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10 CFR 50.36(a)(2)
and 72.44(d)(3)

July 12, 2017

U. S. Nuclear Regulatory Commission
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Washington, DC 20555

Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
NRC Docket Nos. 50-317 and 50-318

Calvert Cliffs Nuclear Power Plant
Independent Spent Fuel Storage Installation, License No. SNM-2505
NRC Docket No. 72-8

Subject: Annual Radioactive Effluent Release Report

References:
1. Calvert Cliffs Unit Nos. 1 and 2 Technical Specification 5.6.3
2. Calvert Cliffs ISFSI Technical Specification 6.3

As required by References 1 and 2, the Annual Radioactive Effluent Release Report is enclosed. Meteorological data is kept in an onsite file and is available upon request.

There are no regulatory commitments contained in this correspondence.

Should you have questions regarding this matter, please contact Mr. Larry D. Smith at (410) 495-5219.

Respectfully,

for Todd A. Tierney
Plant Manager

TAT/PSF/bjm

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NRR

Enclosure: (1) Annual Radioactive Effluent Release Report for Calvert Cliffs Nuclear Power Plant and Independent Spent Fuel Storage Installation

cc: NRC Project Manager, Calvert Cliffs
NRC Regional Administrator, Region I
NRC Resident Inspector, Calvert Cliffs
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Director, NMSS
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ENCLOSURE (1)

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT FOR CALVERT CLIFFS NUCLEAR POWER PLANT AND INDEPENDENT SPENT FUEL STORAGE INSTALLATION - 2016

This report covers the period January 1, 2016 to December 31, 2016 for Calvert Cliffs Nuclear Power Plant.

This report covers the period June 1, 2016 to May 31, 2017 for the Independent Spent Fuel Storage Installation.

Calvert Cliffs Nuclear Power Plant, LLC
July 12, 2017

Facility - Calvert Cliffs Nuclear Power Plant and Independent Spent Fuel Storage Installation
Licensee – Calvert Cliffs Nuclear Power Plant, LLC

This report covers the period January 1, 2016 to December 31, 2016 for Calvert Cliffs Nuclear Power Plant.
This report covers the period June 1, 2016 to May 31, 2017 for the Independent Spent Fuel Storage Installation.

I. REGULATORY LIMITS

A. Fission and Activation Gases

1. The instantaneous release rate of noble gases in gaseous effluents shall not result in a site boundary dose rate greater than 500 mrem/year to the whole body or greater than 3000 mrem/year to the skin (Offsite Dose Calculation Manual (ODCM) Rev. 00900, 3.11.2.1).
2. Gaseous Radwaste Treatment System and the Ventilation Exhaust Treatment System shall be used to reduce gaseous emissions when the calculated gamma-air dose due to gaseous effluents exceeds 1.20 mRad or the calculated beta-air dose due to gaseous effluents exceeds 2.4 mRad at the site boundary in a 92 day period (ODCM 3.11.2.4).
3. The air dose at the site boundary due to noble gases released in gaseous effluents shall not exceed (ODCM 3.11.2.2):

   10 mRad/qtr, gamma-air
   20 mRad/qtr, beta-air
   20 mRad/year, gamma-air
   40 mRad/year, beta-air
4. All of the above parameters are calculated according to the methodology specified in the ODCM.

B. Iodines and Particulates with Half Lives Greater than Eight Days

1. The instantaneous release rate of iodines and particulates in gaseous effluents shall not result in a site boundary dose-rate in excess of 1500 mrem/year to any organ (ODCM 3.11.2.1).
2. The Gaseous Radwaste Treatment System and the Ventilation Exhaust Treatment System shall be used to reduce radioactive materials in gaseous effluents when calculated doses exceed 1.8 mrem to any organ in a 92 day period at or beyond the site boundary (ODCM 3.11.2.4).
3. The dose to a member of the public at or beyond the site boundary from iodine-131 and particulates with half-lives greater than eight days in gaseous effluents shall not exceed (ODCM 3.11.2.3):

   15 mrem/qtr, any organ
   30 mrem/year, any organ
   less than 0.1% of the above limits as a result of burning contaminated oil.
4. All of the above parameters are calculated according to the methodology specified in the ODCM.

C. Liquid Effluents

1. The concentrations of radionuclides in liquid effluents from the plant shall not exceed the values specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for unrestricted areas (ODCM 3.11.1.1).
2. The liquid radwaste treatment system shall be used to reduce the concentration of radionuclides in liquid effluents from the plant when the calculated dose to unrestricted areas exceeds 0.36 mrem to the whole body, or 1.20 mrem to any organ in a 92 day period (ODCM 3.11.1.3).
3. The dose to a member of the public in unrestricted areas shall not exceed (ODCM 3.11.1.2):

   3 mrem/qtr, total body
   10 mrem/qtr, any organ
   6 mrem/year, total body
   20 mrem/year, any organ
4. All liquid dose parameters are calculated according to the methodology specified in the ODCM.

II. MAXIMUM PERMISSIBLE CONCENTRATIONS

A. Fission and Activation Gases

Prior to the batch release of gaseous effluents, a sample of the source is collected and analyzed by gamma spectroscopy for the principal gamma emitting radionuclides. The identified radionuclide concentrations are evaluated and an acceptable release rate is determined to ensure that the dose rate limits of ODCM 3.11.2.1 are not exceeded.

B. Iodines and Particulates with Half Lives Greater than Eight Days

Compliance with the dose rate limitations for iodines and particulates is demonstrated by analysis of the charcoal and particulate samples of the station main vents. The charcoal samples are analyzed by gamma spectroscopy for quantification of radioiodine. The particulate samples are analyzed by gamma spectroscopy for quantification of particulate radioactive material. Monthly composites of the main vent particulate filters are analyzed for gross alpha. Quarterly composites are analyzed for Sr-89 and Sr-90. All of the above parameters are calculated according to the methodology specified in the ODCM. Additionally, two quarterly composites are analyzed for Fe-55; the Fe-55 analysis is not required by the ODCM, but is driven by site procedure.

