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Products:				
1. Total Release (not including tritium, noble gas, and gross alpha).	Curies	3.80E-03	1.13E-02	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	1.36E-11	1.50E-11	
3. Percent of applicable limit (T.S.)	%	2.20E-05	2.18E-05	
B. Tritium:				
1. Total release activity.	Curies	9.78E+02	3.58E+02	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	3.49E-06	4.75E-07	
3. Percent of applicable limit (T.S.)	%	3.49E-02	4.75E-03	
C. Dissolved and Entrained Gases:				
1. Total release activity.	Curies	0.00E+00	0.00E+00	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	0.00E+00	0.00E+00	
3. Percent of applicable limit (T.S.)	%	0.00E+00	0.00E+00	
D. Gross Alpha Radioactivity:				
1. Total release activity.	Curies	0.00E+00	0.00E+00	2.00E+01
E. Volume of waste released: (prior to dilution).	Liters	9.79E+07	1.01E+08	3.00E+00
F. Total volume of dilution water used during the period.	Liters	2.80E+11	7.54E+11	3.00E+00

TABLE 2A
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT - SUMMATION OF ALL RELEASES FOR (01/16 - 12/16)

	UNITS	3 RD QUARTER	4 TH QUARTER	ESTIMATED TOTAL PERCENT ERROR (%)
A. Fission and Activiation Products:				
1. Total Release (not including tritium, noble gas, and gross alpha).	Curies	1.15E-02	7.58E-03	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	1.47E-11	1.21E-11	
3. Percent of applicable limit (T.S.)	%	1.99E-05	1.52E-05	
B. Tritium:				
1. Total release activity.	Curies	8.19E+02	1.42E+01	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	1.05E-06	2.26E-08	
3. Percent of applicable limit (T.S.)	%	1.05E-02	2.26E-04	
C. Dissolved and Entrained Gases:				
1. Total release activity.	Curies	0.00E+00	0.00E+00	2.00E+01
2. Average diluted concentration during the period.	µCi/ml	0.00E+00	0.00E+00	
3. Percent of applicable limit (T.S.)	%	0.00E+00	0.00E+00	
D. Gross Alpha Radioactivity:				
1. Total release activity.	Curies	0.00E+00	0.00E+00	2.00E+01
E. Volume of waste released: (prior to dilution).	Liters	9.08E+07	1.15E+08	3.00E+00
F. Total volume of dilution water used during the period.	Liters	7.83E+11	6.28E+11	3.00E+00

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Fission & Activation Products:					
Manganese - 54	Ci	N/D	N/D	N/A	N/A
Iron - 59	Ci	N/D	1.18E-04	N/A	N/A
Cobalt - 58	Ci	2.35E-03	7.22E-03	N/A	N/A
Cobalt - 60	Ci	1.42E-03	3.78E-03	N/A	N/A
Strontium - 89	Ci	N/D	N/D	N/A	N/A
Strontium - 90	Ci	N/D	N/D	N/A	N/A
Niobium - 95	Ci	N/D	8.24E-05	N/A	N/A
Antimony-124	Ci	N/D	N/D	N/A	N/A
Silver - 110m	Ci	N/D	7.04E-05	N/A	N/A
Iodine - 131	Ci	N/D	N/D	N/A	N/A
Iodine - 133	Ci	N/D	N/D	N/A	N/A
Cesium - 134	Ci	N/D	N/D	N/A	N/A
Cesium - 137	Ci	2.55E-05	N/D	N/A	N/A
Barium-Lathanum - 140	Ci	N/D	N/D	N/A	N/A
Cerium - 141	Ci	N/D	N/D	N/A	N/A
Tellurium-125m	Ci	N/D	N/D	N/A	N/A
Niickel - 63 (T1/2 > 8 days)	Ci	N/D	N/D	N/A	N/A
Antimony-125	Ci	N/D	N/D	N/A	N/A
Total for Period	Ci	3.80E-03	1.13E-02	N/A	N/A

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	1ST QUARTER	2ND QUARTER	1ST QUARTER	2ND QUARTER
Dissolved & Entrained Noble Gases:					
Xenon - 133	Ci	N/D	N/D	N/A	N/A
Xenon - 133m	Ci	N/D	N/D	N/A	N/A
Xenon - 135	Ci	N/D	N/D	N/A	N/A
Xenon - 135m	Ci	N/D	N/D	N/A	N/A
Other (Specify)	Ci	N/D	N/D	N/A	N/A
Krypton-88 (T1/2 < 8 days)	Ci	N/D	N/D	N/A	N/A
Krypton-85 (T1/2 > 8 days)	Ci	N/D	N/D	N/A	N/A
Total for Period	Ci	N/D	N/D	N/A	N/A
Tritium	Ci	9.78E+02	3.58E+02	N/A	N/A
Gross Alpha	Ci	N/D	N/D	N/A	N/A

