

**ENCLOSURE (1)**

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

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**This report covers the period January 1, 2011 to December 31, 2011 for  
Calvert Cliffs Nuclear Power Plant.**

**This report covers the period June 1, 2011 to May 31, 2012 for the  
Independent Spent Fuel Storage Installation.**

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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, 2011 to December 31, 2011 for Calvert Cliffs Nuclear Power Plant.

This report covers the period June 1, 2011 to May 31, 2012 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. 0802, 3.11.2.1).
2. Gaseous Radwaste Processing 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).

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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 concentration of radioactive material released in liquid effluents to unrestricted areas from the plant shall not exceed the values specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases (ODCM 3.11.1.1).
2. The liquid radwaste processing 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 of the 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. Iodine-131 and Particulates with Half Lives Greater than Eight Days

Compliance with the dose rate limitations for iodine-131 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. All of the above parameters are calculated according to the methodology specified in the ODCM.

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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. 2011 Offsite Dose Due to Carbon-14

Carbon-14 releases from Calvert Cliffs were estimated using the EPRI TR-1021106 methodology, and the Carbon-14 Source Term Calculator using specific reactor core data and reactor coolant chemistry to estimate the products of the activation reactions. Carbon-14 released to the atmosphere is estimated at 7.67 curies from Unit 1 and 7.04 curies from Unit 2.

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

- a. Release was consistent throughout the year.
- b. 10% of the C-14 was in the chemical form of CO<sub>2</sub>, which is the only dose contributor. The bulk of C-14 was in the chemical form of methane (CH<sub>4</sub>) which would exhibit high upward velocity due to its low density relative to air. In addition CH<sub>4</sub> does not have an uptake pathway for humans.
- c. Meteorological dispersion factor, (X/Q), at the site boundary to the hypothetical maximally exposed member of the public is 2.08E-07 sec/m<sup>3</sup>.
- d. Dose calculations and dose factors are from Regulatory Guide 1.109 methodology.
- e. Pathways considered were inhalation and vegetation ingestion.
- f. Critical receptor is child at the site boundary in the SE direction.

Maximum dose values due to C-14 in gaseous effluents in 2011

Organ	Age	mRem/yr
RG-1.109 Bone	Child	3.27E-02
RG-1.109 T.Body/Other	Child	6.49E-03

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2. 2011 Dose Assessment Summary

	Actual Value	Percent of ODCM limit	ODCM Limit
<b>Liquid Waste:</b>			
Maximum Annual Organ Dose (mRem) <sup>1</sup>	0.002	0.010%	20
Maximum Annual Whole Body Dose (mRem)	0.0015	0.007%	6
<b>Gaseous Waste:</b>			
<b>Noble Gases:</b>			
Maximum Quarterly Gamma Air Dose (mRad)	0.002	0.02%	10
Maximum Quarterly Beta Air Dose (mRad)	0.007	0.03%	20
<b>Iodines and Particulates:</b>			
Maximum Annual Organ Dose (mRem) <sup>2</sup>	0.05	0.17%	30

<sup>1</sup> The controlling pathway was the fish and shellfish pathway with adult as the controlling age group and the GI-LLI representing the organ with the highest calculated dose during the calendar year of 2011.

<sup>2</sup> The controlling pathway was the child-kidney pathway representing the organ with the highest calculated dose during the calendar year of 2011. There is currently no milk pathway.

3. 40 CFR 190 and 10 CFR 72.104 Total Dose Compliance

Based upon the calendar year 2011 and the ODCM calculations, the maximum exposed individual would receive 0.044% of the allowable dose. During the calendar year 2011, 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.

4. Solid Waste Report Requirements

During 2011, 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 provides a detailed breakdown of the waste shipments for 2011 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.

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

The ODCM was revised in January 2011 and December 2011. A copy of the ODCM which includes all of these revisions is attached. The PCP was not revised in 2011.

#### B. Radioactive Effluent Monitoring Instrumentation

1. The Unit 2 Steam Generator Blowdown Radiation Monitor 2-RE-4095 was inoperable for more than 30 days once in February/March due to failed check source mechanism and a second time in September/October due to spurious low flow alarms.
2. The Unit 1 Steam Generator Blowdown Radiation Monitor 1-RE-4014 remained inoperable for the entire year as the implementation of the modification to replace this monitor has not been completed.
3. The Unit 1 Steam Generator Blowdown Radiation Monitor 1-RE-4095 was inoperable for more than 30 days once in September/October due to detector and associated cable damage during routine maintenance.
4. The Unit 1 Wide Range Noble Gas Radiation Monitor was inoperable once during March through May. Complex troubleshooting was performed and the power/isolator card was replaced and software configuration was corrected.  
During the reporting period, both the Unit 1 Steam Generator Blowdown Radiation Monitors were inoperable in September and October. Compensatory actions were performed in accordance with the ODCM for items 2 and 3 above as there was no redundant Radiation Monitor available.