C. Liquid Effluents

The Maximum Permissible Concentrations (MPCs) used for radioactive materials released in liquid effluents are in accordance with ODCM 3.11.1.1 and the values from 10 CFR Part 20, Appendix B, Table II, Column 2 including applicable table notes. In all cases, the more restrictive (lower) MPC found for each radionuclide is used regardless of solubility.

III. TECHNICAL SPECIFICATION REPORTING REQUIREMENTS

A. Calvert Cliffs Nuclear Power Plant (CCNPP), Technical Specification 5.6.3

1. 2016 Offsite Dose Due to Carbon-14

Dose due to Carbon-14 in gaseous effluents was calculated using the following conditions:

a. C-14 released to the atmosphere: 9.63 Curies of C-14 from Unit 1 and 10.40 curies from Unit 2.
b. Release was consistent throughout the year.
c. Carbon-14 release values were estimated using the methodology included in the Electric Power Research Institute (EPRI) Technical Report 1021106, using the 2016 Calvert Cliffs Nuclear Power Plant assumed parameters of normalized Carbon-14 production rate of 3.822 Ci/GWt-yr, a gaseous release fraction of 0.98, a Carbon-14 carbon dioxide fraction of 0.30, a reactor power rating of 2737 MWt for Unit 1 and 2737 MWt for Unit 2, and equivalent full power operation of 336.13 days for Unit 1 and 362.86 days for Unit 2.
d. Meteorological dispersion factor (X/Q) at the nearest residence with a garden and beef cattle location at 1.6 miles in the south meteorological sector is 2.51E-07 sec/m^3.
e. Pathways considered to the hypothetical maximally exposed member of the public (child) were inhalation, leafy vegetation ingestion, and cow meat ingestion.

2. 2016 Dose Assessment Summary

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Yearly
Liquid Effluent Dose Limit, Total Body	3 mrem	3 mrem	3 mrem	3 mrem	6 mrem
Total Body Dose	1.09E-03	1.48E-04	3.03E-04	8.38E-04	2.38E-03
% of Limit	3.63E-02	4.95E-03	1.01E-02	2.79E-02	3.97E-02
Liquid Effluent Dose Limit, Any Organ	10 mrem	10 mrem	10 mrem	10 mrem	20 mrem
Organ Dose	3.06E-03	1.60E-04	5.21E-04	2.58E-03	5.26E-03[1]
% of Limit	3.06E-02	1.60E-03	5.21E-03	2.58E-02	2.63E-02
Gaseous Effluent Dose Limit, Gamma Air	10 mrad	10 mrad	10 mrad	10 mrad	20 mrad
Gamma Air Dose	1.39E-04	3.45E-05	2.13E-05	2.01E-05	2.15E-04
% of Limit	1.39E-03	3.45E-04	2.13E-04	2.01E-04	1.08E-03
Gaseous Effluent Dose Limit, Beta Air	20 mrad	20 mrad	20 mrad	20 mrad	40 mrad
Beta Air Dose	2.39E-04	2.30E-05	9.85E-05	7.20E-06	3.68E-04
% of Limit	1.19E-03	1.15E-04	4.92E-04	3.60E-05	9.19E-04
Gaseous Effluent Dose Limit, Any Organ (Iodine, Tritium, Particulates with >8 day half-life)	15 mrem	15 mrem	15 mrem	15 mrem	30 mrem
Organ Dose	7.01E-03	2.23E-04	2.00E-04	2.02E-04	7.57E-03[2]
% of Limit	4.68E-02	1.48E-03	1.34E-03	1.35E-03	2.52E-02
Total Body Dose (NG)	6.03E-03	2.23E-04	1.94E-04	2.02E-04	6.58E-03
Skin Dose (due to NG)					4.61-04
C-14 Total Body/Organ			mrem		
Bone Dose	9.07E-03	1.06E-02	1.09E-02	1.08E-02	4.13E-02
Total Body Dose	1.80E-03	2.11E-03	2.15E-03	2.14E-03	8.20E-03

[1] The controlling liquid pathway was the fish and shellfish pathway with adult as the controlling age group and the GI representing the organ with the highest calculated annual dose during the calendar year of 2016.

[2] The controlling gaseous pathway was the child-thyroid pathway representing the organ with the highest calculated dose during the calendar year of 2016. There is currently no milk pathway.

3. 40 CFR 190 Total Dose Compliance

Based upon the calendar year 2016 and the ODCM calculations, the maximum exposed individual would receive 0.023% of the allowable dose. During the calendar year 2016, there were no on-site sources of direct radiation that would have contributed to a significant or measurable off-site dose. The direct radiation contribution is measured by both on-site and off-site thermoluminescent dosimeters (TLDs). The results of these measurements did not indicate any statistical increase in the off-site radiation doses attributable to on-site sources. Therefore, no increase in the calculated offsite dose is attributed to the direct exposure from on-site sources. A more detailed evaluation may be found in the Annual Radiological Environmental Operating Report.