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Fission & Activation Products:					
Manganese - 54	Ci	1.34E-04	3.51E-05	N/D	N/A
Iron - 59	Ci	N/D	N/D	N/D	N/A
Cobalt - 58	Ci	7.55E-03	5.47E-03	1.24E-06	N/A
Cobalt - 60	Ci	3.41E-03	2.04E-03	2.36E-06	N/A
Strontium - 89	Ci	N/D	N/D	N/D	N/A
Strontium - 90	Ci	N/D	N/D	N/D	N/A
Niobium - 95	Ci	8.57E-05	3.00E-05	4.41E-07	N/A
Zirconium - 95	Ci	N/D	N/D	N/D	N/A
Silver - 110m	Ci	4.63E-05	N/D	N/D	N/A
Iodine - 131	Ci	N/D	N/D	N/D	N/A
Iodine - 133	Ci	N/D	N/D	N/D	N/A
Cesium - 134	Ci	N/D	N/D	N/D	N/A
Cesium - 137	Ci	1.98E-05	N/D	2.26E-06	N/A
Barium-Lathanum - 140	Ci	N/D	N/D	N/D	N/A
Cerium - 141	Ci	N/D	N/D	N/D	N/A
Chromium-51	Ci	2.23E-04	N/D	N/D	N/A
Nickel - 63 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/A
Antimony-122 (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/A
Antimony-125 (T1/2 > 8 days)	Ci		N/D	2.52E-05	N/A
Antimony-124 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/A
Tellurium-125m (T1/2 > 8 days)	Ci		N/D	5.81E-06	N/A
Total for Period	Ci	1.15E-02	7.58E-03	3.73E-05	N/A

TABLE 2B
NORTH ANNA POWER STATION
ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT
LIQUID EFFLUENT RELEASES FOR (01/16 - 12/16)

		CONTINUOUS MODE		BATCH MODE	
NUCLIDES RELEASED	UNITS	3RD QUARTER	4TH QUARTER	3RD QUARTER	4TH QUARTER
Dissolved & Entrained Noble Gases:					
Xenon - 133	Ci	N/D	N/D	N/D	N/A
Xenon - 133m	Ci	N/D	N/D	N/D	N/A
Xenon - 135	Ci	N/D	N/D	N/D	N/A
Xenon - 135m	Ci	N/D	N/D	N/D	N/A
Other (Specify)					
Argon - 41 (T1/2 < 8 days)	Ci	N/D	N/D	N/D	N/A
Krypton - 85 (T1/2 > 8 days)	Ci	N/D	N/D	N/D	N/A
Total for Period	Ci	N/D	N/D	N/D	N/A
Tritium	Ci	8.19E+02	1.42E+01	7.40E-03	N/A
Gross Alpha	Ci	N/D	N/D	N/D	N/A

TABLE 3
NORTH ANNA POWER STATION
RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS
FOR 01-01-16 THROUGH 12-31-16

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (NOT IRRADIATED FUEL)				
1. Type of Waste		Unit	12-Month Period	Estimated Total Percent Error (%)
a.	Spent resins, sludges, filters sludge, evaporator bottoms, etc.,	m^3	1.80E+01 *	2.50E+01
		Ci	8.92E+01	2.50E+01
b.	Dry compressible waste, contaminated equipment, etc.,	m^3	8.31E+02 **	2.50E+01
		Ci	1.73E+00	2.50E+01
c.	Irradiated components, control rods, etc.,	m^3	0.00E+00 ***	2.50E+01
		Ci	0.00E+00	2.50E+01
d.	Other (describe)			
	Used oil/Blast media/Sewage/Gravel	m^3	2.87E+00 ****	2.50E+01
	Dessicant/Soil/Construction debris	Ci	2.27E-05	2.50E+01
	Animal Carcasses			

