



Larry D. Smith
Regulatory Assurance Manager

Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657
410 495 5219 Office
410 495 2067 Fax
410 610 9729 Mobile

www.constellation.com
larry.smith2@constellation.com

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

June 9, 2023

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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 Units 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 attached.
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 me at (410) 495-5219.

Respectfully,

A handwritten signature in black ink that reads "Larry D. Smith".

Larry D. Smith
Regulatory Assurance Manager

LDS/aj

Attachment: (1) Radioactive Effluent Release Annual Report - 2022

Document Control Desk

June 9, 2023

Page 2

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

S. Seaman, MD-DNR
Director, NMSS
C. Stewart, ANI

ATTACHMENT (1)

**ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT FOR
CALVERT CLIFFS NUCLEAR POWER PLANT UNITS 1 AND 2
AND THE INDEPENDENT SPENT FUEL STORAGE INSTALLATION**



2022

Annual Radioactive Effluent Release Report

Document Number: 50-317 and 50-318

TABLE OF CONTENTS

- 1.0 LIST OF ACRONYMS AND DEFINITIONS 3
- 2.0 EXECUTIVE SUMMARY 5
 - 2.1 Comparison to Regulatory Limits 6
- 3.0 INTRODUCTION 8
 - 3.1 About Nuclear Power 8
 - 3.2 About Radiation Dose 9
 - 3.3 About Dose Calculation 11
- 4.0 DOSE ASSESSMENT FOR PLANT OPERATIONS 12
 - 4.1 Regulatory Limits 12
 - 4.2 Regulatory Limits for Gaseous Effluent Doses: 13
 - 4.3 Regulatory Limits for Liquid Effluent Doses 14
 - 4.4 40 CFR 190 Regulatory Dose Limits for a Member of the Public 14
 - 4.5 Maximum Permissible Concentration (MPC) 14
 - 4.6 Onsite Doses (Within Site Boundary) 15
- 5.0 SUPPLEMENTAL INFORMATION 16
 - 5.1 Gaseous Batch Releases 16
 - 5.2 Liquid Batch Releases 16
 - 5.3 Abnormal Releases 16
 - 5.4 Land Use Census Changes 16
 - 5.5 Meteorological Data 17
 - 5.6 Effluent Radiation Monitors Out of Service Greater Than 30 Days 18
 - 5.7 Offsite Dose Calculation Manual (ODCM) Changes 18
 - 5.8 Process Control Program (PCP) Changes 19
 - 5.9 Radioactive Waste Treatment System Changes 19
 - 5.10 Other Supplemental Information 19
- 6.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM 20
 - 6.1 Voluntary Notification 20

TABLES

- Table 1, Calvert Cliffs Nuclear Power Plant Site Dose Summary 6
- Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for CCNPP 7
- Table 3, Members of the Public Doses Within Site Boundary at Special Interest Locations 15
- Table 4, Classification of Atmospheric Stability for Elevations 10 meters and 60 meters 17
- Table 5, Location with the Highest Meteorological X/Q and D/Q Values and Special Interest Onsite Locations, 2022 18
- Table 6, Gaseous Effluents Summation of All Releases for CCNPP Site 22
- Table 7, Gaseous Effluents – Ground Level Release Batch Mode for CCNPP Site 23
- Table 8, Gaseous Effluents – Ground Level Release Continuous Mode for CCNPP Site 24
- Table 9, Liquid Effluents – Summation of All Releases for CCNPP Site 25

Table 10, Batch Mode Liquid Effluents for CCNPP Site 26

Table 11, Continuous Mode Liquid Effluents for CCNPP Site 27

Table 12, Resins, Filters, and Evaporator Bottoms Summary for the Calvert Cliffs Site 28

Table 13, Dry Active Waste (DAW) Summary for the Calvert Cliffs Site 29

Table 14, Irradiated Components Summary for the Calvert Cliffs Site 30

Table 15, Other Waste Summary for the Calvert Cliffs Site 31

Table 16, Sum of All Low-Level Waste Shipped from the Calvert Cliffs Site 32

Table 17, Solid Waste Shipped from the Calvert Cliff Site 33

FIGURES

Figure 1, Pressurized Water Reactor (PWR) 8

Figure 2, Boiling Water Reactor (BWR) 8

Figure 3, Sources of Radiation Exposure 10

Figure 4, Potential exposure pathways to Members of the Public due to Plant Operations 11

ATTACHMENTS

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables) 22

Attachment 2, Solid Waste Information 28

1.0 LIST OF ACRONYMS AND DEFINITIONS

1. Airborne Activity Sampling: Sampling of air through the collection of particulates and radionuclides on filter media, collection of noble gases in a container, and collection of water vapor containing tritium.
2. Alpha Particle (α): A charged particle emitted from the nucleus of an atom having a mass and charge equal in magnitude of a helium nucleus.
3. BWR: Boiling Water Reactor
4. Composite Sample: A series of single collected portions (aliquots) analyzed as one sample. The aliquots making up the sample are collected at time intervals that are very short compared to the composite period.
5. Control: A sampling station in a location not likely to be affected by plant effluents due to its distance and/or direction from the Plant.
6. Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based on total counts accumulated.
7. Curie (Ci): A measure of radioactivity; equal to 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.
8. Direct Radiation Monitoring: The measurement of radiation dose at various distances from the plant is assessed using thermoluminescent dosimeters (TLDs), optically stimulated luminescent dosimeters (OSLDs), and/or pressurized ionization chambers.
9. Grab Sample: A single discrete sample drawn at one point in time.
10. Indicator: A sampling location that is likely to be affected by plant effluents due to its proximity and/or direction from the plant.
11. Ingestion Pathway: The ingestion pathway includes milk, fish, and garden produce. Meat or other food products may also be included.
12. ISFSI: Independent Spent Fuel Storage Installation
13. Lower Limit of Detection (LLD): The smallest concentration of radioactive material in a sample that will yield a net count (above system background) that will be detected with 95% probability with a 5% probability of a false conclusion that a blank observation represents "real" signal.
14. MDA: Minimum Detectable Activity. - For radiochemistry instruments, the MDA is the a posteriori minimum concentration that a counting system detects. The smallest concentration or activity of radioactive material in a sample that will yield a net count above instrument background and that is detected with 95% probability, with only five % probability of falsely concluding that a blank observation represents a true signal.
15. MDC: Minimum Detectable Concentration, essentially synonymous with MDA for the purposes of radiological monitoring.
16. Mean: The average, i.e., the sum of results divided by the number of results.
17. Microcurie (μCi): 3.7×10^4 disintegrations per second, or 2.22×10^6 disintegrations per minute.

