Perry Nuclear Power Plant
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April 30, 2026
L-26-070

10CFR50.36(a)

ATTN: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Perry Nuclear Power Plant
Docket No. 50-440
Annual Radioactive Effluent Release Report

Enclosed is the Annual Radioactive Effluent Release Report for the Perry Nuclear Power Plant (PNPP) for the period of January 1, 2025 through December 31, 2025. This document partially satisfies the requirements of the PNPP Technical Specifications (TS), the PNPP Offsite Dose Calculation Manual (ODCM), and the Environmental Protection Plan contained in Appendix B of the PNPP Operating License.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Eli Crosby, Senior Manager of Radiation Protection and Chemistry at (440) 280-5032.

Sincerely,

Terry Brown

Enclosures:
A PNPP Annual Radioactive Effluent Release Report 2025

cc: NRC Project Manager
NRC Resident Inspector
NRC Region III

Enclosure A

L-26-070

PNPP Annual Radioactive Effluent Release Report 2025

Annual Radioactive Effluent Release Report 2025

Document Number: L-26-070

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LIST OF ACRONYMS AND DEFINITIONS

1. ARERR: Annual Radioactive Effluent Release Report

2. AREOR: Annual Radiological Environmental Release Report

3. 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.

4. BWR: Boiling Water Reactor

5. Curie (Ci): A measure of radioactivity; equal to 3.7E+10 disintegrations per second, or 2.22E+12 disintegrations per minute.

6. 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.

7. EPRI: Electric Power Research Institute

8. Ingestion Pathway: The ingestion pathway includes milk, fish, and garden produce. Meat or other food products may also be included.

9. ISFSI: Independent Spent Fuel Storage Installation

10. 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.

11. Microcurie (μCi): 3.7E+4 disintegrations per second, or 2.22E+06 disintegrations per minute.

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

13. NA: Not Applicable

14. NEI: Nuclear Energy Institute

15. NRC: Nuclear Regulatory Commission

16. ODCM: Offsite Dose Calculation Manual

17. pCi: one trillionth of a Curie.

18. PNPP: Perry Nuclear Power Point

19. PWR: Pressurized Water Reactor

20. RETS: Radiological Effluent Technical Specifications

21. REMP: Radiological Environmental Monitoring Program

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

23. TLD: Thermoluminescent Dosimeter

24. TS: Technical Specification

1.0 EXECUTIVE SUMMARY

Perry Nuclear Power Plant (PNPP) Radiological Effluent Technical Specifications (RETS) Program was established to limit the quantities of radioactive material that may be released based on calculated radiation doses or dose rates. Dose to Members of the Public due to radioactive materials released from the plant is limited by Appendix I of 10 CFR 50 and by 40 CFR 190. Operational doses to the public during 2025 were calculated to be within the limits required by regulation and pose no health hazard when compared to other sources of radiation dose.

The Annual Radioactive Effluent Release Report (ARERR) details the results of the effluent monitoring program conducted at the Perry Nuclear Power Plant (PNPP) from January 01 through December 31, 2025. This report combined with the PNPP Annual Radioactive Environmental Operating Report 2025 meets all the requirements in PNPP Technical Specifications, the Offsite Dose Calculation Manual (ODCM), and Regulatory Guide 1.21.

In addition to monitoring radioactive effluents, PNPP 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).

1.1 <u>Radioactive Effluent Releases</u>

During the normal operation of a nuclear power plant, small quantities of radioactivity are released to the environment through liquid and gaseous effluent pathways. Radioactive material is also shipped offsite as solid waste. PNPP maintains a comprehensive program to control and monitor the release of radioactive materials from the site in accordance with Nuclear Regulatory Commission (NRC) release regulations.

Dose to the general public from the plant's liquid and gaseous effluent pathways were below regulatory limits, it is worth noting that liquid releases were higher due to it being a refuel outage year and an increase in liquid radwaste releases being performed. There was a notable elevation in particulate activity due to positive identification of hard-to-detect Sr-89 detected in the TB/HB vent effluent.

The calculated maximum individual whole-body dose potentially received by an individual resulting from PNPP liquid effluents was 5.34E-02 mrem (1.8 percent of the regulatory limit). The calculated maximum individual whole-body dose potentially received by an individual resulting from PNPP noble gas effluents was 1.50E-02 mrem (0.300 percent of the regulatory limit).

Radioactivity released to the environment in the form of gaseous C-14 was estimated based on plant type and power production. The calculation is based on an industry initiative supported by the Nuclear Energy Institute (NEI), the Electric Power Research Institute (EPRI), and the NRC. The calculated hypothetical maximum annual individual whole-body dose potentially received by an individual resulting from PNPP gaseous effluents for C-14 is 0.251 mrem/yr (5.019% of the limit). Refer to Section 12 for additional C-14 information.

Shipments of solid waste consisted of waste generated during water treatment, radioactive material generated during normal operations and maintenance, and irradiated components. PNPP complied with regulations governing radioactive shipments of solid radioactive waste.

2.0 INTRODUCTION

Nuclear energy provides an alternative energy source that is readily available with a very limited impact upon the environment. To understand nuclear energy more fully as a source of generating electricity, it is helpful to understand basic radiation concepts and the occurrence of radioactivity in nature.

2.1 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 (Figure 1).

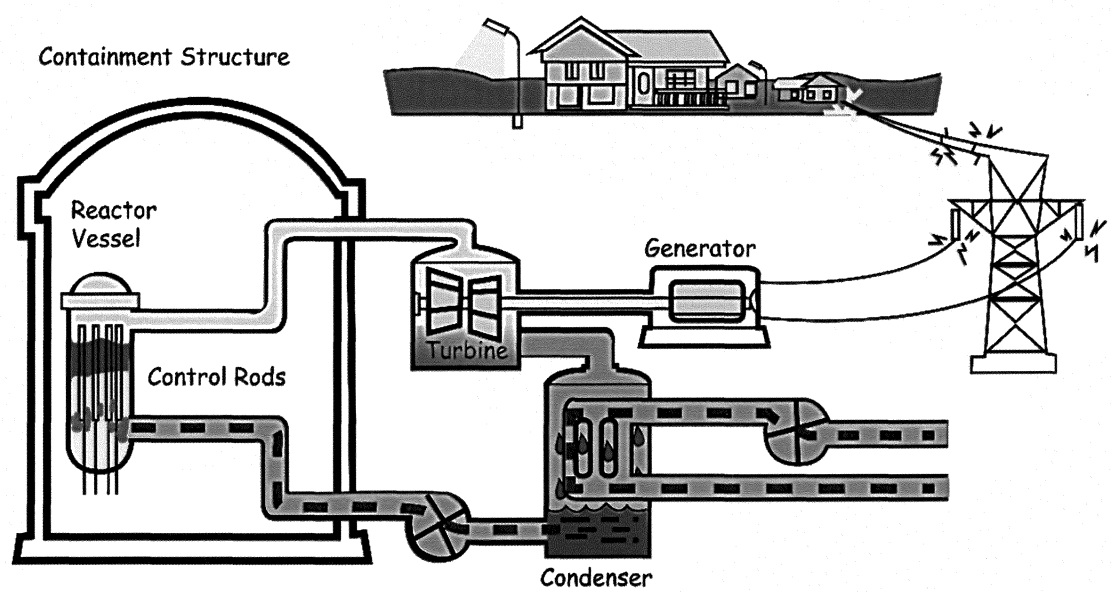

Figure 1: Boiling Water Reactor (BWR) [2]

A PWR, in contrast, includes two separate water systems: radioactive reactor coolant and a secondary system (Figure 2). Reactor coolant is maintained under high pressure to prevent 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.