EPA 40CFR190 Individual in the Unrestricted Area

	Whole Body	Thyroid	Any Other Organ
Dose Limit	25 mrem	75 mrem	25 mrem
Liquid	2.89E-03	1.80E-03	5.46E-03
Gas	3.18E-04	4.33E-03	3.35E-04
C-14	8.20E-03		4.13E-02
Dose	3.21E-03	6.13E-03	5.80E-03
% of Limit	1.28E-02	8.17E-03	2.32E-02

Child bone dose was used for Any Other Organ due to C-14

4. Solid Waste Report Requirements

During 2016, the types of radioactive solid waste shipped from Calvert Cliffs were dry compressible waste, spent resins, and cartridge filters which were shipped in either High Integrity Containers (HICs) within NRC approved casks, Sea/Land containers, or steel boxes. Appendix A of this report provides a detailed breakdown of the waste shipments for 2016 per Technical Specification 5.6.3. At CCNPP, methods of waste and materials segregation are used to reduce the volume of solid waste shipped offsite for processing, volume reduction, and burial.

5. Offsite Dose Calculation Manual (ODCM) and Process Control Program (PCP) Changes

The PCP was not revised in 2016. The ODCM was not revised in 2016.

B. Radioactive Effluent Monitoring Instrumentation

1. During 2016, the Waste Gas RMS, 0-RE-2191, exceeded the 30 days inoperable time period allowed in ODCM section 3.3.3.9. The monitor was declared inoperable on 7/12/13, and has remained inoperable since that time. The RMS is scheduled to be replaced in the year 2020.
2. During 2016, the unit 2 Steam Generator Blowdown RMS, 2-RIT-4014, was inoperable. 2-RIT-4014 was inoperable from 2/21/2016 to 4/8/2016 due to an electrical ground. The electrical failure was corrected by replacing a surge protector within the RMS, and the system was returned to service.

C. Independent Spent Fuel Storage Installation (ISFSI), ISFSI Technical Specification 6.3

Three casks of spent fuel were transferred to the ISFSI during the reporting period. No quantity of radionuclides was released to the environment during the ISFSI operation in 2016. Additional information regarding the ISFSI radiological environmental monitoring program is included in the Annual Radiological Environmental Operation Report.

IV. AVERAGE ENERGY

Not Applicable.

V. MEASUREMENTS AND APPROXIMATIONS AND TOTAL RADIOACTIVITY

A. Fission and Activation Gases

1. Batch Releases

Prior to each batch release of gas from a pressurized waste gas decay tank or containment, a sample is collected and analyzed by gamma spectroscopy using a germanium detector for the principal gamma emitting noble gas radionuclides. The total activity released is based on the pressure/volume relationship (gas laws). The Plant Vent Stack Radiation Monitor and the Wide Range Gas Monitor typically monitor containment releases, and the values from the radiation monitor may be used to assist in the calculation of activity discharged from containment during venting. Carbon-14 is estimated using methodology from EPRI Technical Report 1021106, as described in section III.A.1.

2. Continuous Releases

A gas sample is collected at least weekly from the main vents and analyzed by gamma spectroscopy using a germanium detector for the principal gamma emitting noble gas radionuclides. The total activity released for the week is based on the total sample activity decay corrected to the sample time multiplied by the main vent flow for the week. The Plant Vent Stack Radiation Monitor continuously measures routine plant vent stack releases, per design, and the values from the radiation monitor may be used to assist the calculation of activity discharged in routine plant vent stack discharges.

During each containment purge, a gas sample is collected and analyzed by gamma spectroscopy using a germanium detector to determine the concentration of principal gamma emitting noble gas radionuclides inside containment. Total activity released during a containment purge is based on continuous radiation monitor responses, grab samples, and purge fan flow rate.

A monthly composite sample is collected from the main vents and analyzed by liquid scintillation for tritium. The total tritium release for the month is based on the sample analysis and the main vent flow. Carbon-14 is estimated using methodology from EPRI Technical Report 1021106, as described in section III.A.1.

B. Iodine and Particulates

1. Batch Releases

The total activities of radioiodines and particulates released from pressurized waste gas decay tanks, containment purges, and containment vents are accounted for by the continuous release methodology discussed in section V.B.2.

2. Continuous Releases

During the release of gas from the main vents, samples of iodines and particulates are collected using a charcoal and particulate filter, respectively. The filters are removed weekly (or more often) and are analyzed by gamma spectroscopy using a germanium detector for significant gamma emitting radionuclides. The total activity released for the week is based on the total sample activity decay corrected to the midpoint of the sample period multiplied by the main vent flow for the week. A plate-out correction factor is applied to the results to account for the amount of iodine lost in the sample lines prior to sample collection. The weekly particulate filters are then combined to form monthly composites for gross alpha analysis. The weekly particulate filters are also combined to form quarterly composites for strontium-89 and strontium-90 analyses. Two quarterly composites per year are analyzed for Iron-55; the Iron-55 analysis is not required by the ODCM, but is driven by site procedure.

C. Liquid Effluents

1. Batch Releases

Prior to the release of liquid from a waste tank, a sample is collected and analyzed by gamma spectroscopy for the principal gamma emitting radionuclides. To demonstrate compliance with the concentration requirements addressed in Section I.C.1 above, the measured radionuclide concentrations are compared with the allowable MPCs; dilution in the discharge conduit is considered, and an allowable release rate is verified.

The total activity released in each batch is determined by multiplying the volume released by the concentration of each radionuclide. The actual volume released is based on the difference in tank levels before and after the release. A proportional composite sample is also withdrawn from each release. These composite samples are used for monthly tritium and gross alpha analyses. The composite samples are also used for Iron-55, Nickel-63, Strontium-89, and Strontium-90 analyses that are performed quarterly by an offsite laboratory.

Batch discharges of secondary (normally uncontaminated) waste streams are also monitored for radioactivity. No activity (excluding tritium) is normally detected in these secondary waste streams.

2. Continuous Releases

To account for activity from continuous releases, a sample is collected and analyzed by gamma spectroscopy for the principal gamma emitting radionuclides. The measured radionuclide concentrations are compared with the allowable MPC concentrations in the discharge conduit, and an allowable release rate is verified.

