**Larry D. Smith**
Regulatory Assurance Manager

Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657
667 313 6503 Office
410 610 9729 Mobile

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

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

June 9, 2024

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 (667) 313-6503.

Respectfully,

Larry D. Smith
Regulatory Assurance Manager

LDS/aj
Attachment: (1) Radioactive Effluent Release Annual Report - 2023

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

**Calvert Cliffs Nuclear Power Plant**
**June 9, 2024**

Constellation

Calvert Cliffs Nuclear Power Plant

# Annual Radioactive Effluent Release Report 2023

Docket Number: 50-317 and 50-318

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## 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 $3.7 \times 10^{10}$ disintegrations per second, or $2.22 \times 10^{12}$ 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 x $10^4$ disintegrations per second, or 2.22 x$10^6$ disintegrations per minute.

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. MWe: Megawatts Electric

21. MWTh: Megawatts Thermal

22. NA: Not Applicable

23. NEI: Nuclear Energy Institute

24. NRC: Nuclear Regulatory Commission

25. ODCM: Offsite Dose Calculation Manual

26. OSLD: Optically Stimulated Luminescence Dosimeter

27. Protected Area: The fenced area immediately surrounding the Plant. Access to the protected area requires a security badge or escort.

28. PWR: Pressurized Water Reactor

29. REC: Radiological Effluent Control

30. REMP: Radiological Environmental Monitoring Program

31. Restricted Area: Any area where access is controlled for the purpose of protecting individuals from exposure to radiation or radioactive materials.

32. SLCs: Selected Licensee Commitments

33. 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).

34. TLD: Thermoluminescent Dosimeter

35. TRM: Technical Requirements Manual

36. TS: Technical Specification

## 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 [1] and by 40 CFR 190 [2]. Operational doses to the public during 2023 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 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; solid radioactive waste shipped offsite for disposal; and other information as required by site licensing documents.

In 2023 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 4.01 E-04 mrem to the Liver Table 1, Calvert Cliffs Nuclear Power Plant Site Dose Summary. This annual dose is a small fraction (0.001%) of the 10 CFR 50, Appendix I guideline of 30 mrem to the Maximum Organ per two reactor units.

The critical receptor via the liquid ingestion pathway was the Adult due to the Ingestion pathway at 0.5 miles in the NE sector. The maximum Total Body and Organ dose (Liver) were 3.35E-03 mrem and 3.43E-02 mrem, respectively. These doses were a small fraction (0.056% and 0.1720.172%) of the 10 CFR 50, Appendix I guideline of 6 mrem to the Total Body and 20 mrem to the Maximum Organ per two reactor units.

Solid radioactive waste shipped offsite for disposal included 1.05E+02 curies in 8.09E+01 $m^3$, shipped in 5 shipments.

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 2023 all 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 Summary[1]

| 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] | 1.38E-03 | 3.40E-04 | 4.48E-04 | 1.18E-03 | 3.35E-03 |
| | % of Limit | 0.046 | 0.011 | 0.015 | 0.039 | 0.056 |
| | **Limit** | **10 mrem** | **10 mrem** | **10 mrem** | **10 mrem** | **20 mrem** |
| | Max Organ Dose[3] | 3.20E-02 | 5.32E-04 | 5.76E-04 | 1.17E-03 | 3.43E-02 |
| | % of Limit | 0.320 | 0.005 | 0.006 | 0.012 | 0.172 |
| Gaseous Effluent | | | | | | |
| | **Limit** | **10 mrad** | **10 mrad** | **10 mrad** | **10 mrad** | **20 mrad** |
| | Gamma Air Dose[4] | 1.98E-05 | 2.22E-05 | 2.37E-05 | 1.92E-05 | 8.49E-05 |
| | % of Limit | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| | **Limit** | **20 mrad** | **20 mrad** | **20 mrad** | **20 mrad** | **40 mrad** |
| | Beta Air Dose[4] | 1.02E-05 | 8.83E-06 | 1.14E-05 | 7.20E-06 | 3.76E-05 |
| | % of Limit | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| | **Limit** | **5 mrem** | **5 mrem** | **5 mrem** | **5 mrem** | **10 mrem** |
| | NG Total Body Dose[4] | 1.87E-05 | 2.10E-05 | 2.24E-05 | 1.82E-05 | 8.04E-05 |
| | % of Limit | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 |
| | **Limit** | **15 mrem** | **15 mrem** | **15 mrem** | **15 mrem** | **30 mrem** |
| | Noble Gas Skin Dose[4] | 2.83E-05 | 3.11E-05 | 3.39E-05 | 2.67E-05 | 1.20E-04 |
| | % of Limit | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| | **Limit** | **15 mrem** | **15 mrem** | **15 mrem** | **15 mrem** | **30 mrem** |
| | Max Organ Dose[5] | 1.01E-04 | 1.27E-04 | 4.98E-05 | 1.23E-04 | 4.01 E-04 |
| | % of Limit | 0.001 | 0.001 | <0.001 | 0.001 | 0.001 |

[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-Lli
[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 the Calvert Cliffs Nuclear Power Plant[1]

| | **Whole Body** | **Thyroid** | **Max Other Organ** |
|---|---|---|---|
| Gaseous[2] | | | |
| Noble Gas | 8.04E-05 | 8.04E-05 | 1.20E-04 |
| Particulates/Iodines | 4.01E-04 | 4.01E-04 | 4.01E-04 |
| Carbon-14[3] | 3.07E-02 | 3.07E-02 | 1.54E-01 |
| Liquid | 3.35E-03 | 1.66E-03 | 3.43E-02 |
| Direct Shine | 0 | 0 | 0 |
| Total Site Dose[4] | 3.45E-02 | 3.28E-02 | 1.89E-01 |
| Total w/Other Nearby Facility[5] | 3.45E-02 | 3.28E-02 | 1.89E-01 |
| **Limit** | **25 mrem** | **75 mrem** | **25 mrem** |
| % of Limit | 0.14 | 0.04 | 0.76 |

[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.