2. Estimate of major nuclide composition (by type of waste)		(%)	(Ci)	Estimated Total Percent Error (%)
a.	Co-60	4.44E+01	3.96E+01	2.50E+01
	Fe-55	1.50E+01	1.34E+01	2.50E+01
	Ni-63	1.17E+01	1.04E+01	2.50E+01
	Cs-137	6.76E+00	6.04E+00	2.50E+01
	Mn-54	5.55E+00	4.96E+00	2.50E+01
	Co-58	5.41E+00	4.83E+00	2.50E+01
	Cs-134	2.56E+00	2.28E+00	2.50E+01
	Nb-95	2.03E+00	1.82E+00	2.50E+01
	Zn-65	1.25E+00	1.12E+00	2.50E+01
	Cr-51	1.11E+00	9.90E-01	2.50E+01
	Zr-95	1.07E+00	9.53E-01	2.50E+01
	Be-7	7.10E-01	6.37E-01	2.50E+01
	Eu-154	7.00E-01	6.24E-01	2.50E+01
	Sb-125	6.40E-01	5.67E-01	2.50E+01
	C-14	5.50E-01	4.89E-01	2.50E+01
b.	Co-60	2.61E+01	4.50E-01	2.50E+01
	Cs-137	1.88E+01	3.24E-01	2.50E+01
	Nb-95	1.63E+01	2.82E-01	2.50E+01
	Zr-95	1.18E+01	2.03E-01	2.50E+01
	Fe-55	8.14E+00	1.41E-01	2.50E+01
	Cr-51	4.52E+00	7.81E-02	2.50E+01
	Ni-63	4.21E+00	7.27E-02	2.50E+01
	Co-58	3.62E+00	6.25E-02	2.50E+01
	H-3	2.04E+00	3.53E-02	2.50E+01
	Mn-54	1.52E+00	2.62E-02	2.50E+01
	Sb-125	4.50E-01	7.76E-03	2.50E+01
	Zn-65	3.90E-01	6.65E-03	2.50E+01
	C-14	3.80E-01	6.59E-03	2.50E+01
	Sn-113	3.40E-01	5.87E-03	2.50E+01
	Tc-99	3.40E-01	5.82E-03	2.50E+01
	Ce-144	2.60E-01	4.51E-03	2.50E+01
c.	NONE			
d.	H-3	9.83E+01	4.63E-06	2.50E+01
	Ce-144	8.10E-01	3.80E-08	2.50E+01
	Cs-137	4.20E-01	1.99E-08	2.50E+01
	Co-60	2.90E-01	1.36E-08	2.50E+01

TABLE 3
NORTH ANNA POWER STATION
RADIOACTIVE EFFLUENT RELEASE REPORT
SUMMATION OF SOLID RADIOACTIVE WASTE
AND IRRADIATED FUEL SHIPMENTS
01-01-16 THROUGH 12-31-16

3. **Solid Waste Disposition**

Number of Shipments	Mode of Transportation	Destination
2	Truck	Clive, UT
35	Truck	Oak Ridge, TN

B. Irradiated Fuel Shipments (Disposition)

Number of Shipments	Mode of Transportation	Destination
0	N/A	N/A

* (4) shipments containing resins were shipped to a licensed waste processor for final dewatering and disposal
(1) shipment containing mechanical filters was shipped to a licensed waste facility for disposal
(1) shipment containing mechanical filters was shipped to a licensed waste processor for processing

** (31) shipments containing dry compactable waste were shipped to a licensed waste processor for processing
(1) shipment containing dry compactable waste was shipped to a licensed waste facility for disposal

*** None

**** (1) shipment containing used oil was shipped to a licensed waste disposal facility for processing
(1) shipment containing used blast media was shipped to a licensed waste disposal facility for disposal.

ATTACHMENT 2

ANNUAL AND QUARTERLY DOSES

(01/16 - 12/16)

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 this report, along with an annual total of each effluent pathway will be made as required by ODCM Section 6.7.2.

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Total Body Dose (mrem)	3.46E-1	1.27E-1	2.89E-1	5.12E-3	7.67E-1
Critical Organ Dose (mrem)	3.46E-1	1.27E-1	2.89E-1	5.22E-3	7.67E-1

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual Total
Noble Gas Gamma Dose (mrad)	1.52E-4	6.31E-6	7.61E-6	4.56E-6	1.70E-4
Noble Gas Beta Dose (mrad)	9.60E-5	3.06E-6	6.22E-6	2.05E-6	1.07E-4
Critical Organ (Child bone) Dose for I-131, I-133, H-3, Particulates with T½ > 8 days (including C-14) (mrem)	1.08E+0	3.80E-2	3.07E-2	3.41E-2	1.18E+0
Critical Organ (Child thyroid) Dose for I-131, I-133, H-3, Particulates with T½ > 8 days (excluding C-14) (mrem)	1.25E-2	3.25E-3	4.96E-3	1.02E-2	3.09E-2

ATTACHMENT 3

REVISIONS TO OFFSITE DOSE CALCULATION MANUAL

(ODCM)

(01/16 - 12/16)

As required by Technical Specification 5.5.1.c, revisions to the ODCM, effective for the time period covered by this report, are summarized in this attachment.