When steam generator blowdown is discharged to the circulating water conduits, it is sampled and gamma isotopic analysis is performed at a minimum once per week. These results are multiplied by the actual quantity of blowdown to determine the total activity released. The weekly sample is also used to prepare monthly composites for tritium analysis.

During the monitoring for primary-to-secondary leakage low levels of tritium have been detected in the Turbine Building sumps. This water is sampled and analyzed for principal gamma emitting radionuclides weekly and composited. The composite sample is analyzed at least monthly for tritium. The results are multiplied by the actual quantity of liquid released to determine the total activity released.

D. Estimation of Total Error

Total error for all releases was estimated using, as a minimum, the random counting error associated with typical releases. In addition to this random error, the following systematic errors were also examined:

1. Liquid
   a. Error in volume of liquid released prior to dilution during batch releases.
   b. Error in volume of liquid released via steam generator blowdown.
   c. Error in amount of dilution water used during the reporting period.
2. Gases
   a. Error in main vent release flow.
   b. Error in sample flow rate.
   c. Error in containment purge release flow.
   d. Error in gas decay tank pressure.

Where errors could be estimated they are usually considered additive.

E. Meteorological Data

A summary of required meteorological data is included in the Annual Radiological Environmental Operating Report and is not included in this report.

F. Reporting and Recordkeeping for Decommissioning

In accordance with 10 CFR 50.75.g, each licensee shall keep records of information important to the safe and effective decommissioning of the facility in an identified location until the license is terminated by the Commission. If records of relevant information are kept for other purposes, reference to these records and their locations may be used. Information the Commission considers important to decommissioning consists of records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. These records may be limited to instances when significant contamination remains after any cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the case of possible seepage into porous materials such as concrete. These records must include any known information on identification of involved nuclides, quantities, forms, and concentrations.

To assist in the decommissioning, and to provide early and advance detection of any unmonitored releases of radioactive material from the site, groundwater is routinely sampled. These groundwater samples are analyzed for gamma and tritium activity. Sample size and/or count times are adjusted to achieve analytical sensitivities lower than the environmental LLDs for gamma emitters (listed in ODCM Table 4.12-1). The established LLD limit for tritium is 200 pCi/l. The 2016 analysis results for tritium and gamma are listed in the Annual Radiological Environmental Operating Report and are not included in this report.

VI. ERRATA

I. Corrections to the 2014 ARERR
   a. Appendix B includes a correction to page 6 of the 2014 ARERR to address the adoption of the Exelon Process Control Program procedure, RW-AA-100, Revision 10. This procedure was adopted in August of 2014, but was not reported in the 2014 ARERR. This issue was documented in the CCNPP's CAP through AR 02701092.

II. Corrections to the 2015 ARERR
   a. Appendix C includes a correction to page 5 of the 2015 ARERR to address the adoption of the Exelon Process Control Program procedure, RW-AA-100, Revision 11. This procedure was adopted in August of 2015, but was not reported in the 2015 ARERR. This issue was documented in the CCNPP's CAP through AR 02701092.
   b. Appendix D includes a correction to page 6 of the 2015 ARERR to address a typographical error. The 2015 ARERR incorrectly referred to "2-RE-4014" as being an equivalent monitor to "1-RE-4095". The description should refer to "1-RE-4014" being an equivalent monitor to "1-RE-4095". This issue was documented in the CCNPP's CAP through AR 03970918.

III. 2008-2015 Radioiodines, Tritium, and Particulates in Gaseous Effluents
   a. Appendix E provides a discussion of radioiodione, tritium, and particulate effluents from the main vent during the years 2008 to 2016. Preventative maintenance tasks (PMs) were canceled for the Main Vent Sample Skids 1/2-RE-5320A and 1/2-RE-5320B. The PMs included tasks for the calibration of mass flow controllers. The issue was documented in CCNPP's CAP through AR 02699917. Upon discovery of the issue in August 2016, the flow controllers were recalibrated. 2 of the 8 flow controllers were found to have flow rates which had drifted in a non-conservative direction. The issue was documented in CCNPP's CAP through AR 02701972 and AR 02701973.

VII. BATCH RELEASES

	2016			
A Liquid (1)	**1ST QUARTER**	**2ND QUARTER**	**3RD QUARTER**	**4TH QUARTER**
1. Number of batch releases	15	6	8	12
2. Total time period for batch releases (min)	8.75E+03	3.58E+03	4.78E+03	6.02E+03
3. Maximum time period for a batch release (min)	7.42E+02	6.40E+02	7.27E+02	6.33E+02
4. Average time period for batch release (min)	5.84E+02	5.97E+02	5.98E+02	5.02E+02
5. Minimum time period for a batch release (min)	3.58E+02	5.47E+02	4.20E+02	4.60E+01
6. Average stream flow during periods of effluent into a flowing stream (liters/min of dilution water)	4.64E+06	4.64E+06	4.64E+06	4.64E+06

(1) This table excludes batch releases from the Waste Neutralizing Tanks. While releases from these sources are sampled, documented, permitted, and accounted for in the Dose Assessment Tables, Table 2A, and 2B of this report, they are not significant contributors to radioactive effluent and are therefore not included in this table.