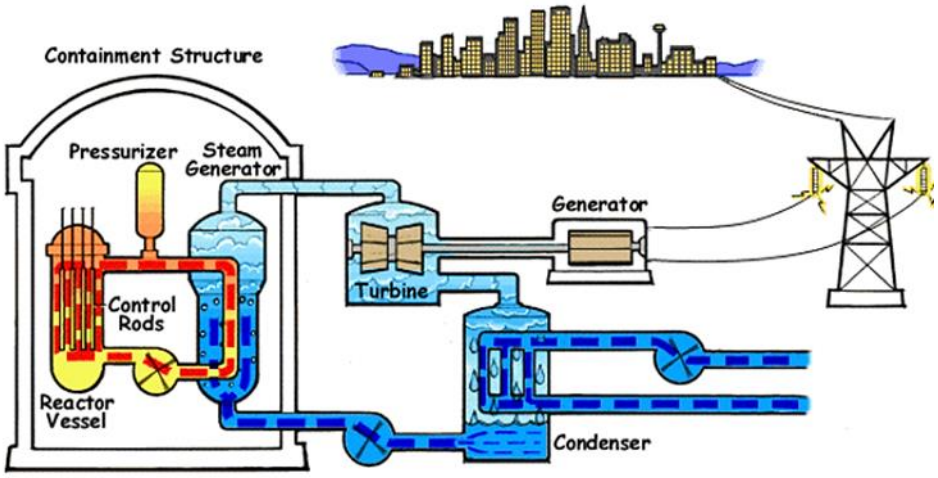


Figure 1, Pressurized Water Reactor (PWR) **[3]**

3.1 (Continued)

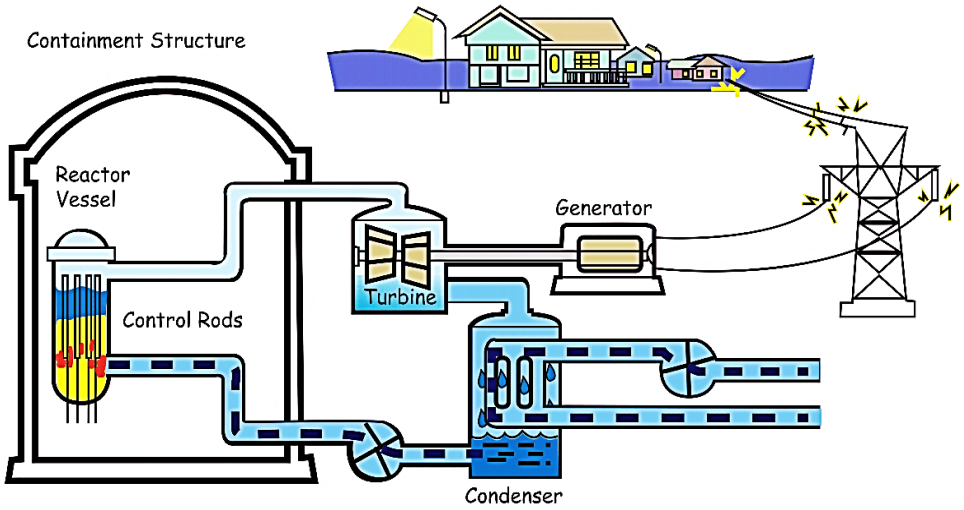


Figure 2, Boiling Water Reactor (BWR) **[4]**

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 spins 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.