There were no revisions to the ODCM during this reporting period.

ATTACHMENT 4

MAJOR CHANGES TO RADIOACTIVE LIQUID, GASEOUS, AND SOLID WASTE TREATMENT SYSTEMS

(01/16 - 12/16)

As required by the ODCM, Section 6.7.2.a.4, major changes to radioactive liquid, gaseous and solid waste treatment systems for the time period covered by this report are synopsized in this attachment. Supporting information as to the reason(s) for the change(s) and a summary of the 10 CFR 50.59 evaluations are included, as applicable.

There were no major changes to the radioactive liquid, gaseous, and solid waste treatment systems for 2016.

ATTACHMENT 5

INOPERABILITY OF RADIOACTIVE LIQUID AND GASEOUS

EFFLUENT MONITORING INSTRUMENTATION

(01/16 - 12/16)

As required by the ODCM, Sections 6.2.2.b.2 and 6.3.2.b.3, a list and explanation for extended inoperability of radioactive liquid and/or gaseous effluent monitoring instrumentation is provided in this attachment.

There was no liquid and/or gaseous effluent monitoring instrumentation inoperable for an extended period, greater than thirty consecutive days, during the reporting period.

ATTACHMENT 6

UNPLANNED RELEASES

(01/16 - 12/16)

As required by the ODCM, Section 6.7.2.a.3, a list of unplanned releases, from the site to unrestricted areas, of radioactive material in gaseous and liquid effluents occurring during the reporting period, is made in this attachment.

There were no unplanned releases during calendar year 2016 meeting the criteria of Section 6.7.2.a.3 of the ODCM from the site to unrestricted areas. Also, there were no spills or leaks that required voluntary communication under the criteria of the NEI Ground Water Protection Initiative, NEI 07-07. Elevated results indicated in Attachment 8 are from the on-going investigation/ mitigation for the voluntary communication made in 2010. The hydrological modeling indicates the horizontal groundwater movement around well #6 is < 1 inch per day.

ATTACHMENT 7
LOWER LIMITS OF DETECTION FOR EFFLUENT SAMPLE ANALYSIS
(01/16 - 12/16)

Gaseous Effluents:

Radioisotope	Required L.L.D. µCi/mL	Typical L.L.D. µCi/mL
Krypton - 87	1.00E-4	2.50E-8 - 7.50E-8
Krypton - 88	1.00E-4	4.00E-8 - 2.50E-7
Xenon - 133	1.00E-4	2.00E-8 - 1.00E-7
Xenon - 133m	1.00E-4	1.00E-7 - 4.00E-7
Xenon - 135	1.00E-4	1.00E-8 - 5.00E-8
Xenon - 135m	1.00E-4	5.00E-8 - 2.00E-7
Xenon - 138	1.00E-4	9.00E-8 - 4.00E-7
Iodine - 131	1.00E-12	3.00E-14 - 1.00E-13
Iodine - 133	1.00E-10	1.00E-14 - 7.00E-13
Manganese - 54	1.00E-11	2.00E-14 - 6.00E-14
Cobalt - 58	1.00E-11	2.00E-14 - 6.00E-14
Iron - 59	1.00E-11	6.00E-14 - 1.00E-13
Cobalt - 60	1.00E-11	3.00E-14 - 1.00E-13
Zinc - 65	1.00E-11	6.00E-14 - 2.00E-13
Strontium - 89	1.00E-11	3.00E-14 - 8.00E-12
Strontium - 90	1.00E-11	3.00E-15 - 9.00E-12
Molybdenum - 99	1.00E-11	2.00E-14 - 1.00E-13
Cesium - 134	1.00E-11	2.00E-14 - 8.00E-14
Cesium - 137	1.00E-11	3.00E-14 - 8.00E-14
Cerium - 141	1.00E-11	3.00E-14 - 1.00E-13
Cerium - 144	1.00E-11	1.50E-13 - 4.00E-13
Gross Alpha	1.00E-11	7.00E-15 - 2.00E-14
Tritium	1.00E-6	4.00E-09 - 9.00E-09

ATTACHMENT 7
LOWER LIMITS OF DETECTION FOR EFFLUENT SAMPLE ANALYSIS
(01/16 - 12/16)

