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, 2025

Constellation

Calvert Cliffs Nuclear Power Plant

Annual Radioactive Effluent Release Report

2024

Document Number: 50-317 and 50-318

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ATTACHMENTS

1.0 LIST OF ACRONYMS AND DEFINITIONS

1. 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.

2. BWR: Boiling Water Reactor

3. 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.

4. 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.

5. Counting Error: An estimate of the two-sigma uncertainty associated with the sample results based on total counts accumulated.

6. Curie (Ci): A measure of radioactivity; equal to 3.7×10^{10} disintegrations per second, or 2.22×10^{12} disintegrations per minute.

7. 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.

8. Grab Sample: A single discrete sample drawn at one point in time.

9. Indicator: A sampling location that is potentially affected by plant effluents due to its proximity and/or direction from the plant.

10. Ingestion Pathway: The ingestion pathway includes milk, fish, drinking water and garden produce. Also sampled (under special circumstances) are other media such as vegetation or animal products when additional information about particular radionuclides is needed.

11. ISFSI: Independent Spent Fuel Storage Installation

12. LLD: Lower Limit of Detection. An *a priori* measure of the detection capability of a radiochemistry measurement based on instrument setup, calibration, background, decay time, and sample volume. An LLD is expressed as an activity concentration. The MDA is used for reporting results. LLD are specified by a regulator, such as the NRC and are typically listed in the ODCM.

13. 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 5% probability of falsely concluding that a blank observation represents a true signal.

14. MDC: Minimum Detectable Concentration. Essentially synonymous with MDA for the purposes of radiological monitoring.

15. Mean: The sum of all of the values in a distribution divided by the number of values in the distribution, synonymous with average.

16. Microcurie (µCi): 3.7 x 10^4 disintegrations per second, or 2.22 x10^6 disintegrations per minute.

17. millirem (mrem): 1/1000 rem; a unit of radiation dose equivalent in tissue.

18. Milliroentgen (mR): 1/1000 Roentgen; a unit of exposure to X- or gamma radiation.

19. N/A: Not Applicable

20. NEI: Nuclear Energy Institute

21. NRC: Nuclear Regulatory Commission

22. ODCM: Offsite Dose Calculation Manual

23. OSLD: Optically Stimulated Luminescence Dosimeter

24. Protected Area: A 10 CFR 73 security term is an area encompassed by physical barriers and to which access is controlled for security purposes. The fenced area immediately surrounding the plant and around ISFSI are commonly classified by the licensee as “Protected areas.” Access to the protected area requires a security badge or escort.

25. PWR: Pressurized Water Reactor

26. REC: Radiological Effluent Control

27. REMP: Radiological Environmental Monitoring Program

28. Restricted Area: A 10 CFRR 20 defined term where access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

29. 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).

30. TLD: Thermoluminescent Dosimeter

31. TRM: Technical Requirements Manual

32. TS: Technical Specification

33. Unrestricted Area: An area, access to which is neither limited nor controlled by the licensee.

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 Technical Specifications,10 CFR 20, 10CFR50, and by 40 CFR 190. Operational doses to the public during 2024 were calculated to be within 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 processing or direct disposal; and other information as required by site licensing documents.

In 2024, the gaseous effluent dose assessments for locations from the Land Use Census showed that the critical receptor for Calvert Cliffs Nuclear Power Plant is the Teenager due to the Inhalation pathway, at 2.4 km in the SE sector. The maximum Annual Organ Dose calculated for this receptor was 4.36E-04 mrem to the Liver.

The maximum dose calculated to any organ due to radioactive liquid effluents was 2.22E-03 mrem, for adult Gi-LLI due to liquid pathway in the NE sector.

Solid radioactive waste shipped offsite for processing or direct disposal included 1.17E+02 Curies and 1.02E+02 m^3, shipped in 11 shipments.

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

2.1 Comparison to Regulatory Limits

During 2024 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 Dose Summary[1]