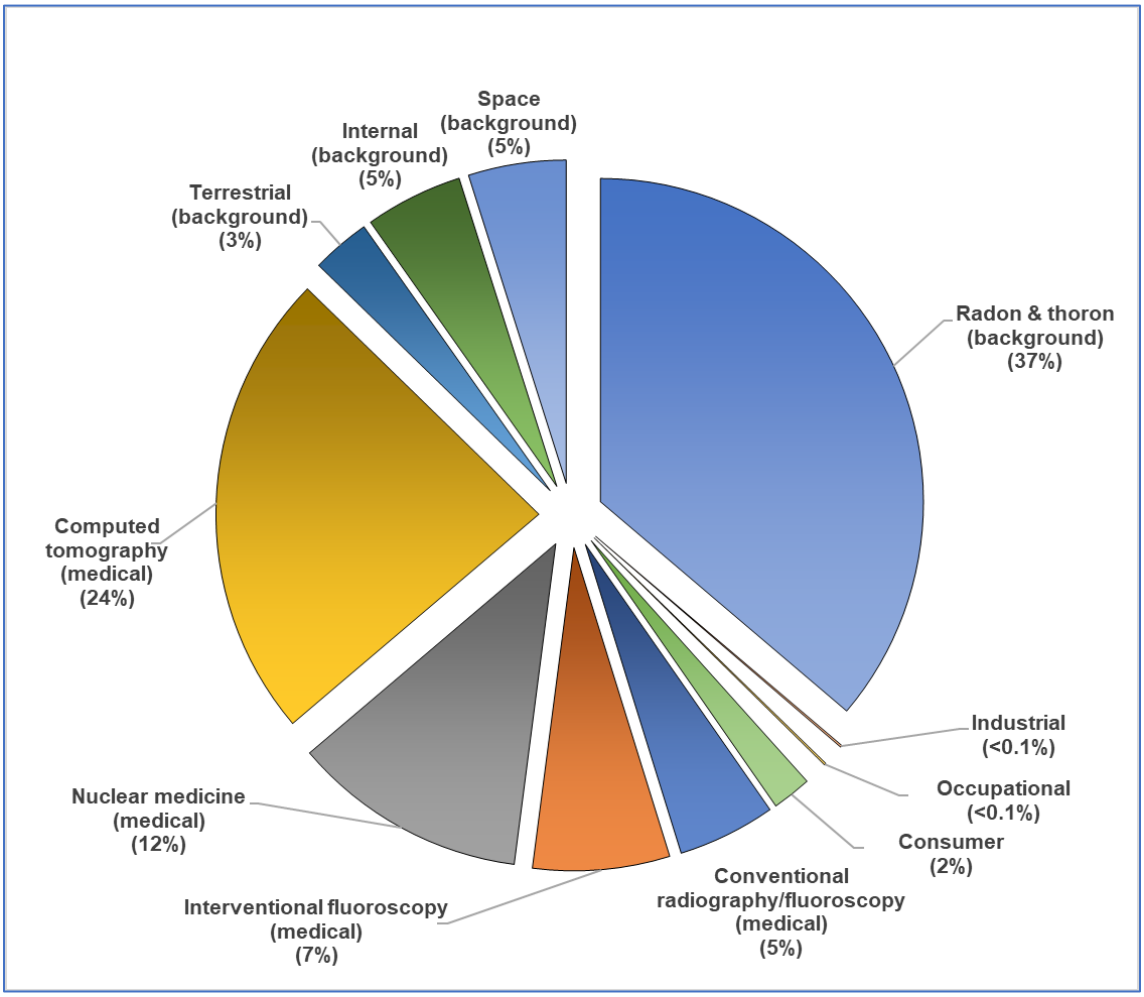


Figure 3, Sources of Radiation Exposure (NCRP Report No. 160) **[5]**

3.2 (Continued)

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 [5]. 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 [6], and from the US Nuclear Regulatory Commission website [7].

## 3.3 About Dose Calculation

The 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.

3.3 (Continued)

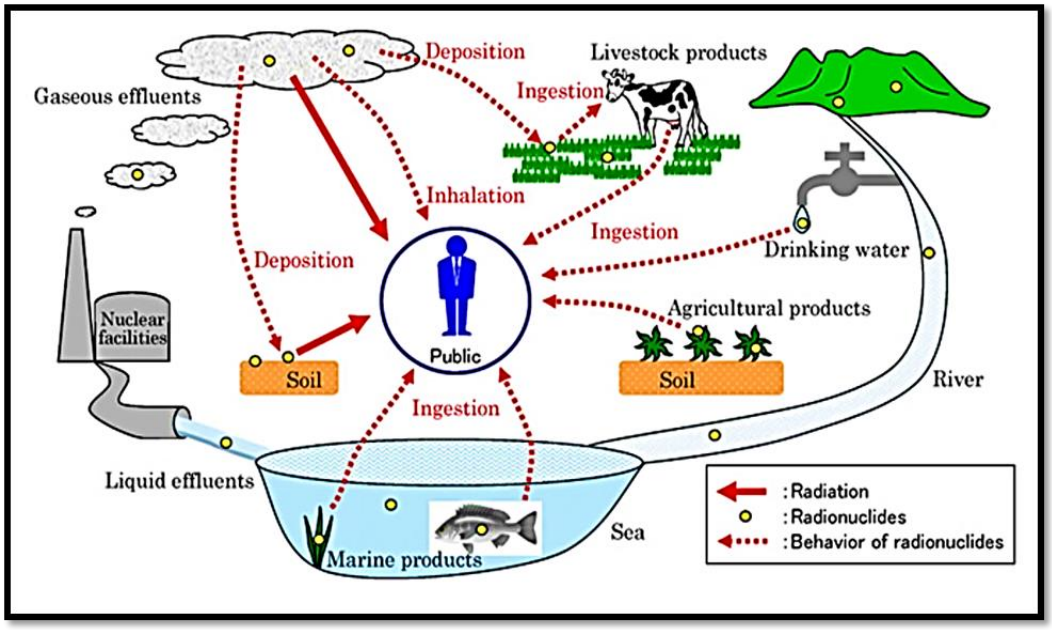


Figure 4, Potential Exposure Pathways to Members of the Public Due to Plant Operations **[8]**

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 [9] and NUREG-0133 [10]. 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 the release point, bioaccumulation factors for the fish or invertebrate and an estimate of the quantity of fish consumed.

3.3 (Continued)

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 most likely to be exposed to radiation dose as a result of plant operation.

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 the ODCM limits. The concentration of liquid radioactive material released shall be limited the concentration specified in 10 CFR 20, Appendix B, Table II, Column 2 (Pre 1994) [11], for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the total concentration released shall be limited to $2.0 \times 10^{-4}$ 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 2023 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 the Calvert Cliffs Nuclear Power Plant.