Company: Constellation**Plant: Calvert Cliffs Nuclear Power Plant**

18. millirem (mrem): 1/1000 rem; a unit of radiation dose equivalent in tissue.
19. Milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X- or gamma radiation.
20. MPC: Maximum Permissible Concentration
21. MWe: Megawatts Electric
22. MWTh: Megawatts Thermal
23. N/A: Not Applicable
24. NEI: Nuclear Energy Institute
25. NRC: Nuclear Regulatory Commission
26. ODCM: Offsite Dose Calculation Manual
27. OSLD: Optically Stimulated Luminescence Dosimeter
28. Protected Area: The fenced area immediately surrounding the Plant. Access to the protected area requires a security badge or escort.
29. PWR: Pressurized Water Reactor
30. REC: Radiological Effluent Control
31. REMP: Radiological Environmental Monitoring Program
32. Restricted Area: Any area where access is controlled for the purpose of protecting individuals from exposure to radiation or radioactive materials.
33. SLCs: Selected Licensee Commitments
34. TEDE: Total Effective Dose Equivalent (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).
35. TLD: Thermoluminescent Dosimeter
36. TRM: Technical Requirements Manual
37. TS: Technical Specification

Company: Constellation**Plant: Calvert Cliffs Nuclear Power Plant**

2.0 EXECUTIVE SUMMARY

Calvert Cliffs Nuclear Power Plant (CCNPP) Radiological Effluent Control (REC) Program was established to limit the quantities of radioactive material that may be released based on calculated radiation doses or dose rates. Dose to Members of the Public due to radioactive materials released from the plant is limited by Appendix I of 10 CFR 50 and by 40 CFR 190. Operational doses to the public during 2022 were calculated to be very small compared to the limits required by regulation and compared to other sources of radiation dose and pose no health hazard. These doses are summarized and compared to the regulatory limits in Section 2.1, Comparison to Regulatory Limits, below.

The Annual Radioactive Effluent Release Report (ARERR) is published per the REC requirements and provides data related to plant operation, including: quantities of radioactive materials released in liquid and gaseous effluents; radiation doses to members of the public; radioactive releases from the ISFSI, solid radioactive waste shipped offsite for disposal; and other information as required by site licensing documents.

In 2022 the Land Use Census dose assessments due to radioactive gaseous effluents showed that the critical receptor for Calvert Cliffs Nuclear Power Plant is Teenager due to the Inhalation pathway, at 2.4 km in the SE sector. The maximum Annual Organ Dose calculated for this receptor was 3.79E-04 mrem to the Liver (Table 1, Calvert Cliffs Nuclear Power Plant Site Dose Summary). This annual dose is a small fraction (0.0013%) of the 10 CFR 50, Appendix I guideline of 30mrem to the Maximum Organ per two reactor units.

Solid radioactive waste shipped offsite for disposal included 2.74E+01 Curies and 1.16E+02 m³, shipped in 9 shipments.

40 CFR 190 [1] limits the total dose to a the maximum exposed Member of the Public to 25 mrem to the total body, 75 mrem to the thyroid and 25 mrem to other organs other than the thyroid. The maximum annual total body and organ doses from gaseous and liquid pathways with all other uranium fuel cycle sources present on site were calculated as required by Control 3.11.4 (Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for CCNPP). The calculated dose to the Total Body, Thyroid, and Organ other than the Thyroid were 4.43E-02, 3.21E-02, and 1.87E-01 mrem, respectively. The Total Body and Organ doses represented 0.177% and 0.746%, respectively of the 25 mrem dose limit. The Thyroid dose was 0.043% of the 75 mrem dose limit.

In addition to monitoring radioactive effluents, CCNPP has a Radiological Environmental Monitoring Program (REMP) that monitors for buildup of radioactivity in the offsite environment. Data from the REMP is published in the Annual Radiological Environmental Operating Report (AREOR).

2.1 Comparison to Regulatory Limits

During 2022 all solid, liquid, and gaseous radioactive effluents from Calvert Cliffs Nuclear Power Plant were well below regulatory limits, as summarized in Table 1 and Table 2.

Table 1, Calvert Cliffs Nuclear Power Plant Site Dose Summary¹

Liquid Effluent		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
	Limit	3 mrem	3 mrem	3 mrem	3 mrem	6 mrem
	Total Body Dose ²	5.82E-03	6.90E-03	4.12E-04	3.78E-04	1.35E-02
	% of Limit	0.194	0.230	0.014	0.013	0.225
	Limit	10 mrem	10 mrem	10 mrem	10 mrem	20 mrem
	Max Organ Dose ³	2.11E-02	9.74E-03	8.14E-04	2.27E-03	3.40E-02
	% of Limit	0.211	0.097	0.008	0.023	0.170
Gaseous Effluent						
	Limit	10 mrad	10 mrad	10 mrad	10 mrad	20 mrad
	Gamma Air Dose ⁴	3.45E-05	2.01E-05	2.21E-05	1.85E-05	9.53E-05
	% of Limit	0.0003	0.0002	0.0002	0.0002	0.0005
	Limit	20 mrad	20 mrad	20 mrad	20 mrad	40 mrad
	Beta Air Dose ⁴	1.23E-04	7.19E-06	1.86E-05	6.59E-06	1.55E-04
	% of Limit	0.0006	0.0000	0.0001	0.0000	0.0004
	Limit	2.5 mrem	2.5 mrem	2.5 mrem	2.5 mrem	5 mrem
	NG Total Body Dose ⁴	3.11E-05	1.91E-05	2.06E-05	1.76E-05	8.83E-05
	% of Limit	0.0012	0.0008	0.0008	0.0007	0.0018
	Limit	7.5 mrem	7.5 mrem	7.5 mrem	7.5 mrem	15 mrem
	Noble Gas Skin Dose ⁴	1.06E-04	2.79E-05	3.32E-05	2.57E-05	1.93E-04
	% of Limit	0.0014	0.0004	0.0004	0.0003	0.0013
	Limit	15 mrem	15 mrem	15 mrem	15 mrem	30 mrem
	Max Organ Dose ⁵	6.77E-05	1.11E-04	9.63E-05	1.04E-04	3.79E-04
	% of Limit	0.0005	0.0007	0.0006	0.0007	0.0013

¹ Table 1 demonstrates compliance with 10 CFR Part 50, App. I Limits.

² Adult at NE 0.5 miles,

³ Adult at NE 0.5 miles, GI-LI

⁴ All age groups SE 2.4 km

⁵ Teenager at SE 2.4 km, Liver. Does not include C-14 dose.

Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for CCNPP¹

	Whole Body	Thyroid	Max Other Organ
Gaseous ²			
Noble Gas	8.83E-05	8.83E-05	8.83E-05
Particulates/Iodines	3.79E-04	3.79E-04	3.79E-04
Carbon-14 ³	3.04E-02	3.04E-02	1.52E-01
Liquid	1.35E-02	1.24E-03	3.40E-02
Direct Shine	N/A	N/A	N/A
Total Site Dose ⁴	4.43E-02	3.21E-02	1.87E-01
Total w/Other Nearby Facility ⁵	4.43E-02	3.21E-02	1.87E-01
Limit	25 mrem	75 mrem	25 mrem
% of Limit	0.177	0.043	0.746

¹ Table 2 is a summation of Units to show compliance with 40 CFR Part 190 Limits.

² Gaseous dose values in Table 2 include Total Body, Thyroid and Organ doses from Noble Gas, Iodine, Tritium, Particulates \geq 8-day half-life and C-14.

³ SW 2.57 km resident and garden

⁴ Individual group with the highest dose used producing a hybrid: Adult for Liquid, Teenager for Gas and Child for C-14. Individual age group sum is lower.

⁵ Other fuel cycle sources within 5 miles of the site are considered in this analysis. However, none exist.

3.0 INTRODUCTION

3.1 About Nuclear Power

Commercial nuclear power plants are generally classified as either Boiling Water Reactors (BWRs) or Pressurized Water Reactors (PWRs), based on their design. A BWR includes a single coolant system where water used as reactor coolant boils as it passes through the core and the steam generated is used to turn the turbine generator for power production. A PWR, in contrast, includes two separate water systems: radioactive reactor coolant and a secondary system. Reactor coolant is maintained under high pressure, preventing boiling. The high-pressure coolant is passed through a heat exchanger called a steam generator where the secondary system water is boiled, and the steam is used to turn the turbine generator for power production.