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Liquid Effluent[2] Dose Limit, Total Body	Limit	3 mrem	3 mrem	3 mrem	3 mrem	6 mrem
	Total Body Dose	3.49E-04	1.33E-04	3.73E-04	3.35E-04	1.19E-03
	% of Limit	1.16E-02	4.43E-02	1.24E-02	1.12E-02	1.98E-02
Liquid Effluent[3] Dose Limit, Any Organ	Limit	10 mrem	10 mrem	10 mrem	10 mrem	20 mrem
	Max Organ Dose	5.08E-04	1.31E-04	3.41E-04	1.24E-03	2.22E-03
	% of Limit	5.08E-03	1.31E-03	3.41E-03	1.24E-02	1.11E-02
Gaseous Effluent Dose Limit, Gamma Air (Noble Gas)	Limit	10 mrad	10 mrad	10 mrad	10 mrad	20 mrad
	Gamma Air Dose	2.40E-05	1.83E-05	1.45E-05	1.46E-05	7.14E-05
	% of Limit	2.40E-04	1.83E-04	1.45E-04	1.46E-04	3.57E-04
Gaseous Effluent Dose Limit, Beta Air (Noble Gas)	Limit	20 mrad	20 mrad	20 mrad	20 mrad	40 mrad
	Beta Air Dose	2.89E-05	6.44E-06	5.10E-06	5.15E-06	4.56E-05
	% of Limit	1.45E-04	3.22E-05	2.55E-05	2.58E-05	1.14E-04
Gaseous Effluent Organ Dose Limit (Iodine, Tritium, Particulates with > 8-day half-life)	Limit	15 mrem	15 mrem	15 mrem	15 mrem	30 mrem
	Max Organ Dose	8.92E-05	9.73E-05	1.56E-04	9.32E-05	4.36E-04[4]
	% of Limit	5.95E-04	6.49E-04	1.04E-03	6.21E-04	1.45E-03

[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] Teenager, 2.4 miles Liver

Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for CCNPP[1]

	Whole Body	**Thyroid**	**Max Other Organ**
Gaseous[2]	8.71E-04	8.71E-04	8.71E-04
Carbon-14	3.24E-02	3.24E-02	1.62E-01
Liquid	1.19E-03	1.01E-03	2.22E-03
Direct Shine	Not Detectable	Not Detectable	Not Detectable
Total Site Dose	3.63E-02	3.61E-02	1.65E-01
Total w/Other Nearby Facility[3]	**N/A**	**N/A**	**N/A**
Limit	**25 mrem**	**75 mrem**	**25 mrem**
% of Limit	1.45E-01	4.81E-02	6.60E-01

[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 organ dose from Noble Gas, Iodine, Tritium, and particulates.
[3] Other fuel cycle sources within 5 miles of the site would be considered if they existed in this analysis.

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.

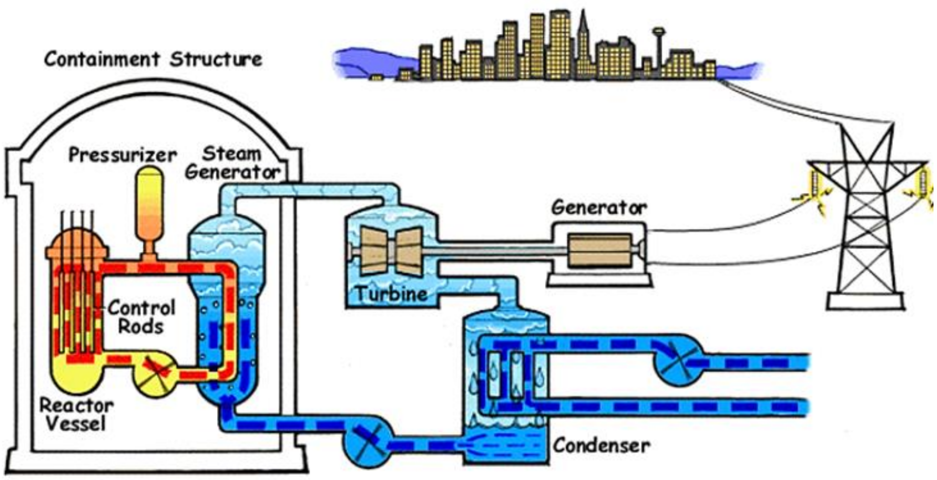

Figure 1, Pressurized Water Reactor (PWR) **[1]**

3.1 (Continued)