## 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 the site to areas at and beyond the site boundary shall be limited to the following:

      1) Quarterly

         a) Less than or equal to 10 mrads gamma

         b) Less than or equal to 20 mrads beta

      2) Yearly

         a) Less than or equal to 20 mrads gamma

         b) Less than or equal to 40 mrads 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 the site to areas at and beyond the site boundary shall be limited to the following:

      1) Quarterly

         a) Less than or equal to 15 mrem to any organ

      2) Yearly

         a) Less than or equal to 30 mrem to any organ

## 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 the site to unrestricted areas shall be limited to the following:

    a. Quarterly

        1) Less than or equal to 3 mrem total body

        2) Less than or equal to 10 mrem critical organ

    b. Yearly

        1) Less than or equal to 6 mrem total body

        2) Less than or equal to 20 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

4.5 (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 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 the 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 Locations[1]

| Location | Sector | Approx. Distance (Meters) | Occupancy Factor | X/Q sec/m$^3$ | D/Q 1/m$^2$ |
|---|---|---|---|---|---|
| Camp Conoy | E | 914.4 | 0.386 | 1.34E-07 | 3.61E-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 | 1.33E-06 | 2.23E-04 | 2.24E-04 | 2.18E-06 | 4.75E-06 | 6.93E-06 | 2.31E-04 | <0.001% |
| Visitor Center | 8.47E-06 | 1.42E-03 | 1.43E-03 | 1.39E-05 | 3.02E-05 | 4.42E-05 | 1.47E-03 | 0.001% |

[1] Pathways are Plume, Ground Plane, and Inhalation
[2] Age Group: Child, Critical Organ: Bone

## 5.0 SUPPLEMENTAL INFORMATION

### 5.1 Batch Releases

#### 5.1.1 Gaseous Batch Releases

Table 4, Gaseous Batch Releases from the CCNPP Site

| | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|---|
| 1. Number of Batch Releases | | 25 | 25 | 21 | 19 | 90 |
| 2. Total duration of batch releases | minutes | 9.24E+03 | 8.47E+03 | 7.96E+03 | 8.03E+03 | 3.37E+04 |
| 3. Maximum batch release duration | minutes | 1.22E+03 | 5.60E+02 | 5.65E+02 | 6.22E+02 | 1.22E+03 |
| 4. Average batch release duration | minutes | 3.70E+02 | 3.39E+02 | 3.79E+02 | 4.23E+02 | 3.74E+02 |
| 5. Minimum batch release duration | minutes | 3.80E+01 | 1.47E+02 | 2.57E+02 | 9.50E+01 | 3.80E+01 |

#### 5.1.2 Liquid Batch Releases

Table 5, Liquid Batch Releases from the CCNPP Site

| | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual |
|---|---|---|---|---|---|---|
| 1. Number of Batch Releases[1] | | 16 | 8 | 8 | 13 | 45 |
| 2. Total duration of batch releases | minutes | 9.33E+03 | 4.76E+03 | 5.83E+03 | 7.10E+03 | 2.70E+04 |
| 3. Maximum batch release duration | minutes | 7.38E+02 | 6.86E+02 | 1.10E+03 | 7.07E+02 | 1.10E+03 |
| 4. Average batch release duration | minutes | 5.83E+02 | 5.94E+02 | 7.28E+02 | 5.46E+02 | 6.00E+02 |
| 5. Minimum batch release duration | minutes | 1.00E+01 | 5.48E+02 | 5.90E+02 | 3.40E+01 | 1.00E+01 |
| 6. Average stream flow during periods of release of liquid Effluent into a flowing stream: | LPM | 4.55E+06 | 4.59E+06 | 4.58E+06 | 4.61E+06 | 4.58E+06 |

### 5.2 Abnormal Releases

#### 5.2.1 Gaseous Abnormal Releases

There were no abnormal gaseous releases from the CCNPP Site in 2023.

#### 5.2.2 Liquid Abnormal Releases

There were no abnormal liquid releases from the CCNPP Site in 2023.

### 5.3 Land Use Census Changes

There were no significant changes in the Land Use Census that would affect the 2023 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 **11**, and Table **12** of this report, they are not significant contributors to radioactive effluent and are therefore not included in this table.

## 5.4 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]

### 5.4.1 Joint Frequency Distributions

1. Period of Record: 2023

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 | 75 | 10 |
| 60 m | 3 | 10 |

### 5.4.2 Stability class

Table 6, Classification of Atmospheric Stability for Elevations 10 meters and 60 meters, 2023

| Stability Condition | Pasquill Categories | Percentage 10 meters | Percentage 60 meters |
|---|---|---|---|
| Extremely Unstable | A | 9.3% | 9.3% |
| Moderately Stable | B | 5.3% | 5.3% |
| Slightly Unstable | C | 5.7% | 5.7% |
| Neutral | D | 29.6% | 29.6% |
| Slightly Stable | E | 28.6% | 28.6% |
| Moderately Stable | F | 13.0% | 13.0% |
| Extremely Stable | G | 8.5% | 8.5% |

Table 7, Location with the Highest Meteorological X/Q and D/Q Values and Special Interest Onsite Locations, 2023[1]

| 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 | 3.67E-07 | 5.19E-09 |
| Resident | SW | 1.77 | 3.50E-07 | 4.76E-09 |
| Garden | S | 2.90 | 1.99E-07 | 1.70E-09 |
| Meat Animal | S | 2.57 | 2.32E-07 | 2.21E-09 |
| | | | | |
| Special Interest | | | | |
| Camp Conoy | E | 0.9 | 1.34E-07 | 3.61E-09 |
| Visitor Center[2] | WNW | 0.3 | 8.68E-06 | 8.68E-08 |

## 5.5 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. Common Liquid Waste Discharge Radiation Monitor 0-RE-2201 was out-of-service on 2/04/2023 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 10/02/2023. 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.