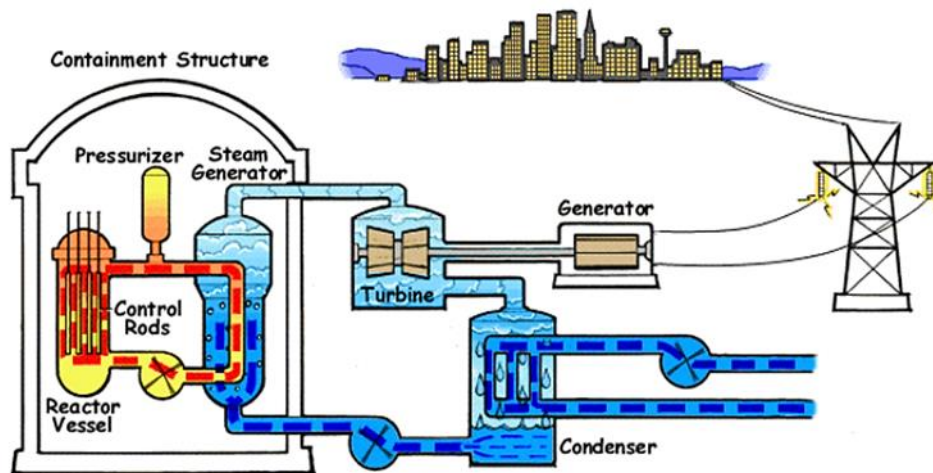


Figure 1, Pressurized Water Reactor (PWR) [2]

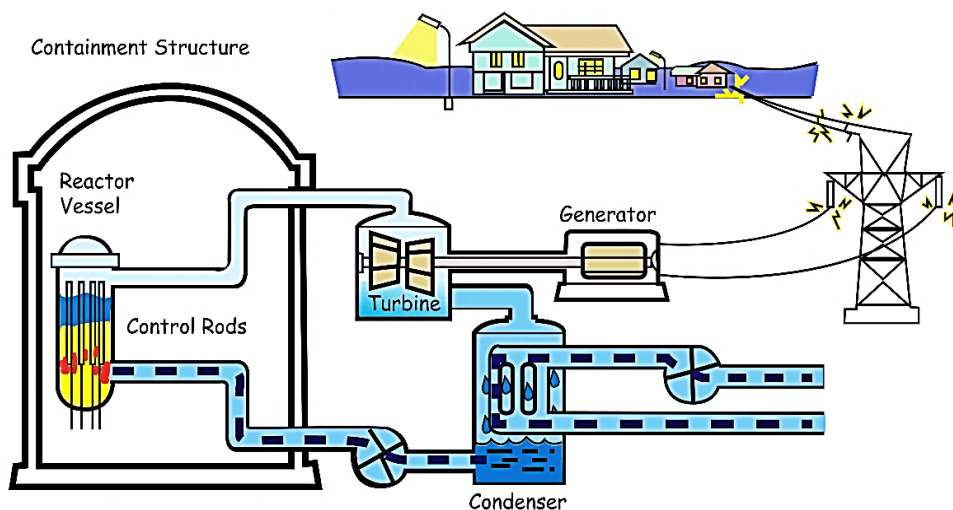


Figure 2, Boiling Water Reactor (BWR) [3]

Annual Radioactive Effluent Release Report	YEAR: 2022	Page 9 of 33
Company: Constellation	Plant: Calvert Cliffs Nuclear Power Plant	

3.1 (Continued)

Electricity is generated by a nuclear power plant similarly to the way that electricity is generated at other conventional types of power plants, such as those driven by coal or natural gas. Water is boiled to generate steam; the steam turns a turbine that is attached to a generator and the steam is condensed back into water to be returned to the boiler. What makes nuclear power different from these other types of power plants is that the heat is generated by fission and decay reactions occurring within and around the core containing fissionable uranium (U-235).

Nuclear fission occurs when certain nuclides (primarily U-233, U-235, or Pu-239) absorb a neutron and break into several smaller nuclides (called fission products) as well as some additional neutrons.

Fission results in production of radioactive materials including gases and solids that must be contained to prevent release or treated prior to release. These effluents are generally treated by filtration and/or hold-up prior to release. Releases are generally monitored by sampling and by continuously indicating radiation monitors. The effluent release data is used to calculate doses to ensure that dose to the public due to plant operation remains within required limits.

3.2 **About Radiation Dose**

Ionizing radiation, including alpha, beta, and gamma radiation from radioactive decay, has enough energy to break chemical bonds in tissues and result in damage to tissue or genetic material. The amount of ionization that will be generated by a given exposure to ionizing radiation is quantified as dose. Radiation dose is generally reported in units of millirem (mrem) in the US.

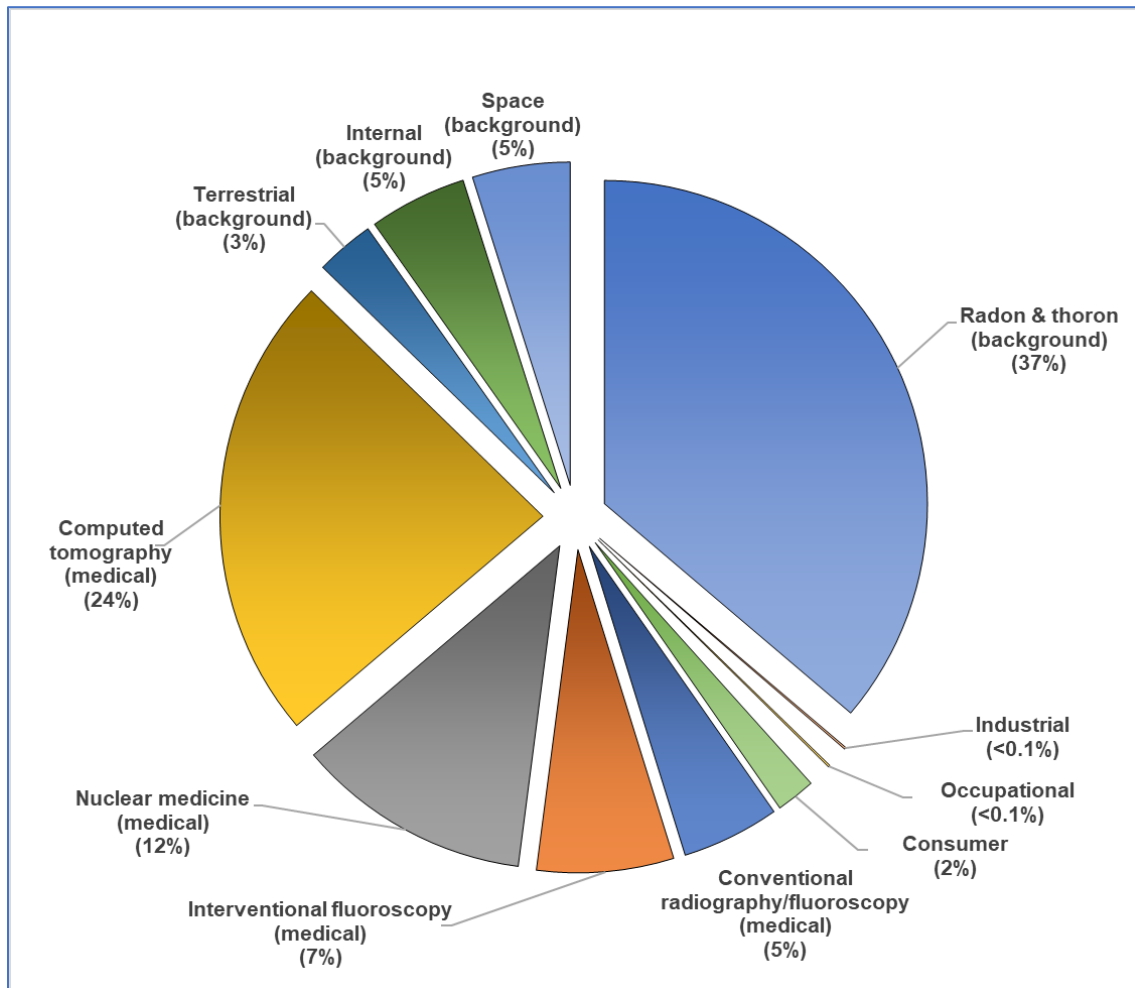


Figure 3, Sources of Radiation Exposure [4]