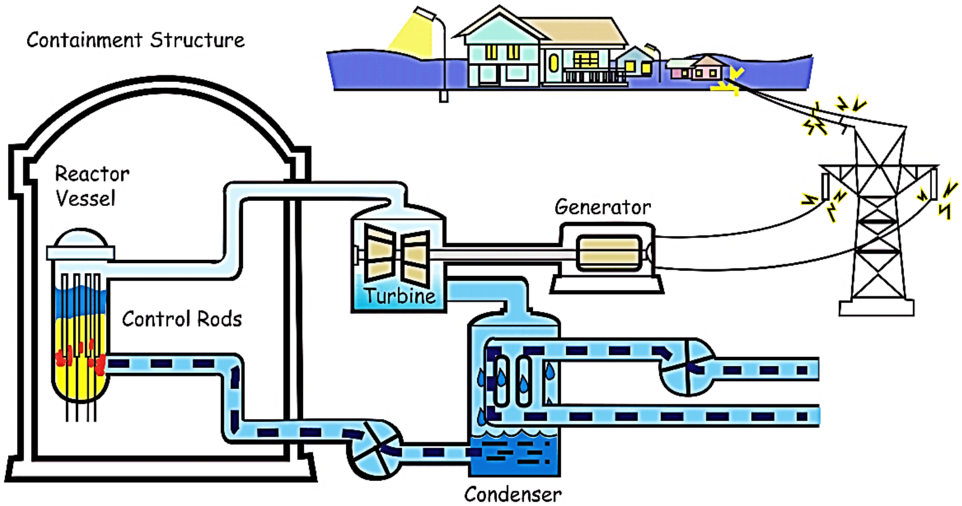

Figure 2, Boiling Water Reactor (BWR) **[2]**

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 powered 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 producing 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 in order 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.

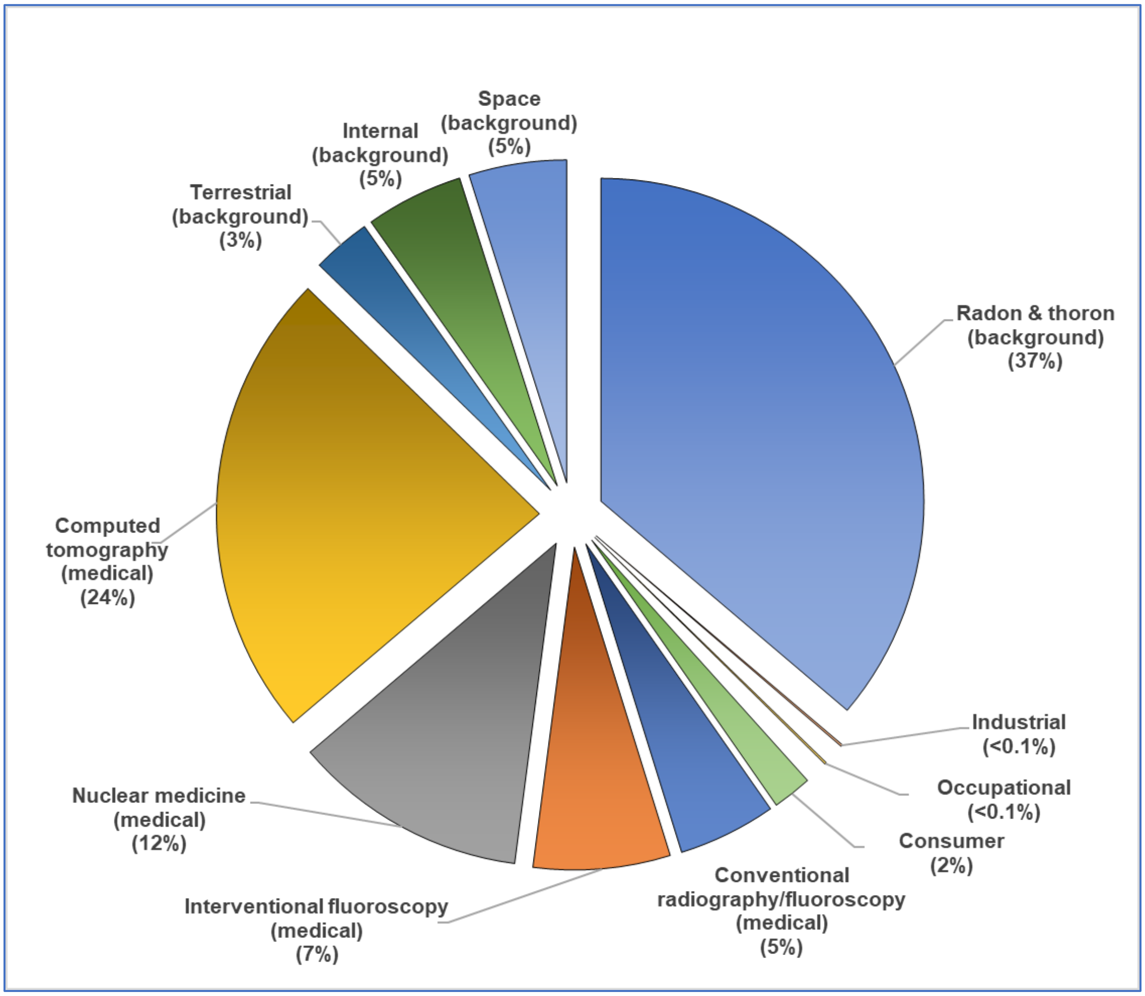

Figure 3, Sources of Radiation Exposure (NCRP Report No. 160) **[3]**

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 [3]. 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% of total mrem per year) 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 [4], and from the US Nuclear Regulatory Commission website [5].