3. U2 Steam Generator Blowdown, 2-RE-4095, was declared out-of-service from 4/16/2020 past 12/31/2023, 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. With 2-RE-4014 OOS, then compensatory grab sampling and analysis once per 48 hours. Administratively, this is performed once per 24 hours.

4. U2 Steam Generator Blowdown, 2-RE-4014, was declared out-of-service from 6/17/2023 – 7/17/2023 for valve interlock light illuminated, and from 7/18/2023 – 9/15/2023 because of sample pump cavitation and loss of flow. Monitor 2-RE-4095 was also out-of-service during this time required compensatory grab sampling and analysis once per 48 hours. Administratively, this is performed once per 24 hours.

## 5.6 Offsite Dose Calculation Manual (ODCM) Changes

There was not a revision to the ODCM in 2023.

[1] Data From Murray and Trettel 2023 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.

## 5.7 Process Control Program (PCP) Changes

There were no changes to the PCP in 2023.

## 5.8 Radioactive Waste Treatment System Changes

There were no changes or modifications to the Radioactive Waste Treatment systems in 2023.

## 5.9 Other Supplemental Information

### 5.9.1 Temporary Outside Tanks

In 2023 the CCNPP site did not utilize temporary outside tanks to hold radioactive materials more than 10 Curies. This requirement does not apply to tritium.

### 5.9.2 Independent Spent Fuel Storage Installation (ISFSI) Monitoring Program

There were 3 casks of spent fuel transferred to the ISFSI during 2023. No radionuclides were released to the environment during the ISFSI operation in 2023. Additional information regarding the ISFSI radiological environmental monitoring program is included in the Annual Radiological Environmental Operation Report.

### 5.9.3 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, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste [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, “Estimation of Carbon-14 in Nuclear Plant Gaseous Effluents” [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 estimated generation for Calvert Cliffs Nuclear Power Plant during 2023 was 19.7 Curies.

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 20-30% of the Carbon-14 gaseous emissions from the station based upon available references and on-site testing. 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.

5.9.4 Errata/Corrections to Previous ARERRs

The 2022 ARERR reported an incorrect sector for the onsite location Camp Conoy as SE. The correct sector was E. All other data was correct.

## 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 2023, 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 2023, Calvert Cliffs Nuclear Power Plant did not make a voluntary NEI 07-07 notification to State/Local officials, NRC, and to other stakeholders required by site procedures

## 7.0 Bibliography

[1] "10 CFR 50 - Domestic Licensing of Production and Utilization Facilities," US Nuclear Regulatory Commission, Washington, DC.

[2] "40 CFR 190 - Environmental Radiation Protection Standards for Nuclear Power Operation," US Environmental Protection Agency, Washington, DC.

[3] Nuclear Regulatory Commission, 30 June 2015. [Online]. Available: http://www.nrc.gov/reading-rm/basic-ref/students/animated-pwr.html. [Accessed October 2020].

[4] Nuclear Regulatory Commission, 25 June 2015. [Online]. Available: http://www.nrc.gov/reading-rm/basic-ref/students/animated-bwr.html. [Accessed October 2020].

[5] "NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States"," National Council on Radiation Protection and Measurements, Bethesda, MD, 2009.

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[7] "NRC Resource Page," [Online]. Available: http://www.nrc.gov/about-nrc/radiation.html. [Accessed 10 November 2020].

[8] "Japan Atomic Energy Agency," 06 November 2020. [Online]. Available: https://www.jaea.go.jp/english/04/ntokai/houkan/houkan_02.html.

[9] "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, Ocotober, 1977.

[10] "NUREG-0133, Preparation of Effluent Technical Specifications for Nuclear Power Plants," Nuclear Regulatory Commission, 1987.

[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.

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

## 1.0 GASEOUS EFFLUENTS

Table 8, Gaseous Effluents Summation of All Releases CCNPP Site

| A. Fission & Activation Gases | Unit | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual | Est. Total Error % |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 7.72E-02 | 4.77E-02 | 7.78E-02 | 3.61E-02 | 2.39E-01 | 1.20E+01 |
| 2. Average release rate for the period | μCi/sec | 9.79E-03 | 6.05E-03 | 9.87E-03 | 4.57E-03 | 7.57E-03 | |
| 3. Percent of Limit | % | | | | | | |
| **B. Iodines** | | | | | | | |
| 1. Total I-131 | Ci | <LLD | <LLD | <LLD | <LLD | <LLD | 6.5E+00 |
| 2. Average release rate for the period | μCi/sec | N/A | N/A | N/A | N/A | N/A | |
| 3. Percent of Limit | % | | | | | | |
| **C. Particulates** | | | | | | | |
| 1. Total Release | Ci | <LLD | <LLD | <LLD | <LLD | <LLD | 1.20E+01 |
| 2. Average release rate for the period | μCi/sec | N/A | N/A | N/A | N/A | N/A | |
| 3. Percent of Limit | % | | | | | | |
| **D. Tritium** | | | | | | | |
| 1. Total Release | Ci | 1.14E+00 | 1.43E+00 | 5.62E-01 | 1.39E+00 | 4.52E+00 | 1.32E+01 |
| 2. Average release rate for the period | μCi/sec | 1.45E-01 | 1.81E-01 | 7.12E-02 | 1.76E-01 | 1.43E-01 | |
| 3. Percent of Limit | % | | | | | | |
| **E. Gross Alpha** | | | | | | | |
| 1. Total Release | Ci | <LLD | <LLD | <LLD | <LLD | <LLD | 2.50E+01 |
| 2. Average release rate for the period | μCi/sec | N/A | N/A | N/A | N/A | N/A | |
| 3. Percent of Limit | % | | | | | | |
| **F. Carbon-14** | | | | | | | |
| 1. Total Release | Ci | 4.42E+00 | 5.11E+00 | 5.15E+00 | 5.07E+00 | 1.97E+01 | |
| 2. Average release rate for the period | μCi/sec | 5.69E-01 | 6.50E-01 | 6.48E-01 | 6.37E-01 | 6.26E-01 | |
| 3. Percent of Limit | % | | | | | | |