Liquid Effluents:

Radioisotope	Required L.L.D. µCi/mL	Typical L.L.D. µCi/mL
Krypton - 87	1.00E-5	3.00E-8 - 1.00E-7
Krypton - 88	1.00E-5	5.00E-8 - 5.00E-7
Xenon - 133	1.00E-5	3.00E-8 - 1.00E-7
Xenon - 133m	1.00E-5	9.00E-8 - 3.00E-7
Xenon - 135	1.00E-5	1.00E-8 - 5.00E-8
Xenon - 135m	1.00E-5	3.00E-8 - 2.00E-7
Xenon - 138	1.00E-5	1.00E-7 - 1.00E-6
Iodine - 131	1.00E-6	1.00E-8 - 5.00E-8
Manganese - 54	5.00E-7	1.00E-8 - 5.00E-8
Iron - 55	1.00E-6	3.00E-7 - 8.00E-7
Cobalt - 58	5.00E-7	1.50E-8 - 6.00E-8
Iron - 59	5.00E-7	3.00E-8 - 7.00E-8
Cobalt - 60	5.00E-7	1.00E-8 - 5.50E-8
Zinc - 65	5.00E-7	3.00E-8 - 6.00E-8
Strontium - 89	5.00E-8	1.00E-8 - 4.00E-8
Strontium - 90	5.00E-8	5.00E-9 - 9.00E-9
Molybdenum - 99	5.00E-7	2.00E-8 - 6.00E-8
Cesium - 134	5.00E-7	1.50E-8 - 5.00E-8
Cesium - 137	5.00E-7	1.50E-8 - 6.00E-8
Cerium - 141	5.00E-7	3.00E-8 - 9.00E-8
Cerium - 144	5.00E-7	1.00E-7 - 5.00E-7
Gross Alpha	1.00E-7	2.00E-8 - 7.00E-8
Tritium	1.00E-5	2.00E-6 - 5.00E-6

ATTACHMENT 8

RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS (01/16 - 12/16)

The Ground Water Protection Program was established to improve North Anna's management of and response to instances where the inadvertent release of radioactive substances may result in low but detectible levels of plant-related materials in subsurface soils and water. It complies with the requirements of NEI 07-07, INDUSTRY GROUND WATER PROTECTION INITIATIVE - FINAL GUIDANCE DOCUMENT. The industry initiative is intended to improve public trust and confidence in the nuclear industry through sampling and analysis of ground water and timely and effective communication with stakeholders, including the public and local, state, and federal officials.

Samples are obtained from monitoring wells installed both inside and outside the restricted area on a quarterly basis and analyzed onsite. Annually, during the second quarter, these samples are analyzed by an Independent Lab. Samples are also obtained from sumps and yard drains on a quarterly basis and analyzed onsite. Samples may be obtained more frequently than normal, if required and may be analyzed on-site or by an Independent Lab. The required Lower Limits of Detection, LLDs, and reporting limits for the ground water detection program are those associated with the radiological environmental program as listed in Attachments 11 and 12 to VPAP-2103N.

On the following pages is a summary of the samples and results of the ground water protection program taken for calendar year 2016. All liquid results are reported in pCi/L, while soil results for tritium are reported in pCi/g of soil, wet. An "N/A" indicates a sample analysis was not performed for that sample. An "N/D" indicates an analysis was performed but the result was less than the Minimum Detectable Activity, MDA, and the required LLD. If a result is greater than the MDA, but less than the LLD the result is listed. Some of these results may be false positives, due to the analysis software or interferences from naturally occurring radioactivity. In these cases, instead of the value, an explanatory footnote is provided.

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/16 - 12/16)