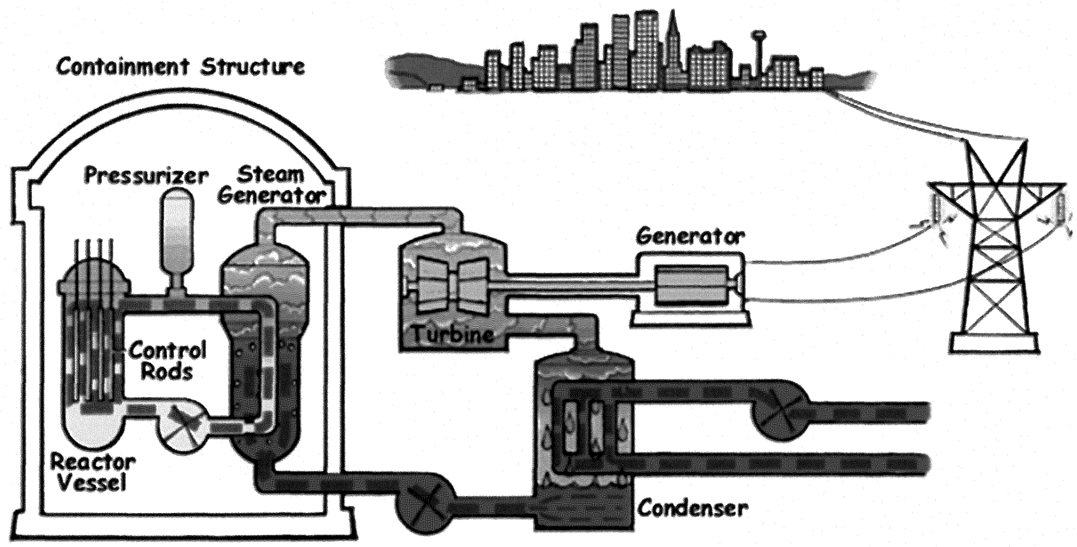

Figure 2: Pressurized Water Reactor (PWR) [1]

Electricity is generated by a nuclear power plant similar to the way that electricity is generated at other conventional types of power plants, such as those driven by coal or natural gas. Water is boiled to generate steam. The steam turns a turbine that is attached to a generator, and the steam is condensed back into water to be returned to the boiler. What makes nuclear power different from these other types of power plants is that 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, and 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

2.2 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.

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 [1] (Figure 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%) 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.

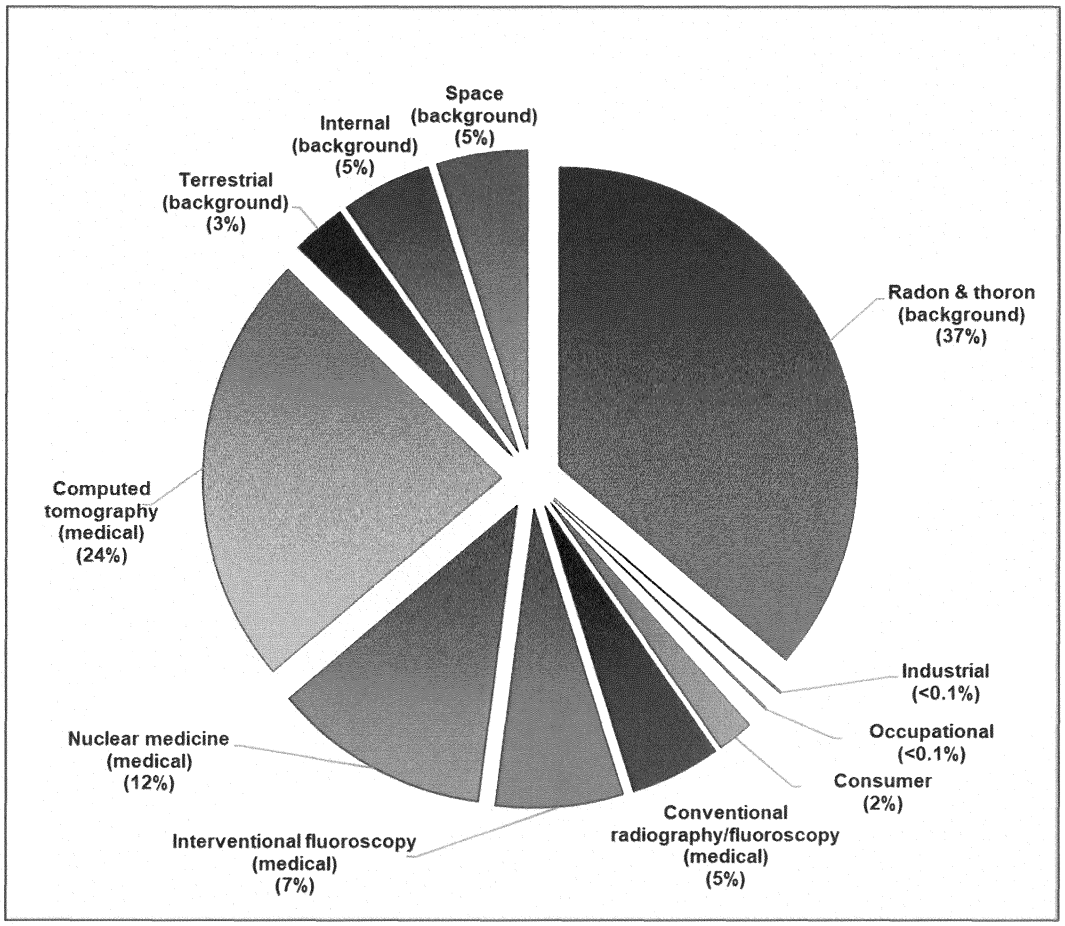

Figure 3: Sources of Radiation Exposure (NCRP Report No. 160) [3]

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 [2], and from the US Nuclear Regulatory Commission website [3].

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: 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.

2.2 Lower Limit of Detection

Sample results are often reported as below the Lower Limit of Detection (LLD), or as None Detected (ND). The LLD for an analysis is the smallest amount of radioactive material that will show a positive result, for which there can be a 95% confidence that radioactivity is present. This statistical parameter is used as a measure of the sensitivity of a sample analysis. When a measurement is reported as less than the LLD (<LLD), it means that no radioactivity was detected. Had radioactivity been present at or above the stated LLD value, it statistically would have been detected. The NRC has established the required LLD values for environmental and effluent sample analyses.

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.

Each year a Land Use Census is performed to determine what potential dose pathways currently exist within a five-mile radius around the plant, the area most affected by plant operations. The Annual Land Use Census identifies the locations of vegetable gardens, nearest residences, milk animals, and meat animals. The data from the census is used to determine who is the likely to be most exposed to radiation dose because of plant 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. Reference Figure 4 for potential exposure pathways to members of the public.

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 the plant effluents, along with REMP results indicating no detectible radioactive material due to plant operations, serve to provide assurance that the site is not having a negative impact on the environment or people living near the plant.

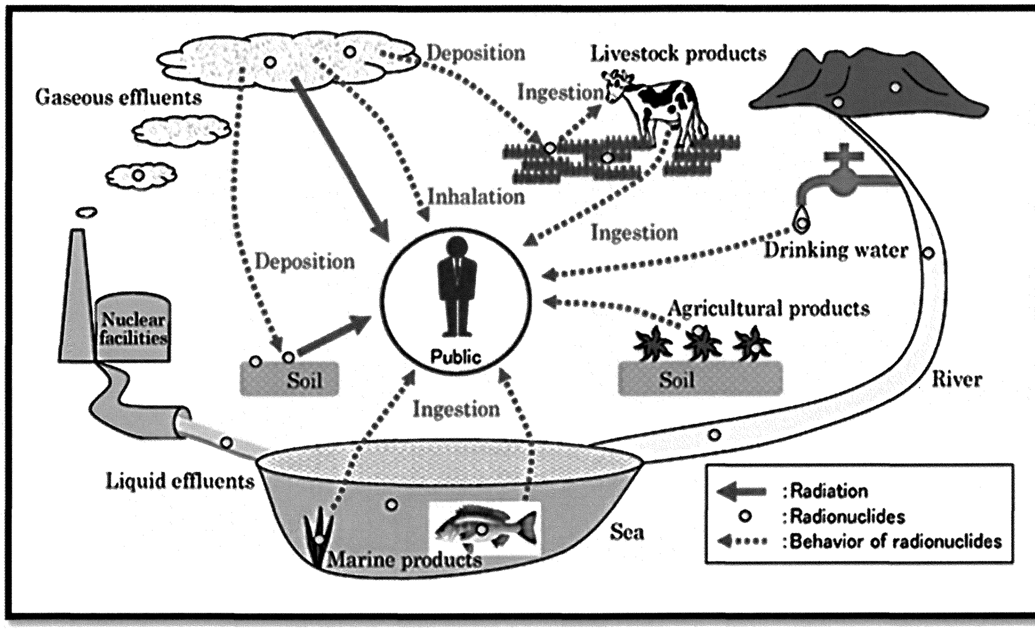

Figure 4: Potential exposure pathways to Members of the Public from Plant Operation [9]

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 [4] and NUREG-0133 [5]. 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.