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.

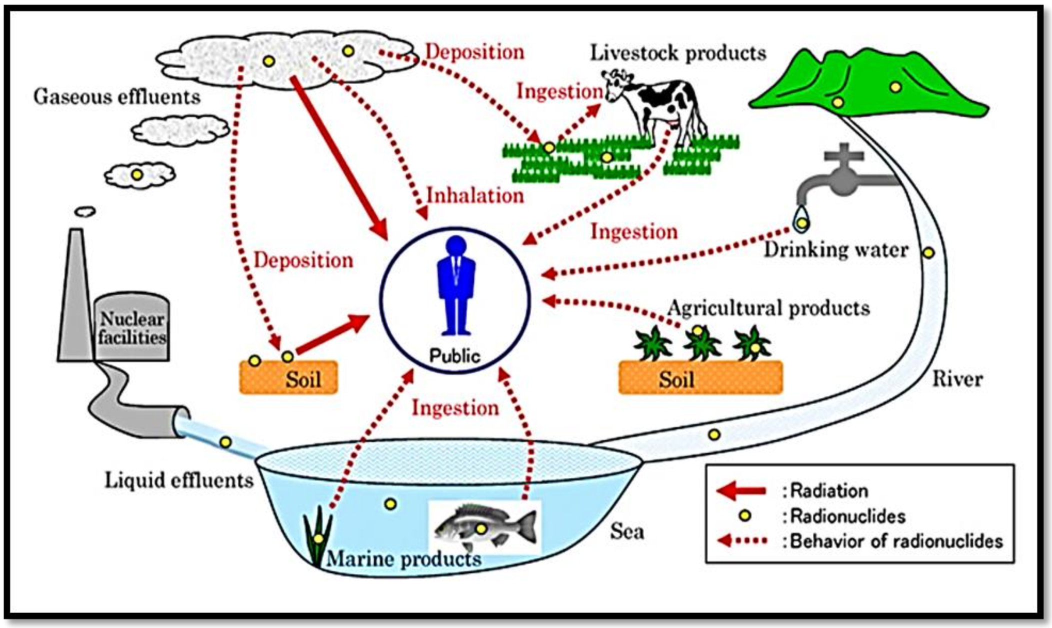

Figure 4, Potential exposure pathways to Members of the Public due to Plant Operations **[6]**

Each plant has an Offsite Dose Calculation Manual (ODCM) that specifies the methodology used to obtain the doses in the Dose Assessment section of this report. The dose assessment methodology in the ODCM is based on NRC Regulatory Guide 1.109 [7] and NUREG-0133 [8]. 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.

3.3 (Continued)

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 (e.g., taken from wells, rivers, or lakes). 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.

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 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 maximum exposed individual due to plant operation are a very small fraction of the annual dose that is received due to other sources. The calculated doses due to plant effluents, along with REMP results, serve to provide assurance that radioactive effluents releases are not exceeding safety standards for 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 plant Technical Specifications and 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 is 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 instantaneous concentration of liquid radioactive material released shall be limited to ten times the concentration specified in 10 CFR 20, Appendix B, Table 2, Column 2, for radionuclides other than dissolved or entrained noble gases. For dissolved or entrained noble gases, the total concentration released shall be limited to 2.0×10^{-4} microcuries/ml.

The annual whole body, skin and organ dose was computed using the 2024 source term using the dose calculation methodology provided in the ODCM. The calculated doses due to gaseous effluents are used to demonstrate compliance with offsite dose limits are presented in Table 1, Calvert Cliffs Nuclear Power Plant 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 mrads gamma

         b) Less than or equal to 10 mrads beta

      2) Yearly

         a) Less than or equal to 10 mrads gamma

         b) Less than or equal to 20 mrads beta

4.2 (Continued)

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

4.3 <u>Regulatory Limits for Liquid Effluent Doses</u>

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 Onsite Doses (Within Site Boundary)

CCNPP classifies individuals within the site boundary as either occupationally exposed individuals or members of the public. 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 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, Onsite Doses (Within Site Boundary)

Location	Sector	Approx. Distance (Meters)	X/Q (s/m^3)	D/Q (1/m^2)	Total Body Dose (mrem)		Direct Dose	Total
					Noble Gas	Iodine, Particulate C-14 & H-3	OSLD	
Camp Conoy	E	914.4	1.91E-07	5.36E-09	2.39E-06	4.01E-04	0.00	4.03E-04
Visitor Center	WNW	304.8	8.68E-06	8.68E-08	1.07E-05	1.79E-03	0.00	1.80E-03