1st Quarter 2016

Sample	Date	Sample Media	H-3[1]	Gamma –Emitting Particulates[1]	I-131[1]	Sr-89/90[1]	Fe-55[1]	Ni-63[1]	Alpha TRU[1]	Pu-241[1]
PZ-3	01/15/16	WATER	3227	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	02/23/16	WATER	4112	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	03/19/16	WATER	4064	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-3	03/18/16	WATER	<967	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-4	03/21/16	WATER	1239	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-5A	03/18/16	WATER	<804	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	01/15/16	WATER	4320	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	02/23/16	WATER	6347	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	02/26/16	WATER	8133	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	03/03/16	WATER	7978	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	03/11/16	WATER	6615	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	03/19/16	WATER	4832	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	03/26/16	WATER	5418	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	03/31/16	WATER	6587	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-7	03/19/16	WATER	<928	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-8	03/18/16	WATER	<851	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-9	03/18/16	WATER	<987	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-13	03/18/16	WATER	<1022	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-14	03/18/16	WATER	<813	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-15	03/30/16	WATER	<862	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-16	03/18/16	WATER	<812	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-17	03/20/16	WATER	<770	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	01/15/16	WATER	1931	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP18	02/23/16	WATER	880	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP18	03/19/16	WATER	2928	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-19	03/20/16	WATER	3251	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-20	03/20/16	WATER	<767	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	01/15/16	WATER	1538	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	02/23/16	WATER	1282	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	03/19/16	WATER	1991	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-22	03/18/16	WATER	<952	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-1	03/25/16	WATER	<857	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-2	03/25/16	WATER	<870	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-4	03/25/16	WATER	<872	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-2	03/25/16	WATER	<883	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-3	03/25/16	WATER	<880	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-5	03/25/16	WATER	<889	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sub Surface Drains	02/23/16	WATER	1334	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Storm Drains	02/17/16	WATER	1515	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Storm Drains	02/17/16	WATER	1538	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disch Canal Storm Drains	02/17/16	WATER	1481	N/A	N/A	N/A	N/A	N/A	N/A	N/A

U-1 Mat Sump East	03/03/16	WATER	<1301	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	03/23/16	WATER	<901	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	03/03/16	WATER	<1355	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	03/23/16	WATER	<907	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Inside	03/03/16	WATER	<1299	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Inside	03/23/16	WATER	<899	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Outside	03/03/16	WATER	<1322	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Outside	03/23/16	WATER	<903	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 AB/FB GWMS	03/03/16	WATER	<1307	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 AB/FB GWMS	03/23/16	WATER	<915	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 AB/FB GWMS	03/03/16	WATER	<1307	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 AB/FB GWMS	03/23/16	WATER	<903	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-1	03/18/16	WATER	Insufficient Volume to Sample							
PZ-2	03/18/16	WATER	Insufficient Volume to Sample							
TTW-1	Well abandoned in place, pending decommissioning.									
TTW-4	Well abandoned in place, pending decommissioning									

(1) pCi/L

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/16 - 12/16)

2nd Quarter 2016

Sample	Date	Sample Media	H-3[1]	Gamma –Emitting Particulates[1]	I-131[1]	Sr-89/90[1]	Fe-55[1]	Ni-63[1]	Alpha TRU[1]	Pu-241[1]
PZ-3	04/22/16	WATER	4956	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	06/02/16	WATER	5200	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	06/28/16	WATER	1900	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3[2]	06/28/16	WATER	2710	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-3[2]	06/09/16	WATER	1580	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-4[2]	06/09/16	WATER	2780	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-5A[2]	06/09/16	WATER	<1050	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	04/09/16	WATER	4859	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	04/22/16	WATER	6733	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	05/04/16	WATER	3639	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	06/02/16	WATER	7000	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	06/09/16	WATER	5966	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6[2]	06/09/16	WATER	8250	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-7[2]	06/09/16	WATER	<1030	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-8[2]	06/09/16	WATER	<1040	ND	N/A	N/A	N/A	N/A	N/A	N/A
GWP-9[2]	06/09/16	WATER	<1030	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-13[2]	06/28/16	WATER	1870	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-14[2]	06/09/16	WATER	<1040	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-15[2]	06/28/16	WATER	1280	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-16[2]	06/28/16	WATER	1260	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-17[2]	06/28/16	WATER	1650	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	04/22/16	WATER	3381	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	06/02/16	WATER	4133	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	06/28/16	WATER	4271	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18[2]	06/28/16	WATER	2570	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-19[2]	06/22/16	WATER	3800	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-20[2]	06/22/16	WATER	2910	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	04/22/16	WATER	1136	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	06/02/16	WATER	2153	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	06/28/16	WATER	1637	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21[2]	06/28/16	WATER	<1050	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-22[2]	06/22/16	WATER	<1050	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-1[2]	06/29/16	WATER	<1060	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-2[2]	06/29/16	WATER	<1040	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-4[2]	06/29/16	WATER	<1050	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-2[2]	06/29/16	WATER	<1060	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-3[2]	06/29/16	WATER	<1030	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-5[2]	06/29/16	WATER	<1060	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sub Surface Drains	05/11/16	WATER	<1480	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Sample	Date	Sample Media	H-3[1]	Gamma –Emitting Particulates[1]	I-131[1]	Sr-89/90[1]	Fe-55[1]	Ni-63[1]	Alpha TRU[1]	Pu-241[1]
U-1 Intake Storm Drains	05/19/16	WATER	<1530	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Storm Drains	05/19/16	WATER	<1530	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disch Canal Storm Drains	05/19/16	WATER	<1530	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	05/12/16	WATER	<1468	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	05/12/16	WATER	<1458	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Inside	05/12/16	WATER	<1462	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Outside	05/12/16	WATER	<1455	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 AB/FB GWMS	05/12/16	WATER	<1460	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 AB/FB GWMS	05/12/16	WATER	<1455	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-1	06/28/16	WATER	Insufficient Volume to Sample							
PZ-2	06/28/16	WATER	Insufficient Volume to Sample							
TTW-1	Well abandoned in place, pending decommissioning									
TTW-4	Well abandoned in place, pending decommissioning									