Figure 4, shown above, depicts how the public may interact with nuclear facility gaseous and liquid effluents – thus determining the pathways monitored through environmental sampling.

3.0 RADIOACTIVE EFFLUENT RELEASES

3.1 Introduction

The source of radioactive material in a nuclear power plant is the generation of fission products (*e.g.*, noble gas, iodine, and particulate) or neutron activation of water and corrosion products (*e.g.*, tritium and cobalt). Most of the fission products generated remain within the nuclear fuel pellet and fuel cladding. Most fission products that escape from the fuel cladding, as well as the majority of the activated corrosion products, are removed by plant processing equipment.

During the normal operation of a nuclear power plant, small amounts of radioactive material are released in the form of solids, liquids, and gases. PNPP was designed and is operated in such a manner as to control and monitor these effluent releases. Effluents are controlled to ensure any radioactivity released to the environment is minimal and within regulatory limits. Effluent release programs include the operation of monitoring systems, in-plant sampling and analysis, quality assurance, and detailed procedures covering all aspects of effluent monitoring.

The liquid and gaseous radioactive waste treatment systems at PNPP are designed to collect and process these wastes in order to remove most of the radioactivity. Effluent monitoring systems are used to provide continuous indication of the radioactivity present and are sensitive enough to measure several orders of magnitude lower than the release limits. This monitoring instrumentation is equipped with alarms and indicators in the plant control room. The alarms are set to provide warnings to alert plant operators when radioactivity levels reach a small fraction of the limits. The waste streams are sampled and analyzed to identify and quantify the radionuclides being released to the environment.

Gaseous effluent release data is coupled with on-site meteorological data in order to calculate the dose to the general public. Devices are maintained at various locations around PNPP to continuously sample the air in the surrounding environment. Frequent samples of other environmental media are also taken to determine if any radioactive material deposition has occurred.

Generation of solid waste is controlled to identify opportunities for minimization. Limiting the amount of material taken into the plant and sorting material as radioactive or non-radioactive waste helps to lower the volume of radioactive solid waste generated. After vendor processing, solid waste is shipped to a licensed burial site.

3.2 Regulatory Limits

The Nuclear Regulatory Commission has established limits for liquid and gaseous effluents that comply with:

10 CFR 20: Title 10 of the Code of Federal Regulations, Part 20, Standards for Protection Against Radiation, Appendix B;

10 CFR 50: Title 10 of the Code of Federal Regulations, Part 50, Domestic Licensing of Production and Utilization Facilities, Appendix I;

10 CFR 72.104: Title 10 of the Code of Federal Regulations, Part 72.104, Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS

40 CFR 190: Title 40 of the Code of Federal Regulations, Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations

These limits were incorporated into the PNPP Technical Specifications, and subsequently into the PNPP ODCM. The ODCM prescribes the maximum doses and dose rates due to radioactive effluents resulting from the operation of PNPP. These limits are defined in several ways and serve to limit the overall impact on persons living near the plant. Since there are no other fuel sources near the PNPP, the 40 CFR 190 limits described below were not exceeded.

3.2.1 Liquid Effluents

The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table 2, Column 2 for radionuclides other than dissolved or entrained noble gases, as required by the ODCM. For dissolved or entrained noble gases, the concentration is limited to 2.0E-04 µCi/ml. These values are the maximum effluent concentrations.

The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released to unrestricted areas shall be limited to the following:

During any calendar quarter:
Less than or equal to 1.5 mrem to the whole body, and
Less than or equal to 5 mrem to any organ

During any calendar year:
Less than or equal to 3 mrem to the whole body, and
Less than or equal to 10 mrem to any organ

3.2.2 Gaseous Effluents

The dose rate due to radioactive materials released in gaseous effluents (including any releases from the on-site ISFSI) from the site to areas at and beyond the site boundary are governed by 10 CFR 20 and shall be limited to the following as required by the PNPP ODCM:

- Noble gases:
  Less than or equal to 500 mrem per year to the whole body, and
  Less than or equal to 3000 mrem per year to the skin

- Iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight days:
  Less than or equal to 1500 mrem per year to any organ

Air dose due to noble gases to areas at and beyond the site boundary are governed by 10 CFR 50 Appendix I and shall be limited to the following:

- During any calendar quarter:
  Less than or equal to 5 mrad for gamma radiation, and
  Less than or equal to 10 mrad for beta radiation
- During any calendar year:
  Less than or equal to 10 mrad for gamma radiation, and
  Less than or equal to 20 mrad for beta radiation

Dose to a member of the public from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half-lives greater than eight days in gaseous effluents released to areas at and beyond the site boundary shall be limited to the following:

Less than or equal to 7.5 mrem to any organ per any calendar quarter, and
Less than or equal to 15 mrem to any organ per any calendar year

The PNPP ODCM does not contain a concentration limit for gaseous effluents. For this reason, effluent concentrations are not used to calculate maximum release rates for gaseous effluents.

3.3 Release Summary

Effluents are sampled and analyzed to identify both the type and quantity of radionuclides present. This information is combined with effluent path flow measurements to determine the composition, concentration, and dose contribution of the radioactive effluents.

3.4 40 CFR 190 and 10 CFR 72.104 – Uranium Fuel Cycle Dose Assessment

The 40 CFR 190 limit for whole body dose is 25 mrem. Considering all sectors, the total whole-body dose to a member of the general public was 0.32 mrem. This value was determined by summing the annual whole-body doses from liquid and gaseous radioactive effluents and the annual gaseous C-14 dose. Since the direct radiation dose, as determined by TLD, was indistinguishable from natural background, it was not included in the calculation. More information regarding direct radiation dose and the Independent Spent Fuel Storage Installation (ISFSI), may be found in Section 3.5.

3.5 Independent Spent Fuel Storage Installation (ISFSI)

Dose rates from the ISFSI contributing to a dose to a member of the public at or beyond the site boundary is governed by 10 CFR 72.104 and shall be limited to the following as required by the PNPP ODCM during any calendar year:

Less than or equal to 25 mrem whole body dose;
Less than or equal to 75 mrem thyroid dose; and
Less than or equal to 25 mrem to any other critical organ.

3.5.1 10 CFR 72.104, ISFSI Compliance

Since installation of the Independent Spent Fuel Storage Installation (ISFSI) in 2011, eight TLDs have been placed on the outer perimeter fence of the cask storage area (located within the site boundary) to monitor dose due to direct radiation from the spent fuel stored on the ISFSI.

Since the dosimeters measure an accumulation of all sources of radiation, the following justification was used to determine how to most accurately calculate the dose received to the nearest resident contributed only by the spent fuel at the ISFSI.

To determine the dose contributed by the spent fuel only, one would need to discriminate out the dose associated with background radiation as described above and other sources. Dosimeters close to the plant are susceptible to “shine” which is radiation from nitrogen-16 that is reflected by the atmosphere. Background radiation and shine affect the surrounding TLDs almost uniformly.

The dosimeters closest to the dry casks receive more dose from the spent fuel and are thus affected by a lesser percentage by background radiation and plant effluents than those further away. To calculate the dose contribution more accurately to the nearest resident from the spent fuel, the dosimeter nearest to the point source is used.