5.0 SUPPLEMENTAL INFORMATION

5.1 Gaseous Batch Releases

5.1.1 CCNPP SITE

Number of batch releases	75
Total time period for a batch release	3.11E+04 minutes
Maximum time period for a batch release	3.60E+03 minutes
Average time period for a batch release	4.14E+02 minutes
Minimum time period for a batch release	9.50E+01 minutes

5.2 Liquid Batch Releases

5.2.1 CCNPP Site

Number of batch releases	53
Total time period for a batch release	5.51E+05 minutes
Maximum time period for a batch release	4.46E+04 minutes
Average time period for a batch release	1.04E+04 minutes
Minimum time period for a batch release	2.05E+02 minutes
Average total flow during period of release	4.37E+06 lpm

5.3 Abnormal Releases

5.3.1 Gaseous Abnormal Releases

There were no abnormal gaseous releases from the CCNPP Site in 2024.

5.3.2 Liquid Abnormal Releases

There were no abnormal liquid releases from the CCNPP Site in 2024.

5.4 Land Use Census Changes

There were no significant changes in the Land Use Census that would affect the 2024 CCNPP Radiological Effluent Control Program.

5.5 Meteorological Data

The CCNPP meteorological monitoring program achieved a 99.5% 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. [9]

5.6 Effluent Radiation Monitors Out of Service Greater Than 30 Days

Effluent Radiation Monitor Name	Number of Days Out of Service	Date Range Out of Service	Reason Out of Service >30 Days	Additional Notes (ODCM or TS)
0-RE-2191 Gaseous Radwaste Processing System	365	07/29/2013	Equipment obsolescence	Failed detector/Retiring in place.
0-RE-2201 Liquid Waste Discharge	330	02/05/2024 – 12/31/2024	High Bkgd/erratic reading	
1-RE-4014 Steam Generator Blowdown Effluent	79	3/23/24 – 6/10/2024	Failed detector	
1-RE-4014 Steam Generator Blowdown Effluent	45	6/25/24 - 8/9/2024	Missed STP	

5.7 Offsite Dose Calculation Manual (ODCM) Changes

There were no changes made to the Offsite Dose Calculation Manual in 2024.

5.8 Process Control Program (PCP) Changes

There were no changes to the Process Control Program (PCP) in 2024.

5.9 Radioactive Waste Treatment System Changes

There were no changes made to the Radwaste Treatment Systems in 2024.

5.10 Other Supplemental Information

5.10.1 Outside Tanks

In 2024, the CCNPP site did not utilize temporary outside tanks to hold radioactive materials more than 10 Curies. This requirement does not apply to tritium.

5.10.2 Independent Spent Fuel Storage Installation (ISFSI) Monitoring Program

There were 5 casks of spent fuel transferred to the ISFSI during 2024. No radionuclides were released to the environment during the ISFSI operation in 2024. 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 5,730-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,” the NRC recommended re-evaluating “principal radionuclides” and reporting C-14 as appropriate. Carbon-14 production and release estimates were calculated using 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 2024 was 2.03E+01 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 Table 1, but is included in Table 2.

5.10.4 Errata/Corrections to Previous ARERRs

There were no errata or corrections to previous ARERRs in 2024.

5.10.5 U1 Main Vent Particulate Filter Sample Missing

U1 Main Vent Particulate Filter Sample for 7/30/24 to 8/5/24 was found missing when preparing U1/U2 MV filters for shipment to vendor lab. Filter was counted for gamma analysis and was to be saved for composite alpha and hard to detects analysis. Main vent filters are placed into the lab source safe until shipment to vendor lab. Note that alpha and hard to detects on MV filters have been less than minimum detectable activity for several years. The remaining filters for the month were analyzed as normal with an adjusted volume for the missing filter.

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 [10]. The purpose of the GPI is to ensure timely detection and an effective response to situations involving inadvertent radiological releases to groundwater in order to prevent migration of licensed radioactive material off-site and to quantify impacts on decommissioning. During 2024, CCNPP collected and analyzed groundwater samples in accordance with the requirements of 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 2024, 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.

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[9] "NUREG-0324, “XOQDOQ, Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations,”," Nuclear Regulatory Commission, September, 1977.

[10] "NEI 07-07 - Industry Ground Water Protection Initiative — Final Guidance Document, Rev. 1," Nuclear Energy Institute, Washington, D.C., 2019.

[11] "10 CFR 50 - Domestic Licensing of Production and Utilization Facilities," US Nuclear Regulatory Commission, Washington, DC.

[12] "40 CFR 190 - Environmental Radiation Protection Standards for Nuclear Power Operation," US Environmental Protection Agency, Washington, DC.