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

Three (3) Dry Shielded Canisters (DSCs) of spent fuel were transferred to the ISFSI during the period June 1, 2011 to May 31, 2012. No quantity of radionuclides was released to the environment during the ISFSI operation this period. 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 typically monitors containment releases, and the values from the radiation monitor may be used to assist in the calculation of activity

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discharged from containment during venting. Carbon-14 is estimated per 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 in the calculation of activity discharged in routine plant vent stack discharges. 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.

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.

Carbon-14 is estimated per 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 and quarterly composites for the gross alpha, and strontium-89 and strontium-90 analyses, Iron-55 is analyzed twice per year.

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

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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 prior to and after the release. A proportional composite sample is also withdrawn from each release, and this is used to prepare monthly tritium and gross alpha. An additional composite sample is also withdrawn from each release to prepare quarterly samples for iron-55, nickel-63, strontium-89, and strontium-90 analyses.

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

There were no major changes to the liquid radwaste system in calendar year 2011.

#### 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.



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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. 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.

During the reporting period there was no radioactive liquid spill/leak to the ground.

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 (see Tables below). Sample size and/or count times are adjusted to achieve analytical sensitivities better than the environmental LLDs for gamma emitters (listed in ODCM Table 4.12-1). Established LLD limits for tritium are approximately 350 pCi/l for tritium.

Groundwater samples were collected from nine on-site piezometer tubes in 2011. A piezometer tube is a shallow monitoring well which allows access to groundwater at a depth of approximately 40 feet beneath the site. Number 19 Piezometer Tube was added to the program in 2010, 3 additional wells were installed in December of 2010 and were included in 2011 monitoring. Of the piezometer tubes sampled, only #11 Piezometer Tube showed any plant related activity. This activity was previously identified and evaluated in December of 2005. The activity consists of tritium originating from normal radwaste discharges and was previously reported in the Annual Radioactive Effluent Release Reports. The tritium contamination is contained on site. No drinking water has been affected; the groundwater at this location does not impact any drinking water pathway. The 2011 analyses results for tritium and gamma emitters are shown in the following tables.

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Sample Date	Concentration of Tritium in Groundwater (Results in units of pCi/L +/- 2σ)								
	Piezometer Tube #s								
	11	12	13	15	18	19	20	21	22
01/30/2011	757 +/- 186	*	*	*	*	*	*	*	*
05/25/2011	*	*	*	*	ND	ND	*	*	*
06/13/2011	ND	ND	ND	ND	*	*	ND	ND	ND
09/26/2011	1280 +/- 194	ND	ND	ND	*	*	*	*	*
09/30/2011	ND	*	*	*	ND	ND	ND	ND	ND
11/7/2011	859 +/-181	*	*	*	*	*	*	*	*

\* Less than Minimum Detectable Activity (<MDA)  
ND = No Data – Quarterly sample obtained as required.

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<b>Gross Concentration of Gamma Emitters in Groundwater (Results in units of pCi/L +/- 2σ)</b>									
Sample Date	Piezometer Tube #s								
	11	12	13	15	18	19	20	21	22
01/30/2011	*	*	*	*	*	*	*	*	*
05/25/2011	*	*	*	*	*	*	*	*	*
09/26/2011	*	ND	*	*	*	*	*	*	*
09/30/2011	ND	*	ND	ND	ND	ND	ND	ND	ND
11/7/2011	*	*	*	*	*	*	*	*	*

\* All Non-Natural Gamma Emitters <MDA  
 ND = No Data – Quarterly sample obtained as required.