(1) pCi/L (2) Vendor Analysis

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/16 - 12/16)

3rd Quarter 2016

Sample	Date	Sample Media	H-3[1]	Gamma –Emitting Particulates[1]	I-131[1]	Sr-89/90[1]	Fe-55[1]	Ni-63[1]	Alpha TRU[1]	Pu-241[1]
PZ-3	07/12/16	WATER	1443	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	08/02/16	WATER	2664	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	08/10/16	WATER	1771	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	09/12/16	WATER	2062	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-3	09/24/16	WATER	<824	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-4	09/24/16	WATER	<840	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-5A	09/24/16	WATER	<820	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	07/12/16	WATER	7399	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	08/02/16	WATER	6674	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	08/10/16	WATER	4797	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	09/12/16	WATER	3322	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-7	09/24/16	WATER	<856	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-8	09/24/16	WATER	<856	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-9	09/24/16	WATER	<849	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-13	09/24/16	WATER	<854	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-14	09/27/16	WATER	<940	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-15	09/27/16	WATER	<929	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-16	09/27/16	WATER	<912	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-17	09/27/16	WATER	1220	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	07/12/16	WATER	1459	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	09/27/16	WATER	1390	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-19	09/27/16	WATER	1310	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-20	09/27/16	WATER	1820	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	07/12/16	WATER	<915	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	09/27/16	WATER	<866	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-22	09/24/16	WATER	<803	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-1	09/27/16	WATER	<906	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-2	09/27/16	WATER	<904	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-4	09/27/16	WATER	<916	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-2	09/27/16	WATER	<1070	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-3	09/27/16	WATER	<912	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-5	09/27/16	WATER	<940	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sub Surface Drains	08/09/16	WATER	<1451	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Storm Drains	08/04/16	WATER	<1540	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Storm Drains	08/04/16	WATER	<1530	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disch Canal Storm Drains	08/04/16	WATER	<1440	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	08/10/16	WATER	<1386	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	09/27/16	WATER	<960	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	08/10/16	WATER	<1443	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	09/27/16	WATER	<942	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Inside	08/10/16	WATER	<1470	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Inside	09/27/16	WATER	<951	N/A	N/A	N/A	N/A	N/A	N/A	N/A

U-2 Mat Sump Outside	08/10/16	WATER	<1427	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Outside	09/27/16	WATER	<957	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 AB/FB GWMS	08/10/16	WATER	<1424	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 AB/FB GWMS	09/27/16	WATER	<839	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 AB/FB GWMS	08/10/16	WATER	<1440	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 AB/FB GWMS	09/27/16	WATER	<955	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-1	09/24/16	WATER	Insufficient volume to sample							
PZ-2	09/24/16	WATER	Insufficient volume to sample							
TTW-1	Well abandoned in place, pending decommissioning									
TTW-4	Well abandoned in place, pending decommissioning									

(1) pCi/L

ATTACHMENT 8
RESULTS OF GROUND WATER PROTECTION INITIATIVE SAMPLE ANALYSIS
(01/16 - 12/16)