[13] "10 CFR 20 - Standards for Protection Against Radiation," US Nuclear Regulatory Commission, Washington, DC.

[14] "40 CFR 141 - National Primary Drinking Water Regulations," US Environmental Protection Agency, Washington, DC..

[15] "NUREG-0324 - XOQDOQ, Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," Nuclear Regulatory Commission, September, 1977.

[16] "NUREG-1301 - Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors," Nuclear Regulatory Commission, April 1991.

[17] "NUREG-1302 - Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors," Nuclear Regulatory Commission, April 1991.

[18] "Regulatory Guide 4.13 - Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications, Revision 2," Nuclear Regulatory Commision, June, 2019.

[19] "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.

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

1.0 GASEOUS EFFLUENTS

Table 4, Gaseous Effluents Summation of All Releases Site [1]

A. Fission & Activation Gases	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error %
1. Total Release	Ci	3.42E-01	2.82E-02	2.23E-02	2.25E-02	1.20E+01
2. Average release rate for the period	μCi/sec	4.33E-02	3.57E-03	2.83E-03	2.86E-03	
B. Iodine						
1. Total Iodine – 131	Ci	<LLD	<LLD	<LLD	<LLD	6.50E+00
2. Average release rate for the period	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
C. Particulates						
1. Particulates with half-lives > 8 days	Ci	<LLD	<LLD	<LLD	<LLD	1.20E+01
2. Average release rate for the period	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
D. Tritium						
1. Total Release	Ci	1.01E+00	1.10E+00	1.76E+00	1.05E+00	1.32+01
2. Average release rate for the period	μCi/sec	1.28E-01	1.39E-01	2.23E-01	1.33E-01	
E. Gross Alpha						
1. Total Release	Ci	<LLD	<LLD	<LLD	<LLD	2.50E+01
2. Average release rate for the period	μCi/sec	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
F. Carbon-14						
1. Total Release	Ci	4.51E+00	5.25E+00	5.19E+00	5.23E+00	
2. Average release rate for the period	μCi/sec	5.74E-01	6.68E-01	6.53E-01	6.58E-01	

[1] % of limit is provided in Table 1, Calvert Cliffs Nuclear Power Plant Dose Summary

Table 5, Gaseous Effluents – Ground Level Release Batch Mode Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission Gases						
Ar-41	Ci	2.51E-02	2.82E-02	2.23E-02	2.25E-02	9.81E-02
Xe-133	Ci	3.09E-01	0.00E+00	0.00E+00	0.00E+00	3.09E-01
Total for Period	**Ci**	3.34E-01	2.82E-02	2.23E-02	2.25E-02	4.07E-01
Iodines						
	Ci	No Nuclides Detected	N/A	N/A	N/A	N/A
Total for Period	**Ci**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulates						
	Ci	No Nuclides Detected	N/A	N/A	N/A	N/A
Total for Period	**Ci**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium						
H-3	Ci	<LLD	<LLD	<LLD	<LLD	0.00E+00
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	0.00E+00
Carbon-14						
C-14	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 6, Gaseous Effluents – Ground Level Release   Continuous Mode Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission Gases						
Xe-133	Ci	7.63E-03	0.00E+00	0.00E+00	0.00E+00	7.63E-03
Total for Period	**Ci**	7.63E-03	0.00E+00	0.00E+00	0.00E+00	7.63E-03
Iodines						
	Ci	No Nuclides Detected	N/A	N/A	N/A	N/A
Total for Period	**Ci**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Particulates						
	Ci	No Nuclides Detected	N/A	N/A	N/A	N/A
Total for Period	**Ci**	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium						
H-3	Ci	1.01E+00	1.10E+00	1.76E+00	1.05E+00	4.92E+00
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	0.00E+00
Carbon-14						
C-14	Ci	4.51E+00	5.25E+00	5.19E+00	5.23E+00	2.03E+01

2.0 LIQUID EFFLUENTS

Table 7, Liquid Effluents – Summation of All Releases Site [1]

A. Fission & Activation Products	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error %
1. Total Release	Ci	3.49E-03	2.37E-04	1.52E-03	3.23E-03	1.03E+1
2. Average diluted concentration	µCi/mL	9.86E-13	6.67E-14	4.46E-13	8.80E-13	
B. Tritium						
1. Total Release	Ci	2.85E+02	1.24E+02	3.05E+02	2.50E+02	1.03E+1
2. Average diluted concentration	µCi/mL	8.05E-08	3.47E-08	8.92E-08	6.80E-08	
C. Dissolved & Entrained Gases						
1. Total Release	Ci	7.08E-05	0.00E+00	0.00E+00	0.00E+00	1.03E+1
2. Average diluted concentration	µCi/mL	2.00E-14	0.00E+00	0.00E+00	0.00E+00	
D. Gross Alpha Activity						
1. Total Release	Ci	<LLD	<LLD	<LLD	<LLD	
E. Volume of Waste Released (prior to dilution)	Liters	1.27E+08	1.19E+08	1.42E+08	1.36E+08	
F. Volume of Dilution Water Used During Period	Liters	3.54E+12	3.56E+12	3.41E+12	3.67E+12	