B. Gaseous

	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
1. Number of batch releases	20	29	23	19
2. Total time period for batch releases (min)	6.96E+03	1.01E+04	8.94E+03	7.78E+03
3. Maximum time period for a batch release (min)	6.44E+02	6.90E+02	8.40E+02	5.70E+02
4. Average time period for batch release (min)	3.48E+02	3.48E+02	3.89E+02	4.09E+02
5. Minimum time period for a batch release (min)	7.00E+00	3.00E+00	6.00E+01	2.25E+02

VIII. ABNORMAL RELEASES

	2016 1ST QUARTER	2016 2ND QUARTER	2016 3RD QUARTER	2016 4TH QUARTER
A. Liquid				
1. Number of releases	- 0 -	- 0 -	- 0 -	- 0 -
2. Total activity released (Curies)	- 0 -	- 0 -	- 0 -	- 0 -
B. Gaseous				
1. Number of releases	- 0 -	- 0 -	3	- 0 -
2. Total activity releases (Curies)	- 0 -	- 0 -	6.69E-01	- 0 -

There were three abnormal releases in 2016. These releases were unplanned radiogas releases that resulted from incipient failures in spent fuel located in the spent fuel pool. Two events occurred while moving fuel assemblies with known leaks. The probable cause of the release during fuel movement was physical agitation and changes in hydrostatic pressure. These occurred on July 27th and August 4th. The third event occurred during a dry cask vacuum procedure on August 17th. All releases were via the monitored plant main vent.

APPENDIX A
CALVERT CLIFFS NUCLEAR POWER PLANT AND INDEPENDENT SPENT FUEL STORAGE INSTALLATION EFFLUENT AND WASTE DISPOSAL 2016 ANNUAL REPORT

TABLE 1A - REG GUIDE 1.21
GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNITS	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	EST. TOTAL ERROR, %
A. FISSION AND ACTIVATION GASES						
1. Total Release	Ci	2.22E+00	1.24E-01	7.04E-01	3.26E-02	±1.20E+01
2. Average release rate for period	μCi/sec	2.81E-01	1.57E-02	8.93E-02	4.14E-03	
3. Percent of ODCM limit (1)	%	(1)	(1)	(1)	(1)	
4. Percent of ODCM limit (2)	%	(2)	(2)	(2)	(2)	
B. IODINES						
1. Total Iodine - 131	Ci	1.43E-04	<LLD	<LLD	<LLD	±6.50E+00
2. Average release rate for period	μCi/sec	1.81E-05	<LLD	<LLD	<LLD	
3. Percent of ODCM limit	%	(3)	(3)	(3)	(3)	
C. PARTICULATES						
1. Particulates with half lives greater than 8 days	Ci	<LLD	<LLD	<LLD	<LLD	±1.20E+01
2. Average release rate for period	μCi/sec	<LLD	<LLD	<LLD	<LLD	
3. Percent of ODCM limit	%	(3)	(3)	(3)	(3)	
D. TRITIUM						
1. Total Release	Ci	1.42E+00	2.51E+00	2.19E+00	2.28E+00	±1.32E+01
2. Average release rate for period	μCi/sec	1.79E-01	3.18E-01	2.78E-01	2.89E-01	
E. GROSS ALPHA						
1. Total Release	Ci	6.35E-07	<LLD	<LLD	2.87E-07	±2.50E+01
2. Average release rate for period	μCi/sec	8.05E-08	<LLD	<LLD	3.64E-08	
F. Carbon-14						
1. Total Release	Ci	4.39E+00	5.16E+00	5.26E+00	5.22E+00	N/A
2. Average release rate for period	μCi/sec	5.58E-01	6.56E-01	6.62E-01	6.57E-01	

NOTES TO TABLE 1A

(1) Percent of quarterly gamma-air dose limit (10 mRad) can be found in Section III.A.2

(2) Percent of quarterly beta-air dose limit (20 mRad) can be found in Section III.A.2

(3) Iodine, Tritium, Carbon-14, and Particulates are treated as a group. % limit can be found in Section III.A.2

TABLE 1B - REG GUIDE 1.21
GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

	UNITS	CONTINUOUS MODE 1ST QUARTER	CONTINUOUS MODE 2ND QUARTER	CONTINUOUS MODE 3RD QUARTER	CONTINUOUS MODE 4TH QUARTER	BATCH MODE 1ST QUARTER	BATCH MODE 2ND QUARTER	BATCH MODE 3RD QUARTER	BATCH MODE 4TH QUARTER
1. FISSION AND ACTIVATION GASES									
Argon-41	Ci	<LLD	<LLD	<LLD	<LLD	2.20E-02	3.52E-02	3.14E-02	3.09E-02
Krypton-85	Ci	<LLD	<LLD	<LLD	<LLD	1.06E-01	<LLD	6.69E-01	<LLD
Krypton-85m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Krypton-87	Ci	<LLD	<LLD	<LLD	<LLD	3.35E-05	<LLD	<LLD	<LLD
Krypton-88	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon-131m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon-133	Ci	1.27E+00	<LLD	<LLD	<LLD	1.47E-01	1.95E-03	3.41E-03	1.69E-03
Xenon-133m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon-135	Ci	6.73E-01	8.65E-02	<LLD	<LLD	3.13E-04	<LLD	1.04E-05	<LLD
Xenon-135m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon-138	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Total for Period	Ci	1.94E+00	8.65E-02	<LLD	<LLD	2.76E-01	3.72E-02	7.04E-01	3.26E-02
2. IODINES									
Iodine-131	Ci	1.43E-04	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Iodine-132	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Iodine-133	Ci	2.20E-05	<LLD	2.96E-05	<LLD	(1)	(1)	(1)	(1)
Iodine-135	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Total for Period	Ci	1.65E-04	<LLD	2.96E-05	<LLD	(1)	(1)	(1)	(1)
3. PARTICULATES (half life > 8 days)									
Manganese-54	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Iron-55	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Iron-59	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Cobalt-58	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Cobalt-60	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Zinc-65	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Strontium-89	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Strontium-90	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Molybdenum-99	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Cesium-134	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Cesium-137	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Cerium-141	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)