The dose calculation was performed using the location of the nearest residence, assuming they remain at the location all year, because that individual would incur the maximum potential dose from direct exposure. The TLD at REMP location 7 found in the AREOR is positioned neighboring the nearest resident, was also reviewed for significant changes in readings.

To determine the dose rate to the nearest resident and demonstrate compliance, the following equation was used:

$$D_1R_1^2=D_2R_2^2$$

Where:

D_1 = dose rates (mrem/yr) at the TLD location
D_2 = dose rates (mrem/yr) to nearest resident
R_1 = distance (feet) of nearest TLD location to max individual
R_2 = distance (feet) to nearest resident

The two nearest TLDs were chosen to estimate dose rates, which were #15 and #20, directly east and west of the dry casks. The corresponding estimated dose rates to the nearest resident was 1.85E-01 and 2.53E-01 mrem/yr, respectively, in 2025.The dose rates of 1.85E-01 and 2.53E-01 mrem/yr are an estimate based on TLD readings to demonstrate compliance. The calculation confirms that direct dose from the ISFSI does not exceed the 40 CFR 190 limit of 25 mrem/year.

Review of the TLD results from 2025 have shown no detectable impact on dose to the public due to radiation from the ISFSI nor significant changes in results to the public since employment of the ISFSI.

4.0 LIQUID EFFLUENTS

The PNPP liquid radioactive waste system is designed to collect and treat all radioactive liquid waste produced in the plant. The treatment process used for radioactive liquid waste depends on its physical and chemical properties. It is designed to reduce the concentration of radioactive material in the liquid by filtration to remove suspended solids and demineralization to remove dissolved solids. Normally, the effluent from the liquid radioactive waste system is returned to plant systems. To reduce the volume of water stored in plant systems, however, the processed liquid effluents may be discharged from the plant via a controlled release. In this case, effluent activity and dose calculations are performed prior to and after discharging this processed water to Lake Erie to ensure regulatory compliance and dose minimization principles are maintained.

Liquid radioactive waste system effluents may be intermittently released. These intermittent releases are considered “batch” releases. Table 1 provides information on the number and duration of these releases for 2025.

Table 1: Liquid Batch Releases

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Number of batch releases	14	23	16	0
Total time period for batch releases, min	3.68E+03	7.39E+03	3.81E+03	0
Maximum time for a batch release, min	5.43E+02	1.68E+03	3.38E+02	0
Average time period for a batch release, min	2.63E+02	3.21E+02	2.38E+02	0
Minimum time for a batch release, min	1.70E+01	2.10E+01	2.20E+01	0
Average quarterly flow rate, L/min	2.22E+05	2.25E+05	2.22E+05	0

Table 2 provides information on the nuclide composition for all liquid radioactive effluent system releases. In each case, LLDs were at or below the required values. Table 2a provides information specific to radioactive effluent batch releases and Table 2b provides information specific to continuous radioactive effluent releases. A batch release is the discharge of liquid waste of a discrete volume. Potential sources for a batch release at PNPP are Liquid Radwaste Discharges via the Emergency Service Water system and Auxiliary Steam tritium in-leakage to the Auxiliary Boiler vented into the atmosphere. A continuous release is the discharge of fluid wastes of a non-discrete volume. Potential sources for a continuous release at Perry are Residual Heat Removal (RHR) heat exchanger leakage into the Emergency Service Water system, Nuclear Closed Cooling (NCC) out-leakage into the Service Water system, tritium activity in the Turbine Building Ventilation (M35) Supply Plenum drain into storm drains, and Alternate Decay Heat Removal (ADHR) heat exchanger leakage into Service Water.

Table 2: Summation of All Liquid Effluent Releases

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error, (%)
A. Fission and Activation Products					
1. Total Released, Ci (excluding tritium, gases, alpha)	**4.85E-02**	**4.64E-02**	**5.57E-02**	**4.60E-04**	**5.00E+00**
2. Average Diluted Concentration, µCi/mL *	5.94E-08	2.79E-08	6.58E-08	8.20E-11	
3. Percent of Applicable Limit, %	7.37E-01	5.87E-01	8.73E-01	1.99E-04	
B. Tritium					
1. Total Released, Ci	**2.49E+00**	**3.92E+00**	**3.42E+00**	**2.32E-03**	**4.00E+00**
2. Average Diluted Concentration, µCi/mL	3.06E-06	2.36E-06	4.04E-06	4.13E-10	
3. Percent of Applicable Limit, %	3.06E-01	2.36E-01	4.04E-01	4.13E-05	
C. Dissolved and Entrained Gases					
1. Total Released, Ci	ND [1]	ND [1]	ND [1]	ND [1]	**7.00E+00**
2. Average Diluted Concentration, µCi/mL	ND [1]	ND [1]	ND [1]	ND [1]	
3. Percent of Applicable Limit, %	ND [1]	ND [1]	ND [1]	ND [1]	
D. Gross Alpha Activity, Ci	**1.13E-05**	**6.22E-05**	**1.09E-05**	**3.36E-07**	**8.00E+00**
E. Waste Volume Released, Liters (prior to dilution)*	**4.10E+06**	**3.04E+06**	**1.39E+07**	**2.37E+06**	
F. Dilution Water Volume Used, Liters	**4.31E+09**	**1.84E+09**	**1.25E+10**	**5.61E+09**	

*Average diluted concentrations are based on total volume of water released during quarter.

1 – ND denotes no activity detected

Table 2a: Summation of Batch Liquid Effluent Releases

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error, (%)
A. Fission and Activation Products					
Total Released, Ci (excluding tritium, gases, alpha)	**4.85E-02**	**4.63E-02**	**5.57E-02**	**ND [1]**	**5.00E+00**
B. Tritium					
Total Released, Ci	2.49E+00	3.92E+00	3.42E+00	ND [1]	4.00E+00
C. Dissolved and Entrained Gases					
Total Released, Ci	ND [1]	ND [1]	ND [1]	ND [1]	7.00E+00
D. Gross Alpha Activity, Ci	6.87E-06	6.22E-05	ND [1]	ND [1]	8.00E+00
E. Waste Volume Released, Liters (prior to dilution)*	1.58E+06	3.04E+06	1.93E+06	0.00E+00	

1 – ND denotes no activity detected

*Average diluted concentrations are based on total volume of water released during quarter.

Table 2b: Summation of Continuous Liquid Effluent Releases

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error, (%)
A. Fission and Activation Products					
Total Released, Ci (excluding tritium, gases, alpha)	**ND [1]**	**ND [1]**	**2.69E-05**	**4.60E-04**	**5.00E+00**
B. Tritium					
Total Released, Ci	ND [1]	ND [1]	7.05E-03	2.32E-03	4.00E+00
C. Dissolved and Entrained Gases					
Total Released, Ci	ND [1]	ND [1]	ND [1]	ND [1]	7.00E+00
D. Gross Alpha Activity, Ci	4.46E-06	ND [1]	1.09E-05	3.36E-07	8.00E+00
E. Waste Volume Released, Liters (prior to dilution)*	2.52E+06	ND [1]	1.20E+07	2.37E+06	

[1] – ND denotes no activity detected

*Average diluted concentrations are based on total volume of water released during quarter.

Table 3 lists the total number of curies of each radionuclide present in liquid effluent releases for each quarter. In each case, the LLDs were either met or were below the levels required by the ODCM.