The National Council on Radiation Protection (NCRP) has evaluated the population dose for the US and determined that the average individual is exposed to approximately 620 mrem per year [4]. There are many sources for radiation dose, ranging from natural background sources to medical procedures, air travel, and industrial processes. Approximately half (310 mrem) of the average exposure is due to natural sources of radiation including exposure to Radon, cosmic radiation, and internal radiation and terrestrial due to naturally occurring radionuclides. The remaining 310 mrem of exposure is due to man-made sources of exposure, with the most significant contributors being medical (48%) due to radiation used in various types of medical scans and treatments. Of the remaining 2% of dose, most is due to consumer activities such as air travel, smoking cigarettes, and building materials. A small fraction of this 2% is due to industrial activities including generation of nuclear power.

Readers that are curious about common sources and effects of radiation dose that they may encounter can find excellent sources of information from the Health Physics Society, including the Radiation Fact Sheets [5], and from the US Nuclear Regulatory Commission website [6].

3.3 About Dose Calculation

Concentrations of radioactive material in the environment resulting from plant operations are very small and it is not possible to determine doses directly using measured activities of environmental samples. To overcome this, Dose Calculations based on measured activities of effluent streams are used to model the dose impact for Members of the Public due to plant operation and effluents. There are several mechanisms that can result in dose to Members of the Public, including: Ingestion of radionuclides in food or water; Inhalation of radionuclides in air; Immersion in a plume of noble gases; and Direct Radiation from the ground, the plant or from an elevated plume.

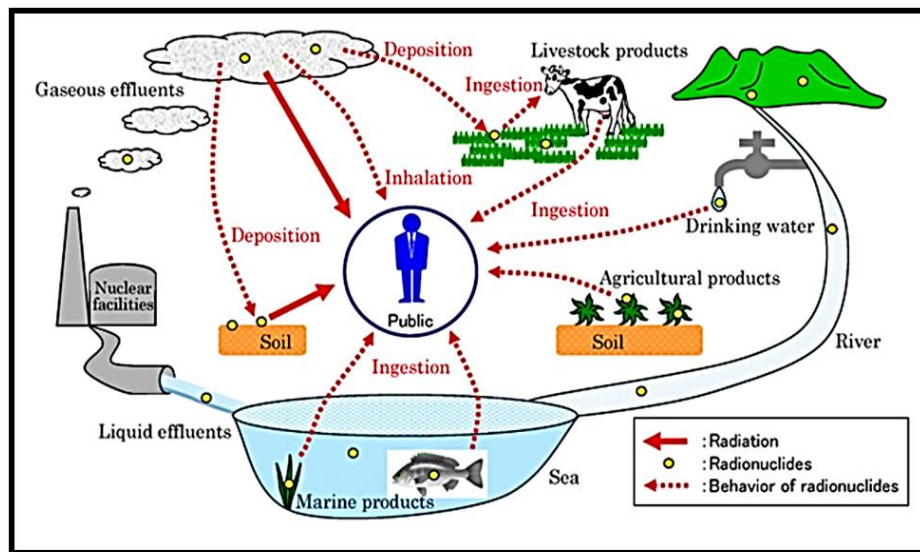


Figure 4, Potential exposure pathways to Members of the Public due to Plant Operations [7]

The Offsite Dose Calculation Manual (ODCM) specifies the methodology used to obtain the doses in the Dose Assessment section of this report. The methodology in the ODCM is based on NRC Regulatory Guide 1.109 [8] and NUREG-0133 [9]. Doses are calculated by determining what the nuclide concentration will be in air, water, on the ground, or in food products based on plant effluent releases. Release points are continuously monitored to quantify what concentrations of nuclides are being released. For gaseous releases meteorological data is used to determine how much of the released activity will be present at a given location outside of the plant either deposited onto the ground or in gaseous form. Intake patterns and nuclide bio-concentration factors are used to determine how much activity will be transferred into animal milk or meat. Finally, human ingestion factors and dose factors are used to determine how much activity will be consumed and how much dose the consumer will receive. Inhalation dose is calculated by determining the concentration of nuclides and how much air is breathed by the individual.

For liquid releases, dilution and mixing factors are used to model the environmental concentrations in water. Drinking water pathways are modeled by determining the concentration of nuclides in the water at the point where the drinking water is sourced. Fish and invertebrate pathways are determined by using concentration at

3.3 (Continued)

the release point, bioaccumulation factors for the fish or invertebrate and an estimate of the quantity of fish consumed.

Each year a Land Use Census is performed to determine what potential dose pathways currently exist within a five-mile radius around the plant, the area most affected by plant operations. The Annual Land Use Census identifies the locations of vegetable gardens, nearest residences, milk animals and meat animals. The data from the census is used to determine who is the likely to be most exposed to radiation dose because of plant operations.

There is significant uncertainty in dose calculation results, due to modeling dispersion of material released and bioaccumulation factors, as well as assumptions associated with consumption and land-use patterns. Even with these sources of uncertainty, the calculations do provide a reasonable estimate of the order of magnitude of the exposure. Conservative assumptions are made in the calculation inputs such as the number of various foods and water consumed, the amount of air inhaled, and the amount of direct radiation exposure from the ground or plume, such that the actual dose received are likely lower than the calculated dose. Even with the built-in conservatism, doses calculated for the highest hypothetical exposed individual due to plant operation are a very small fraction of the annual dose that is received due to other sources. The low calculated doses due to plant effluents, along with REMP results, serve to provide assurance that the site is not having a negative impact on the environment or people living near the plant.

4.0 DOSE ASSESSMENT FOR PLANT OPERATIONS

4.1 Regulatory Limits

Regulatory limits are detailed in Station Licensing documents such as the Offsite Dose Calculation Manual (ODCM) and Technical Specifications 5.5.f., 5.5.g., 5.5.h., 5.5.i., 5.5.j., 5.5.k., and 5.5.l. These documents contain the limits to which CCNPP must adhere. CCNPP drives to maintain the philosophy to keep dose "as low as reasonably achievable" (ALARA) and actions are taken to reduce the amount of radiation released to the environment. Liquid and gaseous release data show that the dose from CCNPP is well below these limits. The concentration of liquid radioactive material released shall be limited to the concentration specified in 10 CFR 20, Appendix B, Table II, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the total concentration released shall be limited to 2.0×10^{-4} microcuries/ml. These data reveals that the radioactive effluents have an overall minimal dose contribution to the surrounding environment.