TABLE 1B - REG GUIDE 1.21
GASEOUS EFFLUENTS - GROUND LEVEL RELEASES

		CONTINUOUS MODE				BATCH MODE			
	UNITS	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
Cerium-144	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
Total for period	Ci	<LLD	<LLD	<LLD	<LLD	(1)	(1)	(1)	(1)
4. GROSS ALPHA RADIOACTIVITY									
Gross Alpha	Ci	6.35E-07	<LLD	<LLD	2.87E-07	<LLD	<LLD	<LLD	<LLD
5. TRITIUM									
Tritium	Ci	1.41E+00	2.51E+00	2.19E+00	2.28E+00	<LLD	2.55E-04	<LLD	<LLD
6. Carbon-14(2)									
Carbon-14	Ci	4.39E+00	5.16E+00	5.26E+00	5.22E+00	N/A	N/A	N/A	N/A

NOTES TO TABLE 1B

(1) Iodines and particulates in batch releases are accounted for with the main vent continuous samplers when the release is made through the plant main vent.

(2) Carbon-14 is estimated using the methodology from EPRI Technical Report 1021106, as described in section III.A.1.

TABLE 2A - REG GUIDE 1.21
LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	UNITS	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	EST. TOTAL ERROR, %
A. FISSION AND ACTIVATION PRODUCTS						
1. Total Release (not including tritium, gases, alpha)	Ci	7.83E-02	6.73E-04	3.60E-03	1.57E-02	±1.03E+01
2. Average diluted concentration during period	µCi/ml	2.19E-11	1.84E-13	1.10E-12	4.26E-12	
3. Percent of ODCM limit (1)	%	(1)	(1)	(1)	(1)	
4. Percent of ODCM limit (2)	%	(2)	(2)	(2)	(2)	
B. TRITIUM						
1. Total Release	Ci	2.83E+02	1.35E+02	2.20E+02	4.46E+02	±1.03E+01
2. Average diluted concentration during period	µCi/ml	7.94E-08	3.70E-08	6.68E-08	1.21E-07	
3. Percent of applicable limit (3)	%	2.65E-03	1.23E-03	2.23E-03	4.03E-03	
C. DISSOLVED AND ENTRAINED GASES						
1. Total Release	Ci	5.71E-03	<LLD	<LLD	4.49E-04	±1.03E+01
2. Average diluted concentration during period	µCi/ml	1.60E-12	<LLD	<LLD	1.22E-13	
D. GROSS ALPHA RADIOACTIVITY						
1. Total Release	Ci	<LLD	<LLD	<LLD	<LLD	N/A
E. VOLUME OF WASTE RELEASED (prior to dilution)						
1. Volume of waste released	liters	1.26E+08	8.31E+07	8.43E+07	8.34E+07	±1.30E+00
F. VOLUME OF DILUTION WATER USED DURING PERIOD (4)	liters	3.57E+12	3.65E+12	3.29E+12	3.68E+12	±1.64E+01

NOTES TO TABLE 2A

(1) Percent of I.C.3 Quarterly Organ Dose Limit (10 mrem) can be found in Section III.A.2
(2) Percent of I.C.3 Quarterly Whole Body Dose Limit (3 mrem) can be found in Section III.A.2
(3) Limit used is 3 x 10-3 µCi/ml
(4) Includes dilution water used during continuous discharges.

TABLE 2B - REG GUIDE 1.21
LIQUID EFFLUENTS

NUCLIDES RELEASED	Units	CONTINUOUS MODE 1ST QUARTER	CONTINUOUS MODE 2ND QUARTER	CONTINUOUS MODE 3RD QUARTER	CONTINUOUS MODE 4TH QUARTER	BATCH MODE 1ST QUARTER	BATCH MODE 2ND QUARTER	BATCH MODE 3RD QUARTER	BATCH MODE 4TH QUARTER
Beryllium – 7	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Sodium – 24	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Chromium - 51	Ci	<LLD	<LLD	<LLD	<LLD	1.71E-03	<LLD	<LLD	1.11E-04
Manganese - 54	Ci	<LLD	<LLD	<LLD	<LLD	1.40E-04	<LLD	<LLD	3.42E-05
Iron – 55	Ci	(2)	(2)	(2)	(2)	6.06E-03	<LLD	1.41E-03	1.18E-02
Cobalt – 57	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Cobalt – 58	Ci	<LLD	<LLD	<LLD	<LLD	1.10E-02	2.88E-04	2.43E-04	3.39E-04
Iron – 59	Ci	<LLD	<LLD	<LLD	<LLD	1.69E-04	<LLD	<LLD	<LLD
Cobalt – 60	Ci	<LLD	<LLD	<LLD	<LLD	2.31E-03	8.66E-05	1.48E-03	8.46E-04
Nickel-63	Ci	<LLD	<LLD	<LLD	<LLD	2.06E-03	<LLD	<LLD	2.19E-03
Zinc – 65	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Strontium - 89	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Strontium - 90	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Strontium – 91	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Strontium - 92	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Niobium - 95	Ci	<LLD	<LLD	<LLD	<LLD	1.39E-04	<LLD	<LLD	1.19E-05
Zirconium - 95	Ci	<LLD	<LLD	<LLD	<LLD	7.01E-05	<LLD	<LLD	3.02E-05
Niobium - 97	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Zirconium - 97	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Molybdenum - 99	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Technetium - 99m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Ruthenium - 103	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Rhodium - 105	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Ruthenium - 105	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Silver - 110m	Ci	<LLD	<LLD	<LLD	<LLD	4.46E-05	<LLD	<LLD	<LLD
Tin – 113	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Tin – 117m	Ci	<LLD	<LLD	<LLD	<LLD	1.24E-04	<LLD	<LLD	<LLD
Antimony - 122	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Antimony - 124	Ci	<LLD	<LLD	<LLD	<LLD	2.20E-04	<LLD	<LLD	<LLD
Antimony - 125	Ci	<LLD	<LLD	<LLD	<LLD	1.41E-02	<LLD	2.09E-04	7.30E-05
Tellurium – 125m	Ci	<LLD	<LLD	<LLD	<LLD	2.41E-02	<LLD	<LLD	<LLD
Tellurium - 132	Ci	<LLD	<LLD	<LLD	<LLD	8.57E-05	<LLD	<LLD	<LLD