% 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 9, Gaseous Effluents – Ground Level Release - Batch Mode CCNPP Site

| Radionuclide Released | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total for year |
|---|---|---|---|---|---|---|
| Fission Gases | | | | | | |
| Ar-41 | Ci | 2.86E-02 | 3.34E-02 | 3.43E-02 | 2.93E-02 | 1.26E-01 |
| Kr-85m | Ci | <LLD | <LLD | 1.64E-05 | <LLD | 1.64E-05 |
| Xe-133 | Ci | 4.48E-02 | 1.29E-02 | 3.98E-02 | 6.73E-03 | 1.04E-01 |
| Xe-135 | Ci | 5.69E-05 | 1.41E-03 | 3.66E-03 | 3.82E-05 | 5.17E-03 |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **7.35E-02** | **4.77E-02** | **7.78E-02** | **3.61E-02** | **2.35E-01** |
| Iodines | | | | | | |
| None | Ci | <LLD | <LLD | <LLD | <LLD | <LLD |
| | | | | | | |
| **Total for Period** | **Ci** | **<LLD** | **<LLD** | **<LLD** | **<LLD** | **<LLD** |
| Particulates | | | | | | |
| None | Ci | <LLD | <LLD | <LLD | <LLD | <LLD |
| | 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 10, Gaseous Effluents – Ground Level Release - Continuous Mode CCNPP Site

| Radionuclide Released | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total for year |
|---|---|---|---|---|---|---|
| Fission Gases | | | | | | |
| Xe-133 | Ci | 2.95E-03 | <LLD | <LLD | <LLD | 2.95E-03 |
| Xe-135 | Ci | 7.76E-04 | <LLD | <LLD | <LLD | 7.76E-04 |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **3.72E-03** | **<LLD** | **<LLD** | **<LLD** | **3.72E-03** |
| Iodines | | | | | | |
| None | Ci | N/A | N/A | N/A | N/A | N/A |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** |
| Particulates | | | | | | |
| None | Ci | N/A | N/A | N/A | N/A | N/A |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** |
| Tritium | | | | | | |
| H-3 | Ci | 1.14E+00 | 1.43E+00 | 5.62E-01 | 1.39E+00 | 4.52E+00 |
| Gross Alpha | | | | | | |
| Alpha | Ci | <LLD | <LLD | <LLD | <LLD | <LLD |
| Carbon-14 | | | | | | |
| C-14 | Ci | 4.42E+00 | 5.11E+00 | 5.15E+00 | 5.07E+00 | 1.97E+01 |

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

## 2.0 LIQUID EFFLUENTS

Table 11, Liquid Effluents – Summation of All Releases from CCNPP Site

| A. Fission & Activation Products | Unit | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Annual | Est. Total Error % |
|---|---|---|---|---|---|---|---|
| 1. Total Release | Ci | 8.11E-02 | 5.57E-03 | 2.25E-03 | 1.48E-02 | 1.04E-01 | 1.03E+01 |
| 2. Average diluted concentration | μCi/mL | 3.07E-11 | 1.62E-12 | 6.13E-13 | 3.99E-12 | 7.72E-12 | |
| 3. Percent of Limit | % | | | | | | |
| B. Tritium | | | | | | | |
| 1. Total Release | Ci | 1.78E+02 | 2.54E+02 | 3.85E+02 | 7.95E+02 | 1.61E+03 | 1.03E+01 |
| 2. Average diluted concentration | μCi/mL | 6.74E-08 | 7.42E-08 | 1.05E-07 | 2.15E-07 | 1.20E-07 | |
| 3. Percent of Limit | % | | | | | | |
| C. Dissolved & Entrained Gases | | | | | | | |
| 1. Total Release | Ci | 1.17E-04 | <LLD | <LLD | 3.06E-04 | 4.23E-04 | 1.03E+01 |
| 2. Average diluted concentration | μCi/mL | 4.44E-14 | N/A | N/A | 8.27E-14 | 3.15E-14 | |
| 3. Percent of Limit | % | | | | | | |
| D. Gross Alpha Activity | | | | | | | |
| 1. Total Release | Ci | <LLD | <LLD | <LLD | <LLD | <LLD | |
| 2. Average diluted concentration | μCi/mL | N/A | N/A | N/A | N/A | N/A | |
| 3. Percent of Limit | % | | | | | | |
| E. Volume of Waste Released (prior to dilution) | Liters | 7.95E+07 | 1.08E+08 | 1.13E+08 | 1.40E+08 | 4.41E+08 | |
| F. Volume of Dilution Water Used During Period | Liters | 2.64E+12 | 3.43E+12 | 3.67E+12 | 3.70E+12 | 1.34E+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 12, Liquid Effluents - Batch Mode CCNPP Site