Table 3: Radioactive Liquid Effluent Nuclide Composition

Isotope	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Tritium	Ci	2.49E+00	3.92E+00	3.43E+00	2.32E-03	9.84E+00
Sodium-24	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Chromium-51	Ci	8.47E-04	3.51E-04	ND [1]	ND [1]	1.20E-03
Manganese-54	Ci	4.36E-03	3.57E-03	1.60E-03	ND [1]	9.53E-03
Iron-55	Ci	1.74E-02	8.20E-03	2.55E-02	ND [1]	5.11E-02
Manganese-56	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cobalt-58	Ci	2.65E-03	3.41E-03	4.96E-03	ND [1]	1.10E-02
Iron-59	Ci	4.29E-04	ND [1]	5.27E-04	ND [1]	9.56E-04
Cobalt-60	Ci	1.38E-02	2.45E-02	1.71E-02	ND [1]	5.54E-02
Nickel-63	Ci	4.26E-03	6.99E-06	5.63E-04	4.03E-04	5.23E-03
Zinc-65	Ci	2.67E-03	4.81E-03	5.32E-03	ND [1]	1.28E-02
Zinc-65m	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Strontium-89	Ci	ND [1]	ND [1]	3.34E-06	5.69E-05	6.02E-05
Strontium-90	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Yttrium-91m	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Strontium-92	Ci	2.87E-05	ND [1]	ND [1]	ND [1]	2.87E-05
Molybdenum-99	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Technetium-99m	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Silver-110m	Ci	1.67E-03	4.26E-04	1.75E-04	ND [1]	2.27E-03
Tin-113	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Antimony-124	Ci	3.77E-04	8.08E-04	ND [1]	ND [1]	1.19E-03
Antimony-125	Ci	ND [1]	1.97E-04	ND [1]	ND [1]	1.97E-04
Iodine-131	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cesium-137	Ci	ND [1]	4.89E-05	ND [1]	ND [1]	4.89E-05
Lanthanum-140m	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cerium-144	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Xenon-133	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Xenon-135	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Gross Alpha	Ci	1.13E-05	6.22E-05	1.09E-05	3.36E-07	8.48E-05

[1] – ND denotes no activity detected

5.0 GASEOUS EFFLUENTS SUMMARY

Gaseous effluents are made up of fission and activation gases, iodine, and particulate releases. Gaseous effluents from PNPP exit the plant via one of four effluent vents. Each of these four effluent vents contains radiation detectors that continuously monitor the air to ensure that the levels of radioactivity released are below regulatory limits. Samples are also collected and analyzed on a periodic basis to ensure regulatory compliance. Gaseous effluents released from PNPP are considered continuous and at ground level. A summation of all gaseous radioactive effluent releases is given in Table 4.

Table 4: Summation of All Gaseous Effluents

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Est. Total Error, (%)
A. Fission and Activation Gases					
1. Total Released, Ci	**1.38E+00**	**3.46E+00**	**2.21E-01**	**1.95E-01**	1.00E+00
2. Average Release Rate, µCi/sec	1.78E-01	4.40E-01	2.78E-02	2.45E-02	
3. Percent of Applicable Limit, %	N/A	N/A	N/A	N/A	
B. Iodine					
1. Total Iodine-131 Released, Ci	**1.81E-05**	**ND [1]**	**ND [1]**	**ND [1]**	2.00E+00
2. Average Release Rate, µCi/sec	2.32E-06	0.00E+00	0.00E+00	0.00E+00	
3. Percent of Applicable Limit, %	6.62E-06	N/A	N/A	N/A	
C. Particulates with Half-Lives > 8 days					
1. Total Released, Ci	**1.26E-05**	**2.39E-02**	**8.20E-03**	**3.66E-06**	3.00E+00
2. Average Release Rate, µCi/sec	1.62E-06	3.03E-03	1.03E-03	4.60E-07	
3. Percent of Applicable Limit, %	1.19E-05	8.65E-03	2.94E-03	4.37E-08	
4. Alpha Activity, Ci	**4.48E-06**	**3.85E-06**	**1.02E-06**	**3.66E-06**	
D. Tritium					
1. Total Released, Ci	**7.15E-01**	**1.56E+00**	**1.10E-01**	**1.56E+00**	4.00E+00
2. Average Release Rate, µCi/sec	9.19E-02	1.98E-01	1.38E-02	1.96E-01	
3. Percent of Applicable Limit, %	5.24E-04	1.13E-03	7.86E-05	1.12E-03	
E. Carbon-14, Ci	**3.06E+00**	**3.57E+00**	**4.69E+00**	**4.77E+00**	1.00E+01

N/A – Not Applicable, the ODCM does not have a release rate limit for gaseous effluents.
Carbon-14 activity was calculated based on power production using the EPRI-provided spreadsheet
1 – ND denotes no activity detected

The radionuclide composition of all gaseous radioactive effluents for a continuous-mode, ground-level release is given in Table 5. In each case, LLDs were met or were below the levels required by the ODCM.

Table 5: Radioactive Gaseous Effluent Nuclide Composition

Isotope	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
1. Fission and Activation Gases						
Tritium	Ci	7.15E-01	1.56E+00	1.10E-01	1.56E+00	3.95E+00
Argon-41	Ci	ND [1]	3.46E+00	ND [1]	ND [1]	3.46E+00
Krypton-85m	Ci	6.59E-01	ND [1]	2.21E-01	1.95E-01	1.08E+00
Krypton-87	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Krypton-88	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Xenon-133m	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Xenon-133	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Xenon-135m	Ci	3.38E-01	ND [1]	ND [1]	ND [1]	3.38E-01
Xenon-135	Ci	3.88E-01	ND [1]	ND [1]	ND [1]	3.88E-01
Xenon-138	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Total for Period	Ci	2.10E+00	5.02E+00	3.31E-01	1.76E+00	9.21E+00
2. Iodine/Halogens						
Iodine-131	Ci	1.81E-05	ND [1]	ND [1]	ND [1]	1.81E-05
Iodine-133	Ci	4.13E-05	ND [1]	ND [1]	ND [1]	4.13E-05
Total for Period	Ci	5.94E-05	ND [1]	ND [1]	ND [1]	5.94E-05
3. Particulates						
Chromium-51	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Manganese-54	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Iron-59	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cobalt-58	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cobalt-60	Ci	8.11E-06	ND [1]	ND [1]	ND [1]	8.11E-06
Zinc-65	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Strontium-89	Ci	ND [1]	2.39E-02	8.20E-03	ND [1]	3.21E-02
Molybdenum-99	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cesium-137	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Cerium-141	Ci	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
Alpha	Ci	4.48E-06	3.85E-06	1.02E-06	3.66E-06	1.30E-05
Total for Period	Ci	1.26E-05	2.39E-02	8.20E-03	3.66E-06	3.21E-02

[1] – ND denotes no activity detected

5.1 Land Use Census Changes

To estimate radiation dose attributable to operation of the PNPP, the potential pathways through which public exposure can occur must be known. To identify these pathways, an Annual Land Use Census is performed as part of the REMP. During the census, PNPP personnel travel public roads within a five-mile radius of the plant to locate key radiological exposure pathways. These key pathways include the nearest resident and nearest garden in each of the ten meteorological land sectors that surround the plant. The information obtained from the census is entered into a computer program used to assess hypothetical dose to members of the public. The predominant land use within the census area continues to be rural and/or agricultural. There were no changes to the REMP sampling locations compared to the 2024 Land Use Census.

5.2 Meteorological Data

The Meteorological Monitoring System at PNPP consists of a 60-meter tower equipped with two independent systems for measuring wind speed, wind direction, and temperature at both 10-meter and 60-meter heights. The tower also has instrumentation to measure dew point and barometric pressure. Data is logged from the tower through separate data loggers and transmitted to a common plant computer. The program compiles the data and calculates a variety of atmospheric parameters, communicates with the Meteorological Information Dose Assessment System (MIDAS) and sends data over communication links to the plant Control Room.

A detailed report of the monthly and annual operation of the PNPP Meteorological Monitoring Program is produced as a separate document that is retained in PNPP Records and is available upon request. The report substantiates the quality and quantity of meteorological data collected in accordance with applicable regulatory guidance.

5.3 Dose Assessment

The maximum concentration for any radioactive release is controlled by the limits set forth in 10 CFR 20. Sampling, analyzing, processing, and monitoring the effluent streams ensures compliance with these concentration limits. Dose limit compliance is verified through periodic dose assessment calculations. Some dose calculations are conservatively performed for a hypothetical maximum individual who is assumed to reside on the site boundary at the highest potential dose location all year. This person, called the “maximum individual”, would incur the maximum potential dose from direct exposure (air + ground + water), inhalation, and ingestion of water, vegetation, and fish. Because no individual actually meets these criteria, the actual dose received by a real member of the public is significantly less than what is calculated for this hypothetical individual.