4th Quarter 2016

Sample	Date	Sample Media	H-3[(1)]	Gamma –Emitting Particulates[(1)]	I-131[(1)]	Sr-89/90[(1)]	Fe-55[(1)]	Ni-63[(1)]	Alpha TRU[(1)]	Pu-241[(1)]
PZ-3	10/12/16	WATER	2438	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	11/09/16	WATER	4764	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-3	12/21/16	WATER	4933	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-3	11/22/16	WATER	<847	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-4	11/22/16	WATER	<847	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-5A	11/22/16	WATER	<907	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	10/12/16	WATER	2099	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	11/09/16	WATER	1655	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-6	12/21/16	WATER	1373	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-7	11/22/16	WATER	<871	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-8	11/22/16	WATER	<936	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-9	11/22/16	WATER	<918	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-13	11/22/16	WATER	<887	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-14	11/22/16	WATER	<869	ND	ND	N/A	N/A	N/A	N/A	N/A
GWP-15	11/22/16	WATER	<896	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-16	11/22/16	WATER	<929	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-17	11/22/16	WATER	<887	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-18	11/22/16	WATER	3080	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-19	11/22/16	WATER	1250	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-20	11/22/16	WATER	849	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-21	11/22/16	WATER	<851	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GWP-22	11/22/16	WATER	<904	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-1	12/09/16	WATER	<845	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-2	12/09/16	WATER	<817	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BTW-4	12/09/16	WATER	<914	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-2	12/09/16	WATER	<789	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-3	12/09/16	WATER	<793	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TTW-5	12/09/16	WATER	<886	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sub Surface Drains	11/04/16	WATER	<1582	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Intake Storm Drains	11/17/16	WATER	<1415	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Intake Storm Drains	11/17/16	WATER	<1418	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disch Canal Storm Drains	11/17/16	WATER	<1413	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump East	10/20/16	WATER	<819	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 Mat Sump South	10/20/16	WATER	<840	ND	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Inside	10/20/16	WATER	<823	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 Mat Sump Outside	10/20/16	WATER	<838	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-1 AB/FB GWMS	10/20/16	WATER	<815	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U-2 AB/FB GWMS	10/20/16	WATER	<844	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PZ-1	11/22/16	WATER	Insufficient volume to sample							
PZ-2	11/22/16	WATER	Insufficient volume to sample							
TTW-1	Well abandoned in place, pending decommissioning									
TTW-4	Well abandoned in place, pending decommissioning									

(1) pCi/L

ATTACHMENT 9
CARBON-14 CALCULATIONS
(01/16 - 12/16)

Carbon-14, C-14, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Due to the long half-life of C-14, 5730 years, a significant portion of the C-14 from this testing is still present in the environment. C-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing.

In Regulatory Guide 1.21, Revision 2, "Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste", the NRC has recommended that U.S. nuclear power plants evaluate whether C-14 is a "principal radionuclide", and if so, report the amount of C-14 released. At North Anna, improvements over the years in fuel performance have resulted in a decrease in the amount and distribution of radionuclides released to the environment in gaseous effluents. As a result, C-14 has become a "principal radionuclide" for the gaseous effluent pathway at North Anna, as defined in Regulatory Guide 1.21, Revision 2. Because the dose contribution of C-14 to liquid radioactive waste is a small fraction of the dose compared to other nuclides, evaluation of C-14 in liquid effluents is not required by Regulatory Guide 1.21, Revision 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. North Anna utilized methodology in EPRI Report, Estimation of C-14 in Nuclear Power Gaseous Effluents. Based on this document, at full capacity, North Anna would generate and release about 32.8 Ci of C-14 per year. Since the units did not operate at full power for 100% of the year, this value was corrected for the capacity factor of each unit yielding an estimated 28.7 Ci of C-14 produced and released. North Anna assumed that the fractional release of gaseous C-14 in any quarter and pathway could be approximated by the fraction of noble gasses released via that pathway in that quarter.

Most C-14 species initially produced in a Pressurized Water Reactor are organic, e.g., methane. C-14 releases in PWRs occur primarily as a mix of organic carbon and carbon dioxide released from the waste gas system. C-14 in the primary coolant is essentially all organic with a large fraction as a gaseous species. Any time the RCS liquid or gas is exposed to an oxidizing environment, a slow transformation from an organic to an inorganic chemical form can occur. Various studies documenting measured C-14 releases from PWRs suggest a range of 70% to 95% organic. North Anna used a value of 70% organic and 30% CO_2 in its calculations.

Public dose estimates from airborne C-14 were performed using dose models in NUREG-0133 and Regulatory Guide 1.109. The estimated C-14 dose impact on the maximum organ dose from airborne effluents released at North Anna is estimated to be 6.73E-2 mrem from the inhalation pathway, or 4.49E-03% TS of the 1500 mrem/yr dose rate limit and 1.09E+0 mrem from the ingestion pathway or 3.63E+00% TS of the 10CFR50, Appendix I, ALARA design objective of 15 mrem/yr per unit. In both cases the critical organ was determined to be the child's bone.

Miscellaneous

There were no entries on the Annual Effluent Release Report Log for 2016.