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**VI. BATCH RELEASES**

		<b><u>2011</u></b>			
		<b><u>1ST</u></b>	<b><u>2ND</u></b>	<b><u>3RD</u></b>	<b><u>4TH</u></b>
		<b><u>QUARTER</u></b>	<b><u>QUARTER</u></b>	<b><u>QUARTER</u></b>	<b><u>QUARTER</u></b>
<b>A. <u>Liquid</u></b>					
1. Number of batch releases	20	9	12	9	
2. Total time period for batch releases (min)	1.37E+05	1.34E+05	9.44E+04	4.49E+03	
3. Maximum time period for a batch release (min)	4.46E+04	4.46E+04	4.46E+04	6.31E+02	
4. Average time period for batch releases (min)	6.85E+03	1.49E+04	7.87E+03	4.99E+02	
5. Minimum time period for a batch release (min)	2.43E+01	5.16E+02	2.73E+01	2.63E+01	
6. Average stream flow during periods of effluent into a flowing stream (liters/min of dilution water)	4.36E+06	4.59E+06	4.54E+06	4.41E+06	
<b>B. <u>Gaseous</u></b>					
1. Number of batch releases	18	25	20	18	
2. Total time period for batch releases (min)	9.88E+03	7.99E+03	6.69E+03	6.23E+03	
3. Maximum time period for a batch release (min)	4.34E+03	4.87E+02	5.32E+02	5.31E+02	
4. Average time period for batch release (min)	5.49E+02	3.20E+02	3.35E+02	3.46E+02	
5. Minimum time period for a batch release (min)	9.00E+00	2.00E+00	1.00E+02	1.20E+02	

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VII. ABNORMAL RELEASES

	<u>1ST QUARTER</u>	<u>2ND QUARTER</u>	<u>3RD QUARTER</u>	<u>4TH QUARTER</u>
<b>A. <u>Liquid</u></b>				
1. Number of releases	- 0 -	- 0 -	- 0 -	- 0 -
2. Total activity released (Curies)	- 0 -	- 0 -	- 0 -	- 0 -
<b>B. <u>Gaseous</u></b>				
1. Number of releases	- 0 -	- 0 -	- 0 -	- 0 -
2. Total activity releases (Curies)	- 0 -	- 0 -	- 0 -	- 0 -

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

<b>A. FISSION AND ACTIVATION GASES</b>	<b>UNITS</b>	<b>1ST QUARTER</b>	<b>2ND QUARTER</b>	<b>3RD QUARTER</b>	<b>4TH QUARTER</b>	<b>EST. TOTAL ERROR, %</b>
1. Total Release	Ci	6.62E+01	6.20E+00	9.60E+00	1.32E+01	±1.20E+01
2. Average release rate for period	μCi/sec	8.40E+00	7.86E-01	1.22E+00	1.67E+00	
3. Percent of ODCM limit (1)	%	9.28E-03	9.68E-05	1.25E-04	4.38E-04	
4. Percent of ODCM limit (2)	%	1.94E-04	2.33E-05	2.33E-05	4.24E-05	
5. Percent of ODCM limit (3)	%	1.91E-02	4.31E-04	2.51E-03	2.46E-03	
6. Percent of ODCM limit (4)	%	9.55E-03	9.77E-03	1.10E-02	1.23E-02	
7. Percent of ODCM limit (5)	%	3.44E-02	4.17E-03	4.47E-03	8.00E-03	
8. Percent of ODCM limit (6)	%	1.72E-02	1.93E-02	2.15E-02	2.55E-02	
<b>B. IODINES</b>						
1. Total Iodine - 131	Ci	2.21E-03	4.91E-05	9.87E-05	3.93E-05	±6.50E+00
2. Average release rate for period	μCi/sec	2.80E-04	6.23E-06	1.25E-05	4.98E-06	
3. Percent of ODCM limit (7)	%	4.24E-03	1.05E-04	2.07E-04	8.20E-05	
4. Percent of ODCM limit (8)	%	3.34E+00	2.71E-02	2.87E-03	5.63E-03	
5. Percent of ODCM limit (9)	%	1.67E+00	2.27E-01	2.29E-01	2.32E-01	
<b>C. PARTICULATES</b>						
1. Particulates with half lives greater than 8 days	Ci	(10)	(10)	(10)	2.52E-06	±1.20E+01
2. Average release rate for period	μCi/sec	(10)	(10)	(10)	3.19E-07	
3. Percent of ODCM limit (7)	%	(10)	(10)	(10)	8.20E-05	
4. Percent of ODCM limit (8)	%	(10)	(10)	(10)	5.63E-03	
5. Percent of ODCM limit (9)	%	(10)	(10)	(10)	2.32E-01	±2.50E+01
<b>D. GROSS ALPHA RADIOACTIVITY</b>						
1. Gross alpha radioactivity	Ci	7.71E-07	9.29E-07	0.00E+00	1.98E-07	±2.50E+01
2. Average release rate for period	μCi/sec	9.77E-08	1.18E-07	0.00E+00	2.51E-08	
<b>E. TRITIUM</b>						
1. Total Release	Ci	2.19E+00	4.44E+00	4.37E+00	2.03E+00	±1.32E+01
2. Average release rate for period	μCi/sec	2.78E-01	5.63E-01	5.55E-01	2.58E-01	