The annual whole body, skin and organ dose was computed using the 2022 source term using the dose calculation methodology provided in the ODCM. The calculated doses due to gaseous effluents to demonstrate compliance with offsite dose limits are presented in Table 1, Calvert Cliffs Nuclear Power Plant Site Dose Summary and Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for CCNPP.

4.2 Regulatory Limits for Gaseous Effluent Doses:

1. Fission and activation gases:
 - a. Noble gases dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:
 - 1) Less than or equal to 500 mrem/year to the total body
 - 2) Less than or equal to 3000 mrem/year to the skin
 - b. Noble gas air dose due to noble gases released in gaseous effluents, from each reactor unit to areas at and beyond the site boundary shall be limited to the following:
 - 1) Quarterly
 - a) Less than or equal to 5 mrad gamma
 - b) Less than or equal to 10 mrad beta
 - 2) Yearly
 - a) Less than or equal to 10 mrad gamma
 - b) Less than or equal to 20 mrad beta
2. Iodine, tritium, and all radionuclides in particulate form with half-lives greater than 8 days.
 - a. The dose rate for iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from the site to areas at and beyond the site boundary shall be limited to the following:
 - 1) Less than or equal to 1500 mrem/yr to any organ
 - b. The dose to a MEMBER OF THE PUBLIC from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than 8 DAYS in gaseous effluents released, from each reactor unit to areas at and beyond the site boundary shall be limited to the following:
 - 1) Quarterly
 - a) Less than or equal to 7.5 mrem to any organ
 - 2) Yearly
 - a) Less than or equal to 15 mrem to any organ

Company: Constellation**Plant: Calvert Cliffs Nuclear Power Plant****4.3 Regulatory Limits for Liquid Effluent Doses**

1. The dose or dose commitment to a MEMBER OF THE PUBLIC from radioactive materials in liquid effluents released, from each reactor unit to unrestricted areas shall be limited to the following:
 - a. Quarterly
 - 1) Less than or equal to 1.5 mrem total body
 - 2) Less than or equal to 5 mrem critical organ
 - b. Yearly
 - 1) Less than or equal to 3 mrem total body
 - 2) Less than or equal to 10 mrem critical organ

4.4 40 CFR 190 Regulatory Dose Limits for a Member of the Public

1. Total Dose (40 CFR 190)
 - a. The annual (calendar year) dose or dose commitment to any MEMBER OF THE PUBLIC in the unrestricted area due to releases of radioactivity and to radiation from uranium fuel cycle sources shall be limited to the following:
 - 1) Less than or equal to 25 mrem, Total Body or any Organ except Thyroid.
 - 2) Less than or equal to 75 mrem, Thyroid.

4.5 Maximum Permissible Concentration (MPC)

1. 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.

2. 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 the above

3.34.5 (Continued)

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.

3. Liquid Effluents

The MPC 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.

4.6 Onsite Doses (Within Site Boundary)

This section evaluates dose to non-occupationally exposed workers and members of the public that may be onsite for various reasons. The report must include any other information as may be required by the Commission to estimate maximum potential annual radiation doses to the public resulting from effluent releases as required by 10 CFR 50.36a(a)(2). While within controlled or restricted areas, the limits from Sections 4.1 through 4.4 do not apply; however, 10 CFR 20.1301 [10] dose limit of 100 mrem per year TEDE and dose rate limit of 2 mrem per hour from external sources continue to apply. Occupancy times within the controlled areas are generally sufficiently low to compensate for increase in the atmospheric dispersion factor above the site boundary. Groups of concern include Members of the Public at Camp Conoy and the Visitor Center. Use of a conservative occupancy factors of 0.386 and 0.038 spent inside the site boundary by these groups conservatively represents the most-exposed individual.

Table 3, Members of the Public Doses Within Site Boundary at Special Interest Locations¹

Location	Sector	Approx. Distance (Meters)	Occupancy Factor	X/Q sec/m ³	D/Q 1/m ²
Camp Conoy	SE	914.4	0.386	2.23E-07	5.60E-09
Visitor Center	WNW	304.8	0.038	8.68E-06	8.68E-08

Location	Total Body Dose (mrem)		Total Total Body Dose (mrem)	Organ Dose CDE (mrem) ²			TEDE Dose (mrem)	Percent of 10 CFR 20 [11] Dose Limit 100 mrem
	Noble Gas	Iodine, Particulate, C-14 & H-3		Noble Gas	Iodine, Particulate, C-14 & H-3	Total CDE (mrem)		
Camp Conoy	2.41E-06	3.66E-04	3.69E-04	6.33E-06	1.91E-03	1.92E-03	2.29E-03	0.0023
Visitor Center	9.23E-06	1.40E-03	1.41E-03	2.43E-05	7.33E-03	7.35E-03	8.77E-03	0.0088

¹ Pathways are Plume, Ground Plane, and Inhalation

² Age Group: Child, Critical Organ: Bone

5.0 SUPPLEMENTAL INFORMATION

5.1 Gaseous Batch Releases

5.1.1 CCNPP Site

	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1. Number of Batch Releases		29	24	26	20	99
2. Total duration of batch releases	minutes	1.37E+04	9.75E+03	1.05E+04	8.46E+03	4.24E+04
3. Maximum batch release duration	minutes	4.38E+03	6.08E+02	1.04E+03	6.96E+02	4.38E+03
4. Average batch release duration	minutes	4.72E+02	4.06E+02	4.04E+02	4.23E+02	4.28E+02
5. Minimum batch release duration	minutes	4.60E+01	2.32E+02	1.05E+02	1.98E+02	4.60E+01

5.2 Liquid Batch Releases

5.2.1 CCNPP Site

	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1. Number of Batch Releases ¹		16	8	10	9	43
2. Total duration of batch releases	minutes	3.79E+04	5.11E+03	6.27E+03	5.38E+03	5.47E+04
3. Maximum batch release duration	minutes	1.51E+04	7.49E+02	7.22E+02	6.52E+02	1.51E+04
4. Average batch release duration	minutes	2.37E+03	6.39E+02	6.27E+02	5.98E+02	1.27E+03
5. Minimum batch release duration	minutes	3.43E+02	5.67E+02	5.69E+02	5.42E+02	3.43E+02
6. Average stream flow during periods of release of liquid Effluent into a flowing stream:	LPM	4.61E+06	4.62E+06	4.61E+06	4.62E+06	4.61E+06

5.3 Abnormal Releases

5.3.1 Gaseous Abnormal Releases

There were no abnormal gaseous releases from the CCNPP Site.

5.3.2 Liquid Abnormal Releases

There were no abnormal liquid releases from the CCNPP Site.

5.4 Land Use Census Changes

There were no significant changes in the Land Use Census that would affect the 2022 CCNPP Radiological Effluent Control Program.

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 Table 1, Table 9 and Table 10 of this report, they are not significant contributors to radioactive effluent and are therefore not included in this table.

Company: Constellation**Plant: Calvert Cliffs Nuclear Power Plant****5.5 Meteorological Data**

The CCNPP meteorological monitoring program achieved a 99.9% Joint Frequency Distribution data recovery. A summary of required meteorological data is included in the Annual Radiological Environmental Operating Report and is not included in this report. The Joint Frequency Distribution data is stored on site and available for review upon request. The meteorological data converts the hourly data into X/Q and D/Q values using the NRC computer code XOQDOQ [12].

5.5.1 Joint Frequency Distributions

1. Period of Record: 2022
2. Stability Class: All
 - a. Meteorological data are reported in number of hours for all stability classes.