Dose calculations for this maximum individual at the site boundary are performed for two cases:

- Using data for a 360-degree radius around the plant site (land and water-based meteorological sectors); even though some of these sectors are over Lake Erie, which has no permanent residents.

- Considering only those sectors around the plant in which people reside (land-based meteorological sectors).

The calculated hypothetical, maximum individual dose values at the site boundary are provided in Table 6. This table considers all meteorological sectors around PNPP and provides whole body and worst-case organ-dose values.

Table 6: Maximum Yearly Individual Site Boundary Dose, Considering All Sectors

Type of Dose	Organ	Estimated Dose, (mrem)	Limit (mrem)	% of Limit
Liquid Effluent	Whole body	5.34E-02	3	1.78E+00
	GI Tract	9.27E-02	10	9.27E-01
Noble Gas	Air Dose Gamma (mrad)	5.23E-02	10	5.25E-01
	Air Dose Beta (mrad)	2.03E-02	20	1.02E-01
Noble Gas	Whole body	1.50E-02	5	3.00E-01
	Skin	2.40E-02	15	1.60E-01
Tritium, Particulate & Iodine	Bone	1.23E+00	15	8.20E+00
Carbon-14 *	Whole Body	2.51E-01	5	5.02E+00

* C-14 dose calculated at nearest garden.

The hypothetical maximum dose within a 50-mile radius of site was calculated and is presented in Table 7. This table considers all meteorological sectors around PNPP and provides whole body and worst-case organ dose values.

Table 7: Population Yearly Dose, out to 50 miles.

	Organ	Estimated Dose (person-rem)
Liquid Effluent	Whole body	1.20E+02
	Thyroid	5.92E+01
Gaseous Effluent	Whole body	4.01E-02
	Thyroid	1.19E-02

Table 8 provides the calculated hypothetical maximum site boundary dose values considering only the land-based sectors.

Table 8: Maximum Yearly Individual Site Boundary Dose (Only Land Sectors)

Type of Dose	Organ	Estimated Dose, (mrem)	Limit (mrem)	% of Limit
Liquid Effluent	Whole Body	5.34E-02	3	1.78E+00
	GI Tract	9.27E-02	10	9.27E-01
Noble Gas	Air Dose Gamma (mrad)	5.23E-02	10	5.25E-01
	Air Dose Beta (mrad)	2.03E-02	20	1.02E-01
Noble Gas	Whole Body	1.50E-02	5	3.00E-01
	Skin	2.40E-02	15	1.60E-01
Tritium, Particulate & Iodine	Bone	1.26E+00	15	8.40E+00
Carbon-14 *	Whole Body	2.51E-01	5	5.02E+00

*C-14 dose calculated at nearest garden.

Other dose calculations are performed for a hypothetical individual assumed to be inside the site boundary for some specified amount of time. This person would receive the maximum dose during the time spent inside site boundary. Because no person actually meets the criteria established for these conservative calculations, the actual dose received by a member of the public is significantly less than what is calculated for this hypothetical individual. This dose is assessed relative to the offsite dose, and considers dilution, dispersion, and occupancy factors.

The highest hypothetical dose from liquid effluents to a member of the public inside the site boundary is to a person who is fishing on Lake Erie from the shore on PNPP property. The calculations assume that this person will spend 60 hours per year fishing, with a liquid dilution factor of 10. The ratio of the exposure pathway to the doses calculated for offsite locations yields the dose values shown in Table 9.

Table 9: Maximum Site Dose from Liquid Effluents

	Whole Body Dose, (mrem)	Organ Dose, (mrem)
First Quarter	6.31E-02	1.60E-01
Second Quarter	1.09E-01	2.39E-01
Third Quarter	1.52E-01	2.76E-01
Fourth Quarter	1.86E-02	1.86E-02
Annual	3.41E-01	6.45E-01

Although several cases were evaluated to determine the highest hypothetical dose from gaseous effluents to members of the public inside the site boundary, the activity inside the site boundary with the highest dose potential is also shoreline fishing. The cases evaluated included traversing a public road within the site boundary, shoreline fishing (assuming fishing 60 hours per year), non-plant related training, car-pooling, and job interviews. The maximum on-site gaseous doses generated are shown in Table 10.

Table 10: Maximum Site Dose from Gaseous Effluents

	Whole Body Dose, (mrem)	Organ Dose, (mrem)
First Quarter	4.4E-04	8.3E-04
Second Quarter	6.5E-03	9.8E-03
Third Quarter	2.4E-03	8.2E-02
Fourth Quarter	6.9E-05	7.3E-05
Annual	7.7E-03	1.4E-01

An average whole-body dose to individual members of the public at or beyond the site boundary is then determined by combining the dose from gaseous and liquid radiological effluents. The dose from gaseous radiological effluents is based upon the population that lives within 50 miles of PNPP. The dose from liquid radiological effluents is determined for the population that receives drinking water from intakes within 50 miles of PNPP. The results of this calculation are provided in Table 11.

Table 11: Average Individual Whole-Body Dose

	Liquid Effluents, (mrem)	Gaseous Effluents, (mrem)
First Quarter	8.3E-03	5.3E-07
Second Quarter	1.4E-02	8.6E-06
Third Quarter	2.3E-02	7.1E-06
Fourth Quarter	4.5E-03	5.1E-07
Annual	5.0E-02	1.7E-05

6.0 SOLID WASTE

All solid radioactive waste from PNPP was processed and combined with waste from several other utilities by intermediate vendors. The final waste after processing is sent to Energy Solutions' disposal facility in Clive, Utah for burial. Reference Table 12 for the Solid Waste Shipped Offsite for Burial or Disposal.

Table 12: Solid Waste Shipped Offsite for Burial or Disposal

1. Type of Solid Waste Shipped	Volume (m^3)	Activity (Ci)	Est. Total Error, (%)
a. Resins, Filters, and Evaporator Bottoms	1.11E+02	4.25E+02	± 25
b. Dry Radioactive Waste	8.74E+02	1.80E+01	± 25
c. Irradiated Components	0.00E+00	0.00E+00	± 25
d. Other Radioactive Waste	0.00E+00	0.00E+00	± 25

2. Estimate of Major (1) Nuclide Composition (by type of waste)	Radionuclide	Abundance (%)	Est. Total Error, (%)
a. Resins, Filters and Evaporator Bottoms	Mn-54	4.04	± 25
	Fe-55	41.56	
	Co-58	1.91	
	Co-60	45.45	
	Ni-63	1.89	
	Zn-65	3.86	
b. Dry Active Waste	C-14	4.32	± 25
	Mn-54	3.9	
	Fe-55	50.07	
	Co-60	36.17	
	Ni-63	2.71	
	Zn-65	1.62	
c. Irradiated Components, Control Rods, etc.	N/A	N/A	N/A
d. Other Waste	N/A	N/A	N/A

(1) – "Major" is defined as any individual radionuclide identified as >1% of the waste type abundance.

N/A – Not applicable due to no shipments

3. Dry Active Waste and Resins, Filters, and Evap Bottom Shipments		
Number of Shipments	Mode of Transportation	Destination
44	Hittman Transport	Energy Solutions Bear Creek Operations
19	Hittman Transport	Energy Solutions Memphis Facility
10	Hittman Transport	Erwin ResinSolutions, LLC 151 T.C Runnion Rd

7.0 EFFLUENT RADIATION MONITORS OUT OF SERVICE GREATER THAN 30 DAYS

The Liquid Radwaste to Emergency Service Water radiation monitor was inoperable for greater than 30 days in 2025. This was due to a discovery made on September 21, 2025.