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

**NOTES TO TABLE 1A**

- (1) Percent of I.A.1 whole body dose rate limit (500 mRem/year)
- (2) Percent of I.A.1 skin dose rate limit (3000 mRem/year)
- (3) Percent of I.A.3 quarterly gamma-air dose limit (10 mRad)
- (4) Percent of I.A.3 yearly gamma-air dose limit (20 mRad)
- (5) Percent of I.A.3 quarterly beta-air dose limit (20 mRad)
- (6) Percent of I.A.3 yearly beta-air dose limit (40 mRad)
- (7) Percent of organ dose rate limit (1500 mRem/year)
- (8) Percent of I.B.3 quarterly organ dose limit (15 mRem)
- (9) Percent of I.B.3 yearly organ dose limit (30 mRem)
- (10) Less than minimum detectable activity which meets the lower limit of detection (LLD) requirements of ODCM Surveillance Requirement 4.11.2.1.2.

# APPENDIX A

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

**TABLE 1C - REG GUIDE 1.21**  
**GASEOUS EFFLUENTS - GROUND LEVEL RELEASES**

		UNITS	CONTINUOUS MODE				BATCH MODE			
			1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
1. FISSION AND ACTIVATION GASES										
Argon	-41	Ci	1.50E+00	(2)	(2)	(2)	1.92E-02	3.23E-02	2.58E-02	2.41E-02
Krypton	-85	Ci	2.18E+01	(2)	(2)	(2)	6.53E+00	5.86E+00	2.25E+00	8.50E+00
Krypton	-85m	Ci	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Krypton	-87	Ci	(2)	(2)	(2)	(2)	(2)	1.82E-04	(2)	(2)
Krypton	-88	Ci	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Xenon	-131m	Ci	(2)	(2)	(2)	(2)	3.65E-02	1.95E-02	(2)	4.47E-04
Xenon	-133	Ci	3.60E+01	(2)	6.80E+00	3.60E+00	3.69E-01	2.11E-01	5.54E-02	6.70E-02
Xenon	-133m	Ci	1.34E-02	(2)	(2)	(2)	9.45E-05	(2)	(2)	(2)
Xenon	-135	Ci	2.00E-02	7.18E-02	4.65E-01	9.67E-01	2.21E-04	3.20E-04	2.22E-04	3.00E-04
Xenon	-135m	Ci	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Xenon	-138	Ci	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Total for Period		Ci	5.93E+01	7.18E-02	7.27E+00	4.57E+00	6.95E+00	6.13E+00	2.33E+00	8.59E+00
2. IODINES										
Iodine	-131	Ci	2.21E-03	4.91E-05	9.87E-05	3.93E-05	(1)	(1)	(1)	(1)
Iodine	-132	Ci	4.58E-01	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Iodine	-133	Ci	4.73E-04	3.84E-04	8.05E-04	3.23E-04	(1)	(1)	(1)	(1)
Iodine	-135	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Total for Period		Ci	4.60E-01	4.33E-04	9.04E-04	3.62E-04	(1)	(1)	(1)	(1)



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**TABLE 1C - REG GUIDE 1.21  
GASEOUS EFFLUENTS - GROUND LEVEL RELEASES**

TABLE 1C - REG GUIDE 1.21 GASEOUS EFFLUENTS - GROUND LEVEL RELEASES										
		UNITS	CONTINUOUS MODE				BATCH MODE			
			1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER
3. PARTICULATES (half life > 8 days)										
Manganese	-54	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Iron	-55	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Iron	-59	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Cobalt	-58	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Cobalt	-60	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Zinc	-65	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Strontium	-89	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Strontium	-90	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Molybdenum	-99	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Cesium	-134	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Cesium	-137	Ci	(2)	(2)	(2)	2.52E-06	(1)	(1)	(1)	(1)
Cerium	-141	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Cerium	-144	Ci	(2)	(2)	(2)	(2)	(1)	(1)	(1)	(1)
Total For Period		Ci	(2)	(2)	(2)	2.52E-06	(1)	(1)	(1)	(1)
4. GROSS ALPHA RADIOACTIVITY										
		Ci	7.71E-07	9.29E-07	(2)	1.98E-07	(1)	(1)	(1)	(1)

### NOTES TO TABLE 1C

- (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) Less than minimum detectable activity which meets the LLD requirements of ODCM Surveillance Requirement 4.11.2.1.2.