| Radionuclide Released | Units | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total for year |
|---|---|---|---|---|---|---|
| Fission and Activation Products | | | | | | |
| Ni-63 | Ci | 3.30E-03 | <LLD | <LLD | 1.85E-03 | 5.15E-03 |
| Ag-110m | Ci | 1.13E-03 | <LLD | <LLD | <LLD | 1.13E-03 |
| Sb-125 | Ci | 2.12E-03 | 1.19E-03 | <LLD | <LLD | 3.31E-03 |
| Sn-113 | Ci | 1.14E-04 | <LLD | <LLD | <LLD | 1.14E-04 |
| Cs-137 | Ci | 5.32E-03 | 4.15E-04 | 7.20E-05 | 8.44E-03 | 1.42E-02 |
| Nb-95 | Ci | 3.33E-03 | <LLD | <LLD | 1.17E-06 | 3.33E-03 |
| Mn-54 | Ci | 1.29E-03 | 1.94E-05 | <LLD | <LLD | 1.31E-03 |
| Cs-134 | Ci | 5.03E-05 | <LLD | <LLD | <LLD | 5.03E-05 |
| Cr-51 | Ci | 4.83E-04 | <LLD | <LLD | <LLD | 4.83E-04 |
| Fe-55 | Ci | 8.61E-03 | 1.71E-03 | 1.48E-03 | 3.69E-03 | 1.55E-02 |
| Co-60 | Ci | 4.22E-02 | 4.61E-04 | 5.83E-04 | 4.68E-04 | 4.37E-02 |
| Co-58 | Ci | 1.12E-02 | 1.65E-03 | 1.12E-04 | 3.29E-04 | 1.33E-02 |
| Zr-95 | Ci | 1.49E-03 | <LLD | <LLD | <LLD | 1.49E-03 |
| Sb-124 | Ci | 5.26E-04 | 1.17E-04 | <LLD | <LLD | 6.43E-04 |
| Nb-97 | Ci | 1.87E-05 | <LLD | <LLD | <LLD | 1.87E-05 |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **8.12E-02** | **5.56E-03** | **2.25E-03** | **1.48E-02** | **1.04E-01** |
| Tritium | | | | | | |
| H-3 | Ci | 1.78E+02 | 2.54E+02 | 3.85E+02 | 7.95E+02 | 1.61E+03 |
| Gross Alpha | | | | | | |
| Alpha | Ci | <LLD | <LLD | <LLD | <LLD | <LLD |
| Entrained Gases | | | | | | |
| Xe-133 | Ci | 1.17E-04 | <LLD | <LLD | 3.06E-04 | 4.23E-04 |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **1.17E-04** | **<LLD** | **<LLD** | **3.06E-04** | **4.23E-04** |

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

Table 13, Liquid Effluents - Continuous Mode 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 | | | | | |
| **Total for Period** | **Ci** | **<LLD** | **<LLD** | **<LLD** | **<LLD** | **<LLD** |
| Tritium | | | | | | |
| H-3 | Ci | 1.80E-01 | 2.68E-01 | 1.63E-01 | 2.52E-01 | 8.63E-01 |
| Gross Alpha | | | | | | |
| Alpha | Ci | <LLD | <LLD | <LLD | <LLD | <LLD |
| Entrained Gases | | | | | | |
| None | Ci | <LLD | <LLD | <LLD | <LLD | <LLD |
| | Ci | | | | | |
| **Total for Period** | **Ci** | **<LLD** | **<LLD** | **<LLD** | **<LLD** | **<LLD** |

**Attachment 2, Solid Waste Information**

## 1.0 Solid Waste Shipped Offsite for Burial or Disposal (Not Irradiated Fuel)

Table 14, Resins, Filters, and Evaporator Bottoms Summary Shipped from the CCNPP Site

| Waste Class | Volume $ft^3$ | Volume $m^3$ | Curies Shipped |
|---|---|---|---|
| A | 2.57E+02 | 7.28E+00 | 4.05E-02 |
| B | 2.95E+02 | 8.35E+00 | 1.05E+02 |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Unclassified | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **All** | 5.52E+02 | 1.56E+01 | 1.05E+02 |

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, 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 |
| Cr-51 | 1.03% | 4.19E-04 |
| Fe-55 | 78.68% | 3.19E-02 |
| Co-58 | 5.87% | 2.38E-03 |
| Co-60 | 8.73% | 3.54E-03 |
| Ni-63 | 1.71% | 6.93E-04 |
| Nb-95 | 1.65% | 6.68E-04 |
| | | |
| **Waste Class B** | | **Percent Abundance > 1.0%** |
| Nuclide Name | Percent Abundance | Curies |
| Mn-54 | 3.25% | 3.43E+00 |
| Fe-55 | 13.64% | 1.44E+01 |
| Co-58 | 3.55% | 3.74E+00 |
| Co-60 | 31.04% | 3.27E+01 |
| Ni-63 | 19.67% | 2.07E+01 |
| Sb-125 | 4.61% | 4.86E+00 |
| Cs-137 | 21.82% | 2.30E+01 |
| | | |
| **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 | 3.25% | 3.43E+00 |
| Fe-55 | 13.67% | 1.44E+01 |
| Co-58 | 3.55% | 3.74E+00 |
| Co-60 | 31.03% | 3.27E+01 |
| Ni-63 | 19.66% | 2.07E+01 |
| Sb-125 | 4.61% | 4.86E+00 |
| Cs-137 | 21.81% | 2.30E+01 |
| | | |