Sensor Elevation	Period of Calm (hours)	Missing Data (hours)
10 m	32	6
60 m	2	73

5.5.2 Stability class

Table 4, Classification of Atmospheric Stability for Elevations 10 meters and 60 meters

Stability Condition	Pasquill Categories	Percentage 10 meters	Percentage 60 meters
Extremely Unstable	A	6.19	6.06
Moderately Stable	B	5.54	5.49
Slightly Unstable	C	6.29	6.27
Neutral	D	31.70	31.55
Slightly Stable	E	31.53	31.23
Moderately Stable	F	10.75	10.70
Extremely Stable	G	7.93	7.87

Table 5, Location with the Highest Meteorological X/Q and D/Q Values and Special Interest Onsite Locations, 2022¹

Location with Highest X/Q and D/Q	Sector	Distance km	X/Q sec/m ³	D/Q m ⁻²
Site Boundary	SW	1.70	3.77E-07	4.56E-09
Resident	SW	1.77	3.62E-07	4.21E-09
Garden	SSW	2.57	2.26E-07	1.87E-09
Meat Animal	S	2.57	2.74E-07	2.58E-09
Special Interest				
Camp Conoy	E	0.9	2.23E-07	5.60E-09
Visitor Center ²	WNW	0.3	8.68E-06	8.68E-08

5.6 Effluent Radiation Monitors Out of Service Greater Than 30 Days

1. 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 7/12/2013 and has remained inoperable since that time due to a failed detector. The RMS has remained out of service due to equipment obsolescence. The station is in the process of retiring RMS in place.
2. U1 Steam Generator Blowdown, 1-RE-4095, was declared out-of-service from 6/8/2019 past 12/31/2022, because of sample pump cavitation and loss of flow. 1-RE-4014 is credited by the ODCM as an equivalent monitor. With 1-RE-4014 in service, no compensatory actions were required.
3. U2 Steam Generator Blowdown, 2-RE-4095, was declared out-of-service from 4/16/2020 past 12/31/2022, because of sample pump cavitation and loss of flow. 2-RE-4014 is credited by the ODCM as an equivalent monitor. With 2-RE-4014 in service, no compensatory actions were required.
4. Common Liquid Waste Discharge Radiation Monitor 0-RE-2201 was out-of-service on 3/29/2022 due to high background and erratic readings. Flushing of the monitor with deionized water leveled out the background. The monitor was restored to service on 10/18/2022. The required compensatory sampling analysis of two independent samples and two independent Facility Staff members verified release rate calculations and verified discharge valve line up for each tank released.

5.7 Offsite Dose Calculation Manual (ODCM) Changes

There were no changes to the ODCM in 2022.

¹ Data From Murray and Trettel 2022 Annual Report, Tables 3-6 and 3-7

² X/Q values from ODCM page 203. D/Q value assumed to be 100 times lower.

Company: Constellation**Plant: Calvert Cliffs Nuclear Power Plant****5.8 Process Control Program (PCP) Changes**

There were no changes to the PCP in 2022.

5.9 Radioactive Waste Treatment System Changes

There were no changes to the Radioactive Waste Treatment System in 2022.

5.10 Other Supplemental Information**5.10.1 Temporary Outside Tanks**

There were no temporary outside tanks containing more the 10 curies of radioactive material except for tritium.

5.10.2 Independent Spent Fuel Storage Installation (ISFSI) Monitoring Program

There were 3 casks of spent fuel transferred to the ISFSI during the latter part of 2022. No radionuclides were released to the environment during the ISFSI operation in 2021. Additional information regarding the ISFSI radiological environmental monitoring program is included in the Annual Radiological Environmental Operation Report.

5.10.3 Carbon-14

Carbon-14 (C-14) is a naturally occurring radionuclide with a 5730-year half-life. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Nuclear power plants also produce C-14, but the amount is infinitesimal compared to what has been distributed in the environment due to weapons testing and what is produced by natural cosmic ray interactions.

In accordance with Regulatory Guide 1.21 [13], the NRC recommended re-evaluating "principal radionuclides" and reporting C-14 as appropriate. Carbon-14 production and release estimates were calculated using EPRI Report 1021106. [14] This calculation uses active core coolant mass, average neutron flux by energy and reactor coolant nitrogen concentrations to determine Carbon-14 generation based upon an effective full power year. The Calvert Cliffs Nuclear Power Plant during 2022 released 1.95E+01 Ci of C-14 in the gaseous form from the site.

Public dose estimates were performed using methodology from the ODCM which is based on Regulatory Guide 1.109 methodology. Carbon dioxide is assumed to make up 30% of the Carbon-14 gaseous emissions from the station based upon the EPRI reference. C-14 dose is not included in the dose calculations of Table 1, but is included in Table 2.

Annual Radioactive Effluent Release Report	YEAR: 2022	Page 20 of 33
Company: Constellation	Plant: Calvert Cliffs Nuclear Power Plant	

The pathways considered for C-14 doses was at the highest sector having a resident and garden located at 2.57 km SSW sector.

5.10.4 Errata/Corrections to Previous ARERRs

None

6.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

Calvert Cliffs Nuclear Power Plant has developed a Groundwater Protection Initiative (GPI) program in accordance with NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document [15]. The purpose of the GPI is to ensure timely detection and an effective response to situations involving inadvertent radiological releases to groundwater to prevent migration of licensed radioactive material off-site and to quantify impacts on decommissioning. During 2022, CCNPP collected and analyzed groundwater samples in accordance with the requirements of Site procedure CY-ES-214, Collection of RGPP Water Samples for Radiological Analysis.

The results of the NEI 07-07 Radiological Groundwater Monitoring Program are reported in the Annual Radiological Environmental Operating Report (AREOR).

6.1 Voluntary Notification

During 2022, Calvert Cliffs Nuclear Power Plant did not make any voluntary NEI 07-07 notification to State/Local officials, NRC, and to other stakeholders required by site procedures.

Annual Radioactive Effluent Release Report	YEAR: 2022	Page 21 of 33
Company: Constellation	Plant: Calvert Cliffs Nuclear Power Plant	

BIBLIOGRAPHY

- [1] "40 CFR 190 - Environmental Radiation Protection Standards for Nuclear Power Operation," US Environmental Protection Agency, Washington, DC.
- [2] Nuclear Regulatory Commission, 30 June 2015. [Online]. Available: <http://www.nrc.gov/reading-rm/basic-ref/students/animated-pwr.html>. [Accessed October 2020].
- [3] Nuclear Regulatory Commission, 25 June 2015. [Online]. Available: <http://www.nrc.gov/reading-rm/basic-ref/students/animated-bwr.html>. [Accessed October 2020].
- [4] "NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States", " National Council on Radiation Protection and Measurements, Bethesda, MD, 2009.
- [5] [Online]. Available: <http://hps.org/hpspublications/radiationfactsheets.html>. [Accessed 2020].
- [6] "NRC Resource Page," [Online]. Available: <http://www.nrc.gov/about-nrc/radiation.html>. [Accessed 10 November 2020].
- [7] "Japan Atomic Energy Agency," 06 November 2020. [Online]. Available: https://www.jaea.go.jp/english/04/ntokai/houkan/houkan_02.html.
- [8] "Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Demonstrating Compliance with 10 CFR Part 50, Appendix I," Nuclear Regulatory Commission, October, 1977.
- [9] "NUREG-0133, Preparation of Effluent Technical Specifications for Nuclear Power Plants," Nuclear Regulatory Commission, 1987.
- [10] "NUREG-1301, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," Nuclear Regulatory Commission, April 1991.
- [11] "10 CFR 20 - Standards for Protection Against Radiation," US Nuclear Regulatory Commission, Washington, DC.
- [12] "NUREG-0324, XOQDOQ, Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," Nuclear Regulatory Commission, September, 1977.
- [13] "Regulatory Guide 1.21, Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste," U.S. NRC, Washington, DC, 2009.
- [14] "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents," EPRI, Palo Alto, CA, , 2010 1021106.
- [15] "NEI 07-07 - Industry Ground Water Protection Initiative — Final Guidance Document, Rev. 1," Nuclear Energy Institute, Washington, D.C., 2019.
- [16] "Regulatory Guide 4.13, Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications, Revision 2," Nuclear Regulatory Commission, June, 2019.
- [17] "Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment," Nuclear Regulatory Commission, July, 2007.
- [18] "10 CFR 50 - Domestic Licensing of Production and Utilization Facilities," US Nuclear Regulatory Commission, Washington, DC.
- [19] "40 CFR Part 141, National Primary Drinking Water Regulations," US Environmental Protection Agency, Washington, DC.
- [20] "NUREG-1302, Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," Nuclear Regulatory Commission, April 1991.