# APPENDIX A

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

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

	UNITS	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	EST. TOTAL ERROR, %
<b>A. FISSION AND ACTIVATION PRODUCTS</b>						
1. Total Release (not including tritium, gases, alpha)	Ci	6.54E-03	2.98E-03	1.91E-03	3.72E-04	±1.03E+01
2. Average diluted concentration during period	µCi/ml	3.08E-12	1.23E-12	7.84E-13	1.58E-13	
3. Percent of ODCM limit (1)	%	7.56E-03	2.83E-03	6.27E-03	3.11E-03	
4. Percent of ODCM limit (2)	%	3.78E-03	4.96E-03	8.10E-03	9.65E-03	
5. Percent of ODCM limit (3)	%	1.36E-02	6.67E-03	2.02E-02	1.03E-02	
6. Percent of ODCM limit (4)	%	6.80E-03	1.01E-02	2.02E-02	2.53E-02	
<b>B. TRITIUM</b>						
1. Total Release	Ci	2.73E+02	1.66E+02	6.07E+02	2.91E+02	±1.03E+01
2. Average diluted concentration during period	µCi/ml	1.29E-07	6.86E-08	2.49E-07	1.24E-07	
3. Percent of applicable limit (5)	%	4.30E-03	2.29E-03	8.30E-03	4.13E-03	
<b>C. DISSOLVED AND ENTRAINED GASES</b>						
1. Total Release	Ci	8.15E-02	4.23E-05	7.12E-03	3.04E-03	±1.03E+01
2. Average diluted concentration during period	µCi/ml	3.84E-11	1.75E-14	2.92E-12	1.29E-12	
<b>D. GROSS ALPHA RADIOACTIVITY</b>						
1. Total Release	Ci	2.52E-05	(6)	(6)	(6)	N/A
2. Average diluted conc. During period	µCi/ml	1.19E-14	(6)	(6)	(6)	
<b>E. VOLUME OF WASTE RELEASED (prior to dilution)</b>						
1. Volume processed through radwaste system	liters	8.92E+07	1.01E+08	6.16E+07	1.16E+08	±1.30E+00
<b>F. VOLUME OF DILUTION USED DURING PERIOD (7)</b>	liters	2.12E+12	2.42E+12	2.44E+12	2.36E+12	±1.64E+01

**APPENDIX A**  
**ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT FOR**  
**CALVERT CLIFFS NUCLEAR POWER PLANT AND**  
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**NOTES TO TABLE 2A**

- (1) Percent of I.C.3 Quarterly Organ Dose Limit (10 mRem) to maximum exposed organ
- (2) Percent of I.C.3 Yearly Organ Dose Limit (20 mRem) to maximum exposed organ
- (3) Percent of I.C.3 Quarterly Whole Body Dose Limit (3 mRem)
- (4) Percent of I.C.3 Yearly Whole Body Dose Limit (6 mRem)
- (5) Limit used is  $3 \times 10^{-3}$   $\mu\text{Ci/ml}$
- (6) Less than minimum detectable activity which meets the LLD requirements of ODCM Surveillance Requirement 4.11.1.1.1.
- (7) Includes dilution water used during continuous discharges.