[1] % of limit is provided in Table 1, Calvert Cliffs Nuclear Power Plant Dose Summary

Table 8, Batch Mode Liquid Effluents Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
Co-60	Ci	1.41E-03	0.00E+00	9.19E-05	8.37E-05	1.59E-03
CR-51	Ci	1.50E-04	<LLD	<LLD	<LLD	1.50E-04
Zr-95	Ci	<LLD	<LLD	<LLD	1.07E-04	1.07E-04
Cs-137	Ci	1.03E-03	1.66E-04	1.43E-03	1.68E-03	4.31E-03
Fe-55	Ci	<LLD	<LLD	<LLD	8.08E-04	8.08E-04
Nb-95	Ci	<LLD	<LLD	<LLD	1.52E-04	1.52E-04
Co-58	Ci	9.09E-04	7.16E-05	<LLD	<LLD	9.81E-04
Ni-63	Ci	<LLD	<LLD	<LLD	4.04E-04	4.04E-04
Total for Period	Ci	3.49E-03	2.37E-04	1.52E-03	3.23E-03	8.48E-03
Tritium						
H-3	Ci	2.85E+02	1.23E+02	3.04E+02	2.50E+02	9.62E+02
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	0
Entrained Gases						
Xe-133	Ci	7.08E-05	<LLD	<LLD	<LLD	7.08E-05
Total for Period	Ci	7.08E-05	0	0	0	7.08E-05

Table 9, Continuous Mode Liquid Effluents Site

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
	Ci	None Detected	N/A	N/A	N/A	N/A
Total for Period	Ci	0	0	0	0	0
Tritium						
H-3	Ci	5.45E-02	1.20E-01	3.47E-01	2.10E-01	7.32E-01
Gross Alpha						
Alpha	Ci	<LLD	<LLD	<LLD	<LLD	0
Entrained Gases						
	Ci	None Detected	N/A	N/A	N/A	N/A
Total for Period	Ci	0	0	0	0	0

Attachment 2, Solid Waste Information

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

Table 10, Types of Solid Waste Summary Site

Types of Waste	Total Volume		Curies
a. Spent resins, filter sludges, evaporator bottoms, etc.			
Class	ft³	m³	Curies Shipped
A	4.96E+02	1.41E+01	4.76E+01
B	2.83E+02	8.01E+00	6.92E+01
C	0.00E+00	0.00E+00	0.00E+00
Unclassified	0.00E+00	0.00E+00	0.00E+00
All	7.79E+02	2.21E+01	1.17E+02
Major Nuclides for the 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			
b. Dry compressible waste, contaminated equip, etc.			
Class	ft³	m³	Curies Shipped
A	2.30E+03	6.52E+01	4.19E-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	4.19E-02

Major Nuclides for the 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			
c. Irradiated components, control rods, etc.	None	None	
d. Other (metal for recycling)			
Class	ft³	m³	Curies Shipped
A	5.30E+02	1.50E+01	9.13E-03
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	5.30E+02	1.50E+01	9.13E-03
Major Nuclides for the 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, I-129, Cs-137, Pu-238, Pu-239, Pu-241, Am-241, Cm-242, Cm-243			
Total Combined			
Class	ft³	m³	Curies Shipped
A	3.33E+03	9.43E+01	4.77E+01
B	2.83E+02	8.01E+00	6.92E+01
C	0.00E+00	0.00E+00	0.00E+00
Unclassified	0.00E+00	0.00E+00	0.00E+00
All	3.61E+03	1.02E+02	1.17E+02
Major Nuclides for the 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			