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

1.0 GASEOUS EFFLUENTS

Table 6, Gaseous Effluents Summation of All Releases for CCNPP Site

A. Fission & Activation Gases	Units	Quarter 1	Quarter 2	Quarter3	Quarter4	Total	Est. Total Error %
1. Total Release	Ci	1.16E+00	3.25E-02	1.95E-01	2.94E-02	1.42E+00	1.20E+01
2. Average release rate for the period	μCi/sec	1.47E-01	4.12E-03	2.48E-02	3.72E-03	4.49E-02	
B. Iodine							
1. Total Iodine – 131	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	6.5E+00
2. Average release rate for the period	μCi/sec	<LLD	<LLD	<LLD	<LLD	<LLD	
C. Particulates							
1. Particulates with half-lives > 8 days	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	1.20E+01
2. Average release rate for the period	μCi/sec	<LLD	<LLD	<LLD	<LLD	<LLD	
D. Tritium							
1. Total Release	Ci	7.63E-01	1.25E+00	1.08E+00	1.17E+00	4.26E+00	1.32E+01
2. Average release rate for the period	μCi/sec	9.67E-02	1.59E-01	1.38E-01	1.49E-01	1.35E-01	
E. Gross Alpha							
1. Total Release	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	2.50E+01
2. Average release rate for the period	μCi/sec	<LLD	<LLD	<LLD	<LLD	<LLD	
F. Carbon-14							
1. Total Release	Ci	4.30E+00	5.11E+00	4.96E+00	5.15E+00	1.95E+01	
2. Average release rate for the period	μCi/sec	5.53E-01	6.49E-01	6.24E-01	6.48E-01	6.19E-01	

% of limit is on Table 1 Calvert Cliffs Nuclear Power Plant Site Dose Summary

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 7, Gaseous Effluents – Ground Level Release Batch Mode for CCNPP Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission Gases						
Ar-41	Ci	2.92E-02	3.09E-02	2.78E-02	2.85E-02	1.16E-01
Kr-85	Ci	5.32E-01	<LLD	<LLD	<LLD	5.32E-01
Xe-133	Ci	5.77E-01	1.59E-03	1.68E-01	8.33E-04	7.47E-01
Xe-135	Ci	1.23E-04	<LLD	<LLD	<LLD	1.23E-04
	Ci					
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	1.14E+00	3.25E-02	1.95E-01	2.94E-02	1.40E+00
Iodines						
None	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Particulates						
None	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
	Ci					
	Ci					
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium						
H-3	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Carbon-14						
C-14	Ci	N/A	N/A	N/A	N/A	N/A

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 8, Gaseous Effluents – Ground Level Release Continuous Mode for CCNPP Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission Gases						
Xe-133	Ci	1.72E-02	<LLD	<LLD	<LLD	1.72E-02
Xe-135	Ci	1.98E-03	<LLD	<LLD	<LLD	1.98E-03
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	1.92E-02	<LLD	<LLD	<LLD	1.92E-02
Iodines						
None	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Particulates						
None	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
	Ci					
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium						
H-3	Ci	7.63E-01	1.25E+00	1.08E+00	1.17E+00	4.26E+00
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Carbon-14						
C-14	Ci	4.30E+00	5.11E+00	4.96E+00	5.15E+00	1.95E+01

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

2.0 LIQUID EFFLUENTS

Table 9, Liquid Effluents – Summation of All Releases for CCNPP Site

A. Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total	Est. Total Error %
1. Total Release	Ci	3.06E-01	3.15E-01	4.16E-03	1.16E-02	6.37E-01	±1.03E+01
2. Average diluted concentration	μCi/mL	8.87E-11	8.63E-11	1.13E-12	3.13E-12	4.39E-11	
B. Tritium							
1. Total Release	Ci	5.45E+02	1.16E+02	3.41E+02	2.01E+02	1.20E+03	±1.03E+01
2. Average diluted concentration	μCi/mL	1.58E-07	3.18E-08	9.22E-08	5.44E-08	8.30E-08	
C. Dissolved & Entrained Gases							
1. Total Release	Ci	8.47E-04	<LLD	<LLD	<LLD	8.47E-04	±1.03E+01
2. Average diluted concentration	μCi/mL	2.46E-13	<LLD	<LLD	<LLD	5.84E-14	
D. Gross Alpha Activity							
1. Total Release	Ci	<LLD	<LLD	<LLD	<LLD	<LLD	N/A
E. Volume of Waste Released (prior to dilution)							
1. Total Release	Liters	9.82E+07	1.10E+08	9.45E+07	8.56E+07	3.88E+08	
F. Volume of Dilution Water Used During Period							
1. Total Release	Liters	3.45E+12	3.66E+12	3.69E+12	3.70E+12	1.45E+13	

% of limit is on the Table 1, Calvert Cliffs Nuclear Power Plant Site Dose Summary

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 10, Batch Mode Liquid Effluents for CCNPP Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
Zr-95	Ci	1.55E-03	1.03E-05	<LLD	1.95E-05	1.58E-03
Co-57	Ci	1.96E-04	1.78E-04	<LLD	<LLD	3.74E-04
Sb-125	Ci	1.08E-03	<LLD	<LLD	<LLD	1.08E-03
Cr-51	Ci	1.75E-02	3.03E-03	<LLD	2.67E-04	2.08E-02
Co-60	Ci	1.60E-02	2.05E-02	1.18E-03	3.03E-03	4.07E-02
Cs-134	Ci	2.43E-03	5.33E-03	<LLD	<LLD	7.76E-03
Ni-63	Ci	1.73E-02	1.76E-02	5.20E-04	1.44E-03	3.69E-02
Fe-59	Ci	7.13E-04	2.75E-04	<LLD	<LLD	9.88E-04
Fe-55	Ci	1.08E-02	1.24E-02	1.04E-03	2.89E-03	2.71E-02
Nb-95	Ci	2.10E-03	4.10E-04	3.77E-05	2.32E-04	2.78E-03
Cs-137	Ci	1.35E-01	1.88E-01	3.48E-04	4.54E-04	3.24E-01
Co-58	Ci	9.99E-02	6.30E-02	1.03E-03	3.15E-03	1.67E-01
Mn-54	Ci	1.32E-03	4.81E-03	<LLD	8.10E-05	6.21E-03
	Ci					
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	3.06E-01	3.15E-01	4.16E-03	1.16E-02	6.35E-01
Tritium						
H-3	Ci	5.45E+02	1.16E+02	3.40E+02	2.01E+02	1.20E+03
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Entrained Gases						
Xe-133	Ci	8.47E-04	<LLD	<LLD	<LLD	8.47E-04
	Ci					
(List Others)	Ci					
Total for Period	Ci	8.47E-04	<LLD	<LLD	<LLD	8.47E-04

Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

Table 11, Continuous Mode Liquid Effluents for CCNPP Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
None	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
	Ci					
(List Others)	Ci					
Total for Period	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Tritium						
H-3	Ci	6.27E-02	6.84E-02	1.06E-01	1.91E-01	4.28E-01
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
Entrained Gases						
None	Ci	<LLD	<LLD	<LLD	<LLD	<LLD
	Ci					
(List Others)	Ci					
Total for Period	Ci					

Attachment 2, Solid Waste Information

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

Table 12, Resins, Filters, and Evaporator Bottoms Summary for the Calvert Cliffs Site

Waste Class	Volume		Curies Shipped
	ft ³	m ³	
A	1.13E+03	3.21E+01	2.08E+01
B	9.50E+01	2.69E+00	6.57E+00
C	0.00E+00	0.00E+00	0.00E+00
Unclassified	0.00E+00	0.00E+00	0.00E+00
All	1.23E+03	3.48E+01	2.74E+01
Major Nuclides for Above Table: H-3, C-14, Mn-54, Fe-55, Co-58, Co-60, Ni-59, Ni-63, Sr-90, Zr-95, Nb-95, Tc-99, I-129, Cs-134, Cs-137, Ce-144, Pu-238, Pu-239, Pu-241, Am-241, Cm-242, Cm-243			
Waste Class A		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance	Curies	
Mn-54	4.24%	8.81E-01	
Fe-55	5.49%	1.14E+00	
Co-58	52.03%	1.08E+01	
Co-60	17.1%	3.56E+00	
Ni-63	19.99%	4.16E+00	
Waste Class B		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance	Curies	
Fe-55	3.35%	2.21E-01	
Co-58	12.99%	8.54E-01	
Co-60	14.08%	9.26E-01	
Ni-63	20.68%	1.36E+00	
Cs-134	2.13%	1.40E-01	
Cs-137	44.45%	2.92E+00	
Waste Class C		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance	Curies	
None	N/A	N/A	
Total Combined		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance	Curies	
Mn-54	3.4%	9.31E-01	
Fe-55	4.97%	1.36E+00	
Co-58	42.66%	1.17E+01	
Co-60	16.38%	4.48E+00	
Ni-63	20.15%	5.52E+00	
Cs-137	10.89%	2.98E+00	

Attachment 2, Solid Waste Information

Table 13, Dry Active Waste (DAW) Summary for the Calvert Cliffs Site

Waste Class	Volume		Curies Shipped
	ft ³	m ³	
A	2.87E+03	8.12E+01	1.83E-02
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
Unclassified	0.00E+00	0.00E+00	0.00E+00
All	2.87E+03	8.12E+01	1.83E-02
Major Nuclides for Above Table: H-3, C-14, Cr-51, Mn-54, Fe-55, Co-58, Co-60, Ni-63, Sr-90, Zr-95, Nb-95, Tc-99, Sb-125, I-129, Cs-137, Pu-238, Pu-239, Pu-241, Am-241, Cm-242, Cm-243, Cm-244			
Waste Class A		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
H-3	1.29%		2.35E-04
Cr-51	6.65%		1.22E-03
Mn-54	1.22%		2.23E-04
Fe-55	8.1%		1.48E-03
Co-58	5.83%		1.07E-03
Co-60	29.44%		5.38E-03
Ni-63	3.94%		7.21E-04
Zr-95	14.34%		2.62E-03
Nb-95	24.56%		4.49E-03
Cs-137	3.54%		6.48E-04
Waste Class B		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A
Waste Class C		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A
Total Combined		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
H-3	1.29%		2.35E-04
Cr-51	6.65%		1.22E-03
Mn-54	1.22%		2.23E-04
Fe-55	8.1%		1.48E-03
Co-58	5.83%		1.07E-03
Co-60	29.44%		5.38E-03
Ni-63	3.94%		7.21E-04
Zr-95	14.34%		2.62E-03
Nb-95	24.56%		4.49E-03
Cs-137	3.54%		6.48E-04

Attachment 2, Solid Waste Information

Table 14, Irradiated Components Summary for the Calvert Cliffs Site

Waste Class	Volume		Curies Shipped
	ft ³	m ³	
A	0.00E+00	0.00E+00	0.00E+00
B	0.00E+00	0.00E+00	0.00E+00
C	0.00E+00	0.00E+00	0.00E+00
Unclassified	0.00E+00	0.00E+00	0.00E+00
All	0.00E+00	0.00E+00	0.00E+00
Major Nuclides for Above Table:			
Waste Class A		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A
Waste Class B		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A
Waste Class C		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A
Total Combined		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A

Attachment 2, Solid Waste Information

Table 16, Sum of All Low-Level Waste Shipped from the Calvert Cliffs Site

Waste Class	Volume		Curies Shipped
	ft ³	m ³	
A	4.00E+03	1.13E+02	2.08E+01
B	9.50E+01	2.69E+00	6.57E+00
C	0.00E+00	0.00E+00	0.00E+00
Unclassified	0.00E+00	0.00E+00	0.00E+00
All	4.10E+03	1.16E+02	2.74E+01
Major Nuclides for Above Table: H-3, C-14, Cr-51, Mn-54, Fe-55, Co-58, Co-60, Ni-59, Ni-63, Sr-90, Zr-95, Nb-95, Tc-99, Sb-125, I-129, Cs-134, Cs-137, Ce-144, Pu-238, Pu-239, Pu-241, Am-241, Cm-242, Cm-243, Cm-244			
Waste Class A		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
Mn-54	4.23%		8.82E-01
Fe-55	5.49%		1.14E+00
Co-58	51.99%		1.08E+01
Co-60	17.11%		3.56E+00
Ni-63	19.97%		4.16E+00
Waste Class B		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
Fe-55	3.35%		2.21E-01
Co-58	12.99%		8.54E-01
Co-60	14.08%		9.26E-01
Ni-63	20.68%		1.36E+00
Cs-134	2.13%		1.40E-01
Cs-137	44.45%		2.92E+00
Waste Class C		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
None	N/A		N/A
Total Combined		Percent Abundance > 1.0%	
Nuclide Name	Percent Abundance		Curies
Mn-54	3.4%		9.31E-01
Fe-55	4.98%		1.36E+00
Co-58	42.63%		1.17E+01
Co-60	16.38%		4.49E+00
Ni-63	20.14%		5.52E+00
Cs-137	10.89%		2.98E+00

Attachment 2, Solid Waste Information

2.0 SOLID WASTE DISPOSITION

Table 17, Solid Waste Shipped from the Calvert Cliff Site

Number of Shipments	Mode of Transportation	Destination
5	Hittman	Energy Solutions Bear Creek 1560 Bear Creek Rd
1	Hittman	Energy Solutions LLC. Clive Disposal Site - Containerized Waste Facility
1	Hittman	Waste Control Specialists LLC Compact Waste Disposal Facility
2	SJ Transportation Co Inc.	Energy Solutions Services, Inc. Memphis 1790 Dock Street
Total 9		