TABLE 2B - REG GUIDE 1.21
LIQUID EFFLUENTS

NUCLIDES RELEASED	Units	CONTINUOUS MODE				BATCH MODE			
		1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
Iodine - 131	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Iodine - 132	Ci	<LLD	<LLD	<LLD	<LLD	1.32E-04	<LLD	<LLD	<LLD
Iodine – 133	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Iodine – 135	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Cesium – 134	Ci	<LLD	<LLD	<LLD	<LLD	9.19E-04	<LLD	<LLD	<LLD
Cesium – 136	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Cesium – 137	Ci	<LLD	<LLD	<LLD	<LLD	1.48E-02	2.98E-04	2.62E-04	2.32E-04
Cesium – 138	Ci	<LLD	<LLD	<LLD	<LLD	1.26E-04	<LLD	<LLD	<LLD
Barium – 140	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Lanthanum - 140	Ci	<LLD	<LLD	<LLD	<LLD	6.95E-05	<LLD	<LLD	<LLD
Cerium – 144	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Europium – 154	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Europium – 155	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Tungsten – 187	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Total For Period (I,P)	Ci	<LLD	<LLD	<LLD	<LLD	7.83E-02	6.73E-04	3.60E-03	1.57E-02
Krypton – 85	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon - 131m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon – 133	Ci	<LLD	<LLD	<LLD	<LLD	5.54E-03	<LLD	<LLD	4.49E-04
Xenon – 133m	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD	<LLD
Xenon – 135	Ci	<LLD	<LLD	<LLD	<LLD	1.62E-04	<LLD	<LLD	<LLD
Total For Period (NG)	Ci	<LLD	<LLD	<LLD	<LLD	5.71E-03	<LLD	<LLD	4.49E-04
Tritium	Ci	9.17E-02	1.31E-01	1.61E-01	1.28E-01	2.83E+02	1.35E+02	2.20E+02	4.46E+02
Total For Period (Tritium)	Ci	9.17E-02	1.31E-01	1.6E-01	1.28E-01	2.83E+02	1.35E+02	2.20E+02	4.46E+02

NOTES TO TABLE 2B

(1) Less than minimum detectable activity which meets the LLD requirements of ODCM Surveillance Requirement 4.11.1.1.1.

(2) Continuous mode effluents are not analyzed for Fe-55.

TABLE 3A
SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

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

1. Type of Waste	Units	12-Month Period	Est. Total Error %
a) Spent resins, Filters	m^3 Ci	2.23E+01 2.44E+02	25%
b) Dry compressible waste, contaminated equipment, etc.	m^3 Ci	4.20E+02 9.41E-01	25%
c) Irradiated components, control rods, etc.	m^3 Ci	0.00E+00 0.00E+00	N/A
d) Other (cartridge filters, misc. dry compressible, Oil)	m^3 Ci	3.28E+01 4.96E-03	25%
e) Solidification agent or absorbent	m^3	N/A	N/A

Volume shipped represents waste generated prior to offsite volume reduction.

2. Estimate of Major Nuclides (By Type of Waste - Only nuclides >1 % are reported)

Spent Resins, Filters	
Nuclide	Abundance (%)
C-14	6.84
Mn-54	1.22
Fe-55	13.68
Co-58	1.62
Co-60	25.16
Ni-63	38.89
Cs-134	1.22
Cs-137	10.53

2. **Estimate of Major Nuclides** (By Type of Waste - Only nuclides >1 % are reported)(cont.)

Dry Active Waste	
Nuclide	Abundance (%)
H-3	2.30
C-14	1.56
Cr-51	4.77
Fe-55	11.69
Co-58	21.76
Co-60	8.79
Ni-63	24.22
Zr-95	4.51
Nb-95	7.56
Sb-125	1.02
Cs-137	10.55

Irradiated Components	
Nuclide	Abundance (%)
N/A	

Other Waste	
Nuclide	Abundance (%)
H-3	1.35
C-14	13.84
Fe-55	15.33
Co-58	12.37
Co-60	18.12
Ni-63	16.68
Zr-95	5.45
Nb-95	10.08
Cs-137	2.85
Pu-241	1.33

3. Solid Waste Disposition

Number of Shipments	Mode of Transportation	Destination
1	Motor Surface Transit (CAST Transportation)	Energy Solutions Oak Ridge, TN
14	Motor Surface Transit (Hittman)	Energy Solutions Oak Ridge, TN
3	Motor Surface Transit (Hittman)	Energy Solutions Clive, UT
3	Motor Surface Transit (Hittman)	Waste Control Specialists LLC Andrews, TX
1	Motor Surface Transit (Interstate Ventures)	Energy Solutions Oak Ridge, TN
1	Motor Surface Transit (CAST Transportation)	Diversified Scientific Services, Inc. Kingston, Tn

B. <u>IRRADIATED FUEL SHIPMENTS (DISPOSITION)</u> N/A

APPENDIX B
ERRATA/CORRECTIONS TO 2014 ARERR PAGE 6
CALVERT CLIFFS NUCLEAR POWER PLANT AND INDEPENDENT SPENT FUEL STORAGE INSTALLATION EFFLUENT AND WASTE DISPOSAL 2016 ANNUAL REPORT

Offsite Dose Calculation Manual (ODCM) and Process Control Program (PCP) Changes

The ODCM was not revised in 2014.