The LRW to ESW Rad Monitor setpoint is changed in support of liquid radwaste discharges. When a setpoint change is required, the HI-HI Alarm setpoint on the Yokogawa recorder is adjusted per Chemistry provided data using site surveillances. Due to a human performance error on new equipment the incorrect setpoint was changed on the Radwaste to ESW Rad Monitor from March 31, 2025 up to and including September 21, 2025. This Yokogawa recorder has multiple channels (channel 1 and channel 2) that interact with different rad monitors. Channel #2 is the channel that interacts with the LRW to ESW radiation monitor – inadvertently channel #1 was the channel that was being changed. This resulted in the rad monitor not being updated for 19 discharges. The radiation monitor serves as a backup to the calculation in that it will isolate the discharge if the calculation should be performed incorrectly.

No 10CFR20 limits have been exceeded during the time of the discharges between March 31 – Sept 21, 2025.

8.0 OFFSITE DOSE CALCULATION MANUAL (ODCM) CHANGES

There were no ODCM changes in 2025.

9.0 PROCESS CONTROL PROGRAM (PCP) CHANGES

There were no changes to the PCP in 2025.

10.0 RADIOACTIVE WASTE TREATMENT SYSTEM CHANGES

There were no changes to the Radioactive Waste Treatment System in 2025.

11.0 CORRECTIONS TO PREVIOUS ARERRS

Corrections to previous ARERRs for 2023 and 2024 were necessary. These were due to an error in labeling Outdoor Piezometer Well N-3 instead of the well that was sampled N-4. Refer to Table 13.

12.0 CARBON-14 SUPPLEMENTAL INFORMATION

Carbon-14, with a half-life of 5730 years, is a naturally occurring isotope of carbon produced by cosmic ray interactions in the atmosphere. Nuclear weapons testing in the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Carbon-14 is also produced in commercial nuclear reactors, but the amounts produced are much less than those produced naturally or from weapons testing. It is released primarily from Boiling Water Reactors through the Off-gas system in the form of carbon dioxide (CO_2). The quantity of gaseous C-14 released to the environment can be estimated using a C-14 source term scaling factor based on power generation.

The U.S. Nuclear Regulatory Commission requires an assessment of gaseous C-14 dose impact to a member of the public resulting from routine releases in radiological effluents. Prior to 2011, the industry did not estimate the dose impact of C-14 releases because the dose contribution had been considered negligible compared to the dose impact from effluent releases of noble gases, tritium, particulates, and radioiodine.

This report contains estimates of the gaseous C-14 radioactivity released and the resulting public dose resulting from this release. The calculation is performed using a spreadsheet provided by EPRI and is based on power production and is adjusted for growing season, percent daylight, age (adult), and undepleted atmospheric dispersion (χ/Q) value for the critical receptor. This method for estimating C-14 released has been endorsed by the NRC. Because the dose contribution of C-14 from liquid radioactive waste is much less than that contributed by gaseous radioactive waste, evaluation of C-14 in liquid radioactive waste at PNPP is not required. Refer to Table 4, Table 6, and Table 8 for C-14 estimated release values and dose attributed to C-14.

13.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

Based on the Environmental Resource Management hydrogeology study,12 groundwater monitoring wells were recommended for the site. Since most groundwater flow drains north toward Lake Erie, most wells are drilled north of the plant. A set of control wells were drilled south of the plant to assess a typical groundwater profile.

There are sets of three wells installed at four locations. Each set has a shallow well with a depth of approximately 25 feet, a mid-depth well with a depth of approximately 50 feet, and a deep well with a depth of approximately 75 feet. These three depths are designated A, B, and C from shallowest to deepest, respectively.

More than 30 piezometers comprise the outdoor piezometers located in four separate transects oriented in the north, south, east, and west directions (Quadrant Piezometers). These wells were installed to monitor the performance of the Underdrain System and ensure reduction in groundwater levels around the Power Block. Four quadrant piezometers were added to the sampling list for groundwater monitoring at the recommendation of Environmental Resource Management. The closest quadrant piezometer from each cardinal direction to the power block was chosen based on well integrity and sample recharge rate.

PNPP has an Underdrain system to prevent groundwater hydrostatic pressure buildup on plant structures. The Underdrain system has two installed radiation monitors that assess the process stream prior to the stream flowing into the Emergency Service Water system. Figure 5 illustrates the locations of Groundwater Wells 1A through 4C, Outdoor Quadrant Piezometers north through south, and Underdrain Manholes 20 and 23. Monitoring wells are identified as green circles, manholes are identified as blue squares. These wells, piezometers, and manholes encompass the groundwater monitoring locations at PNPP.

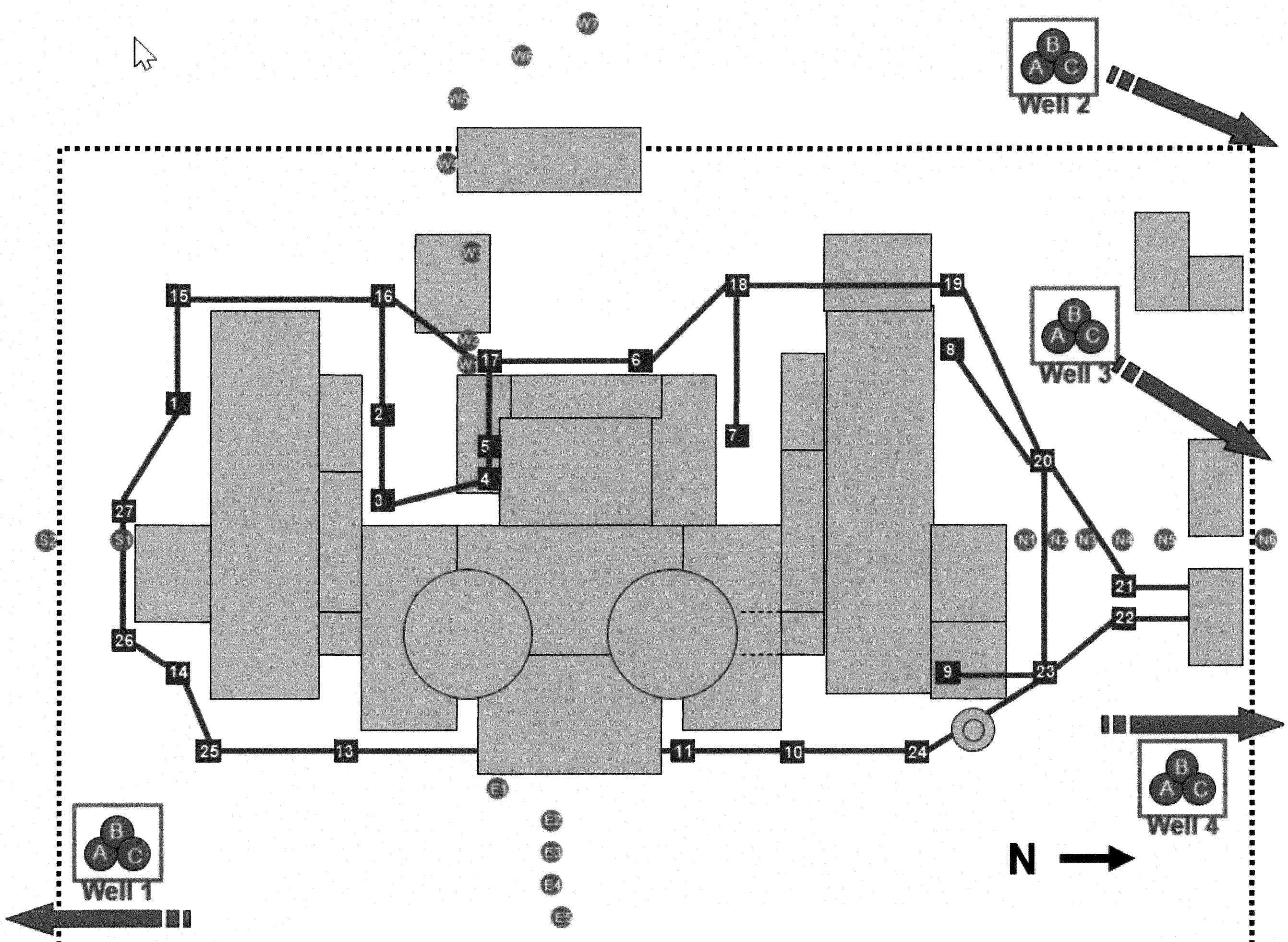

Figure 5: Underdrain System and Groundwater Monitoring Wells

PNPP also has internal plant building piezometers that were installed during construction to monitor the performance of the Underdrain System and ensure reduction in groundwater levels at the lowest building elevations in the Power Block. These internal plant piezometers interact two inches into the concrete structural mat beneath the plant. PNPP has found that sampling these internal plant piezometers gives an early indication of the potential to contaminate groundwater. As such, NEI 07-07 reporting thresholds are applied to activity that may be identified during routine sampling. Figure 6 illustrates the plant Underdrain System and the internal plant piezometers. Figure 6 shows internal plant piezometers as green circles.