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**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
Beryllium - 7	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Sodium - 24	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Chromium - 51	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Manganese - 54	Ci	(1)	(1)	(1)	(1)	6.28E-06	(1)	1.68E-06	2.65E-06
Iron - 55	Ci	(2)	(2)	(2)	(2)	2.98E-03	(1)	1.47E-05	(1)
Cobalt - 57	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Cobalt - 58	Ci	(1)	(1)	(1)	(1)	9.29E-04	2.29E-03	1.93E-04	3.24E-05
Iron - 59	Ci	(1)	(1)	(1)	(1)	(1)	(1)	1.77E-06	(1)
Cobalt - 60	Ci	(1)	(1)	(1)	(1)	2.21E-04	1.05E-04	1.28E-04	7.31E-05
Nickel-63	Ci	(1)	(1)	(1)	(1)	1.13E-03	(1)	7.35E-06	(1)
Zinc - 65	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Strontium - 89	Ci	(1)	(1)	(1)	(1)	4.13E-04	(1)	(1)	(1)
Strontium - 90	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Strontium - 91	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Strontium - 92	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Niobium - 95	Ci	(1)	(1)	(1)	(1)	2.02E-06	(1)	(1)	(1)
Zirconium - 95	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Niobium - 97	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Zirconium - 97	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Molybdenum - 99	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Technetium - 99m	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Ruthenium - 103	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Rhodium - 105	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Ruthenium - 105	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Silver - 110m	Ci	(1)	(1)	(1)	(1)	8.25E-05	(1)	(1)	(1)
Tin - 113	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tin - 117m	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Antimony - 122	Ci	(1)	(1)	(1)	(1)	(1)	(1)	4.41E-05	(1)
Antimony - 124	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)

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**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
Antimony - 125	Ci	(1)	(1)	(1)	(1)	2.53E-06	3.26E-05	9.52E-05	(1)
Tellurium - 125m	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tellurium - 132	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Iodine - 131	Ci	(1)	(1)	(1)	(1)	4.58E-06	(1)	(1)	2.12E-05
Iodine - 132	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Iodine - 133	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	1.98E-06
Iodine - 135	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Cesium - 134	Ci	(1)	(1)	(1)	(1)	2.36E-04	1.58E-04	2.92E-04	3.27E-05
Cesium - 136	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Cesium - 137	Ci	(1)	(1)	(1)	(1)	5.34E-04	3.92E-04	1.13E-03	2.08E-04
Barium - 140	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Lanthanum - 140	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Cerium - 144	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Europium - 154	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Europium - 155	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tungsten - 187	Ci	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Total For Period	Ci	(1)	(1)	(1)	(1)	6.54E-03	2.98E-03	1.91E-03	3.72E-04
Krypton - 85	Ci	(1)	(1)	(1)	(1)	6.03E-03	(1)	(1)	(1)
Xenon - 131m	Ci	(1)	(1)	(1)	(1)	7.57E-04	(1)	(1)	(1)
Xenon - 133	Ci	(1)	(1)	(1)	(1)	7.47E-02	4.23E-05	7.12E-03	3.04E-03
Xenon - 133m	Ci	(1)	(1)	(1)	(1)	7.84E-06	(1)	(1)	(1)
Xenon - 135	Ci	(1)	(1)	(1)	(1)	1.59E-05	(1)	(1)	(1)
Total For Period	Ci	(1)	(1)	(1)	(1)	8.15E-02	4.23E-05	7.12E-03	3.04E-03

**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.

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**TABLE 3A - SOLID WASTE AND IRRADIATED FUEL SHIPMENTS**

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

<b>1. Type of Waste</b>	<b>Units</b>	<b>12-Month Period</b>	<b>Est. Total Error % (Ci)</b>
a) Spent resins, Filters	m <sup>3</sup> Ci	1.86E+01 1.25+02	25%
b) Dry compressible waste, contaminated equipment, etc.	m <sup>3</sup> Ci	1.04E+03 1.23E+00	25%
c) Irradiated components, control rods, etc.	m <sup>3</sup> Ci	0.00E-00 0.00E+00	N/A
d) Other (cartridge filters, misc. dry compressible, Oil)	m <sup>3</sup> Ci	2.55E+00 1.97E+00	25%

Volume shipped represents waste generated prior to offsite volume reduction.

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

a)	Fe-55	16.6%
	Co-58	1.71%
	Co-60	5.40%
	Ni-63	33.2%
	Sb-125	1.5%
	Cs-134	16.4%
	Cs-137	23.3%
b)	H-3	1.0%
	Cr-51	1.1%
	Fe-55	38.9%
	Co-58	15.4%
c)	N/A	
d)	H-3	3.9%
	Fe-55	6.1%
	Co-60	5.2%
	Ni-63	39.8%
	Cs-134	12.4%
	Cs-137	31.5%

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**3. Solid Waste Disposition**

<u>Number of Shipments</u>	<u>Mode of Transportation</u>	<u>Destination</u>
24	Motor Surface Transit	Studsvik Processing Facility Memphis, TN
6	Motor Surface Transit	Studsvik Processing Facility Erwin, TN

**B. IRRADIATED FUEL SHIPMENTS (DISPOSITION)** N/A