2.0 ESTIMATE OF MAJOR NUCLIDE COMPOSITION (BY WASTE TYPE) ONLY >1% ARE REPORTED. [NOTE 1]

Table 11, Major Nuclides Site

Major Nuclide Composition (> 1.0%)	%	Curies
a. Spent resins, filter sludges, evaporator bottoms, etc.		
Waste Class A		
Nuclide Name	Abundance	Activity
Cr-51	1.05%	5.00E-01
Fe-55	66.20%	3.15E+01
Co-58	6.01%	2.86E+00
Co-60	9.67%	4.61E+00
Ni-63	2.40%	1.14E+00
Zr-95	1.37%	6.54E-01
Nb-95	2.59%	1.23E+00
Cs-137	8.83%	4.21E+00
Waste Class B		
Nuclide Name	Abundance	Activity
Mn-54	1.02%	7.05E-01
Fe-55	2.72%	1.88E+00
Co-58	3.82%	2.64E+00
Co-60	19.04%	1.32E+01
Ni-63	32.96%	2.28E+01
Cs-134	1.06%	7.33E-01
Cs-137	37.97%	2.63E+01
Total Combined		
Nuclide Name	Abundance	Activity
Fe-55	28.62%	3.34E+01
Co-58	4.71%	5.50E+00
Co-60	15.22%	1.78E+01
Ni-63	20.50%	2.39E+01
Nb-95	1.06%	1.24E+00
Cs-137	26.08%	3.05E+01
	Total	1.12E+02

Table 11, Major Nuclides Site

b. Dry compressible waste, contaminated equip, etc.		
Waste Class A		
Nuclide Name	Abundance	Activity
Cr-51	2.81%	1.18E-03
Fe-55	73.98%	3.10E-02
Co-58	8.12%	3.40E-03
Co-60	8.10%	3.39E-03
Ni-63	1.56%	6.54E-04
Zr-95	1.29%	5.41E-04
Nb-95	2.16%	9.03E-04
	Total	4.11E-02
c. Irradiated components, control rods, etc.		
None		
d. Other (metal sent for reprocessing)		
Waste Class A		
Nuclide Name	Abundance	Activity
H-3	12.48%	1.14E-03
Fe-55	41.80%	3.81E-03
Co-58	2.99%	2.73E-04
Co-60	7.63%	6.96E-04
Ni-63	29.97%	2.73E-03
Cs-137	2.07%	1.88E-04
	Total	8.84E-03

Sum of All 4 Categories

Waste Class A		
Nuclide Name	Abundance	Activity
Cr-51	1.05%	5.01E-01
Fe-55	66.20%	3.16E+01
Co-58	6.01%	2.87E+00
Co-60	9.67%	4.61E+00
Ni-63	2.40%	1.15E+00
Zr-95	1.37%	6.54E-01
Nb-95	2.59%	1.24E+00
Cs-137	8.82%	4.21E+00

Table 11, Major Nuclides Site

Waste Class B		
Nuclide Name	Abundance	Activity
Mn-54	1.02%	7.05E-01
Fe-55	2.72%	1.88E+00
Co-58	3.82%	2.64E+00
Co-60	19.04%	1.32E+01
Ni-63	32.96%	2.28E+01
Cs-134	1.06%	7.33E-01
Cs-137	37.97%	2.63E+01
Total Combined		
Nuclide Name	Abundance	Activity
Fe-55	28.63%	3.35E+01
Co-58	4.71%	5.51E+00
Co-60	15.22%	1.78E+01
Ni-63	20.49%	2.39E+01
Nb-95	1.06%	1.24E+00
Cs-137	26.07%	3.05E+01
	Total curies shipped	1.12E+02

3.0 SOLID WASTE DISPOSITION

Table 12, Solid Waste Disposition Site

Number of Shipments	Mode of Transportation	Destination
4	Hittman	Energy Solutions Bear Creek 1560 Bear Creek Rd
1	Hittman	Energy Solutions Services, Inc. Memphis 1790 Dock Street
2	Hittman	Energy Solutions LLC. Clive Disposal Site - Containerized Waste Facility
1	Hittman	Erwin Resin Solutions, LLC 151 T.C. Runion Road
2	Hittman	Waste Control Specialists LLC Compact Waste Disposal Facility
1	Landstar Ranger	Energy Solutions Bear Creek 1560 Bear Creek Rd
11	Total	

4.0 IRRADIATED FUEL DISPOSITION

Table 13, Irradiated Fuel Shipments Disposition Site

There were no irradiated Fuel shipments from the Site in 2024

Attachment 3, Meteorological Data

1.0 METEOROLOGICAL DATA SUMMARY

1.1 Joint Frequency Distributions

1. Period of Record: 2024
2. Stability Class: All

Sensor Elevation	Period of Calm (hours)	Missing Data (hours)
10 m	99	41
60 m	6	41

1.2 Stability class

Table 14, Classification of Atmospheric Stability

Stability Condition	Pasquill Categories	Percentage 10m	Percentage 60m
Extremely Unstable	A	7.76%	7.68%
Moderately Stable	B	4.34%	4.29%
Slightly Unstable	C	6.26%	6.19%
Neutral	D	35.10%	34.75%
Slightly Stable	E	31.09%	30.90%
Moderately Stable	F	9.07%	9.27%
Extremely Stable	G	6.39%	6.91%