The PCP was revised in 2014. RW-AA-100 Revision 10 was adopted as the site's PCP in August 2014. RW-AA-100, an Exelon fleet procedure, superseded Calvert Cliffs Nuclear Power Plant's prior PCP, CH-1-110.

APPENDIX C
ERRATA/CORRECTIONS TO 2015 ARERR PAGE 5
CALVERT CLIFFS NUCLEAR POWER PLANT AND
INDEPENDENT SPENT FUEL STORAGE INSTALLATION
EFFLUENT AND WASTE DISPOSAL 2016 ANNUAL REPORT

Offsite Dose Calculation Manual (ODCM) and Process Control Program (PCP) Changes

The ODCM was revised in 2015; Revision 00900 of the ODCM was approved in 2015 and a copy of the revision was submitted to the NRC with the 2015 ARERR.

The PCP was also revised in 2015. RW-AA-100 Revision 11 was adopted as the site's PCP in August 2015. The changes to the PCP in 2015 included provisions for concentration averaging allowed by the NRC Branch Technical Position on Concentration Averaging and Encapsulation. Although the revised PCP allows these specific activities, CCNPP has not made physical equipment changes or process changes to perform those activities.

APPENDIX D
ERRATA/CORRECTIONS TO 2015 ARERR PAGE 6
CALVERT CLIFFS NUCLEAR POWER PLANT AND
INDEPENDENT SPENT FUEL STORAGE INSTALLATION
EFFLUENT AND WASTE DISPOSAL 2016 ANNUAL REPORT

Radioactive Effluent Monitoring Instrumentation

The Steam Generator Blowdown Effluent Radiation Monitor, 1-RE-4095, was declared inoperable on 7/7/15 and exceeded the 30 days allowed in ODCM section 3.3.3.9. It remained out of service for the rest of 2015. 1-RE-4014 is credited by the ODCM as an equivalent monitor. With 1-RE-4014 in service, no compensatory actions were required. Repairs to 1-RE-4095 were scheduled through the work control process and completed in January 2016 under Work Order C93125862. The cause of the RMS malfunction was a drift in the response of the low flow switch, 1FS4095. Upon recalibration of 1FS4095, the RMS was placed back in service on 1/4/2016.

APPENDIX E
ERRATA/CORRECTIONS TO 2008-2015 ARERRs
CALVERT CLIFFS NUCLEAR POWER PLANT AND
INDEPENDENT SPENT FUEL STORAGE INSTALLATION
EFFLUENT AND WASTE DISPOSAL 2016 ANNUAL REPORT

1/2-5320-A/B Main Vent Sample Skid Mass Flow Controller Calibration 2018-2016

Flow instrumentation in the main vent sample skids had not been calibrated from 2008 to 2016. This issue was documented in CCNPP's CAP through AR 02699917. The issue was identified during a Chemistry, Radwaste, Effluent and Environmental Monitoring Audit, NOSA-CAL-16-04 (results of the audit are documented in AR 2670954). The flow controllers were promptly recalibrated. The PMs were restored as Surveillance Test Procedures, and incorporated in the ODCM.

The preventative maintenance tasks (PMs) for the main vent sample skids had been canceled in batches, starting in 2008 and continuing through 2014. The PMs included tasks for replacing consumable parts and calibrating the flow controllers. The main vent sample skids had been planned to be replaced in 2015. Parts for the legacy main vent sample skids are no longer manufactured. In an effort to conserve consumable components that could no longer be procured, the PMs were canceled with the assumption that the skids would be replaced prior to the next scheduled maintenance interval. The main vent sample skid replacement was deferred to 2020, but the PMs remained inactive.

There are two main vent sample skids for each unit at Calvert Cliffs, for a total of four sample skids. There are two flow controllers for each sample skid: low flow controllers for tritium sampling and high flow controllers for particulate/iodine sampling, for a total of eight flow controllers. Upon recalibration, it was determined that two of the eight mass flow controllers had drifted in a non-conservative direction.

The flow rates had shifted in a non-conservative direction from between 5% (2FCV5320A1, a tritium sampler flow controller in the 2-5320-A skid) and 20% (1FCV5320B2, a radioiodine sampler flow controller in the 1-5320-B skid). With flow through the sampling media lower than what was documented, the concentrations and total activities of radionuclides in the effluent stream were higher than what was documented in the routine effluent permits for those analytes, during the timeframes when the two non-conservative flow controllers were in service.

The other six flow controllers were either within the accepted range of flow or had drifted in a conservative direction, meaning that flow through the sample media was higher than documented. Therefore, the concentrations and total activities of radionuclides in the effluent stream was lower than what was documented in the routine effluent permits for radioiodines, tritium, and particulates, during the timeframes when the six conservative flow controllers were in service.

Considering that 2FCV5320A1 and 1FCV5320B2 are each installed in individual, redundant skids that are in service for approximately 50% of effluent release reporting timeframe, and that each pair of redundant sample skids respectively accounts for 50% of the site's total radioiodine, tritium, and particulate effluent activity, it can be assumed that an individual flow controller's sample collection contribution represents 25% of the total site effluent for an analyte in the main vent release pathway. Applying the 0.25 weighting factor to the maximum documented 20% error in flow rate for 1FCV5320B2 establishes that effluent for the site was miscalculated by a maximum of 5%.

Error estimation is described in section V.D, "Estimation of Error", of this year and previous years' reports. Additionally, error ranges are identified in tables 1A and 2A for each analyte. The error in effluent released during the years 2008 to 2016 is within the established error ranges. Additionally, since most of the other flow controllers drifted in a conservative direction, it is likely that effluents were overestimated during the interval of 2008 to 2016, within the reported range of error.