## Attachment 2, Solid Waste Information

Table 15, Dry Active Waste (DAW) Summary Shipped from the CCNPP Site

| Waste Class | Volume $ft^3$ | Volume $m^3$ | Curies Shipped |
|---|---|---|---|
| A | 2.30E+03 | 6.52E+01 | 6.23E-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** | 2.30E+03 | 6.52E+01 | 6.23E-02 |

Major Nuclides for Above Table:
H-3, Be-7, C-14, Cr-51, Mn-54, Fe-55, Co-58, Co-60, Ni-63, Sr-90, Zr-95, Nb-95, Tc-99, Sn-125, I-129, Cs-137, Pu-238, Pu-239, Pu-241, Am-241, Cm-242, Cm-243

| **Waste Class A** | | **Percent Abundance > 1.0%** |
|---|---|---|
| Nuclide Name | Percent Abundance | Curies |
| Be-7 | 1% | 6.26E-04 |
| Cr-51 | 3.04% | 1.90E-03 |
| Fe-55 | 73.36% | 4.57E-02 |
| Co-58 | 8.41% | 5.24E-03 |
| Co-60 | 8.01% | 4.99E-03 |
| Ni-63 | 1.54% | 9.62E-04 |
| Zr-95 | 1.34% | 8.37E-04 |
| Nb-95 | 2.22% | 1.38E-03 |
| | | |
| **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 |
| Be-7 | 1% | 6.26E-04 |
| Cr-51 | 3.04% | 1.90E-03 |
| Fe-55 | 73.36% | 4.57E-02 |
| Co-58 | 8.41% | 5.24E-03 |
| Co-60 | 8.01% | 4.99E-03 |
| Ni-63 | 1.54% | 9.62E-04 |
| Zr-95 | 1.34% | 8.37E-04 |
| Nb-95 | 2.22% | 1.38E-03 |
| | | |

## Attachment 2, Solid Waste Information

Table 16, Irradiated Components Summary Shipped from the CCNPP Site

| Waste Class | Volume $ft^3$ | Volume $m^3$ | Curies Shipped |
|---|---|---|---|
| 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 17, Other Waste Summary Shipped from the CCNPP Site

| **Waste Class** | **Volume** $ft^3$ | $m^3$ | **Curies Shipped** |
|---|---|---|---|
| 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 18, Sum of All Low-Level Waste Shipped from the CCNPP Site

| Waste Class | Volume $ft^3$ | Volume $m^3$ | Curies Shipped |
|---|---|---|---|
| A | 2.56E+03 | 7.25E+01 | 1.03E-01 |
| B | 2.95E+02 | 8.35E+00 | 1.05E+02 |
| C | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Unclassified | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **All** | 2.86E+03 | 8.09E+01 | 1.05E+02 |

Major Nuclides for Above Table:
H-3, Be-7, C-14, Cr-51, Mn-54, Fe-55, Co-58, Co-60, Ni-59, Ni-63, Sr-90, Zr-95, Nb-95, Tc-99, Sn-125, Sb-125, I-129, Cs-134, 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 |
| Cr-51 | 2.25% | 2.31E-03 |
| Fe-55 | 75.46% | 7.76E-02 |
| Co-58 | 7.41% | 7.61E-03 |
| Co-60 | 8.30% | 8.53E-03 |
| Ni-63 | 1.61% | 1.66E-03 |
| Zr-95 | 1.17% | 1.20E-03 |
| Nb-95 | 2% | 2.05E-03 |
| | | |
| **Waste Class B** | | **Percent Abundance > 1.0%** |
| Nuclide Name | Percent Abundance | Curies |
| Mn-54 | 3.25% | 3.43E+00 |
| Fe-55 | 13.64% | 1.44E+01 |
| Co-58 | 3.55% | 3.74E+00 |
| Co-60 | 31.04% | 3.27E+01 |
| Ni-63 | 19.67% | 2.07E+01 |
| Sb-125 | 4.61% | 4.86E+00 |
| Cs-137 | 21.82% | 2.30E+01 |
| | | |
| **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 | 3.25% | 3.43E+00 |
| Fe-55 | 13.7% | 1.44E+01 |
| Co-58 | 3.56% | 3.74E+00 |
| Co-60 | 31.01% | 3.27E+01 |
| Ni-63 | 19.65% | 2.07E+01 |
| Sb-125 | 4.6% | 4.86E+00 |
| Cs-137 | 21.8% | 2.30E+01 |
| | | |

**Attachment 2, Solid Waste Information**

## 2.0 SOLID WASTE DISPOSITION

Table 19, Solid Waste Shipped from the CCNPP Site

| Number of Shipments | Mode of Transportation | Destination |
| --- | --- | --- |
| 2 | Hittman | Energy Solutions Bear Creek 1560 Bear Creek Rd |
| 3 | Hittman | Waste Control Specialists LLC Compact Waste Disposal Facility |
| Total 5 | | |

## 3.0 IRRADIATED FUEL DISPOSITION

Table 20, Irradiated Fuel Shipments Disposition Shipped from the CCNPP Site

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