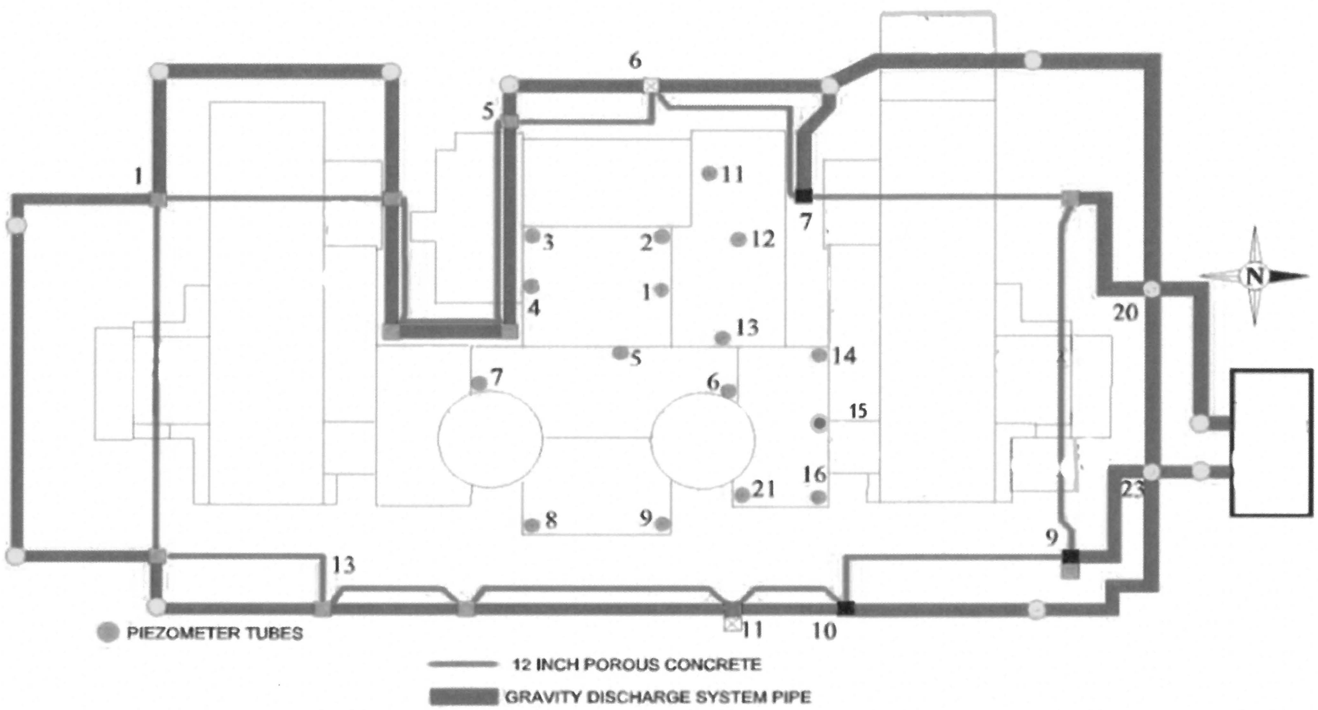

Figure 6: Perry Underdrain System and Internal Plant Piezometers.

Effluent tritium activity LLDs are classified as µCi/ml in the ODCM. Groundwater reporting levels for tritium activity are stated in pCi/L. The unit conversion from µCi/ml to pCi/L causes a change of nine orders of magnitude.

The monitoring wells and quadrant piezometers are sampled twice annually, in spring and fall – with the exception of two deep wells. Due to the slow recharge rate on Wells 2C and 3C, these wells are sampled at least once per 24 months. The samples are shipped to a vendor for gamma isotopic and tritium analysis. Any positive result less than 500 pCi/L is considered background activity and not due to plant operations. The ODCM reporting level for tritium in an environmental water sample is 20,000 pCi/L. The tritium results of samples obtained in 2025 can be found in Table 13.

Table 13: Summary of Onsite Groundwater and Outdoor Piezometer Samples

Sample Type	Location		Spring H-3, pCi/L	Fall H-3, pCi/L
Outdoor Piezometer	N-4-83		213	321
Outdoor Piezometer	E-2-83		237	114
Outdoor Piezometer	S-2-89		<182	<110
Outdoor Piezometer	W-7-83		<182	<110
Monitoring Well	1A		<182	<110
Monitoring Well	1B		<182	<110
Monitoring Well	1C		<182	<110
Monitoring Well	2A		<182	<110
Monitoring Well	2B		<182	<110
Monitoring Well	2C		NS	<110
Monitoring Well	3A		<182	<110
Monitoring Well	3B		<182	<110
Monitoring Well	3C		NS	<110
Monitoring Well	4A		<182	<110
Monitoring Well	4B		<182	<110
Monitoring Well	4C		<180	<110

(<) Less than values represent the MDA (minimum detectable activity) of the instrument at the time of analysis

NS- Insufficient sample volume for analysis

The Underdrain manholes are sampled and analyzed quarterly for principal gamma emitters and tritium by PNPP personnel in accordance with site procedures. The Underdrain manhole 20 and 23 effluent pathway is through Emergency Service Water. The tritium results of samples obtained in 2024 are quarterly averages and can be found in Table 14

Table 14: Summary of Underdrain Manhole Tritum Samples.

Table 14: Summary of Underdrain Manhole Tritum Samples

Underdrain Manhole	Quarter 1 H-3, µCi/ml	Quarter 2 H-3, µCi/ml	Quarter 3 H-3, µCi/ml	Quarter 4 H-3, µCi/ml
20	ND [1]	ND [1]	ND [1]	ND [1]
23	4.09E-06	2.68E-06	3.90E-06	3.17E-06

[1] – ND denotes no activity detected

Investigation of elevated groundwater tritium began at PNPP in January 2024. During long term trending of previous tritium leaks, it was noted in January 2024 that internal plant piezometers 21 and 6 had a substantial increase in activity. State and local notifications were made as tritium activity in internal plant piezometer activity exceeded 20,000 pCi/l. This relaunched an extensive effort of a cross functional problem-solving team to assemble and investigate into active leak determination. Walkdowns were performed and resulted in the identification of a radwaste transfer line leak that was making its way to the rattle space in radwaste building and elevating internal building piezometers in the area. The radwaste transfer line was repaired and activity mitigation pumps were installed to pump internal building piezometer groundwater back into radwaste systems for processing.
The radwaste line that was identified as leaking is not always in use, and not always transferring enough water to fill the pipe chase and spill over into the associated rattle space. This resulted in not being able to determine the rate of degradation of the piping itself. This was added to the list of potentials that may have caused the 2023 leak, but it is still unable to be determined at this time.

The internal plant piezometers can interact with the Underdrain System that has a monitored effluent release pathway to Emergency Service Water. Any contributing activity from this tritium release has been accounted for in Table 2, Table 2a, Table 2b, Table 3, Table 6, Table 7, Table 8, Table 9, Table 11, and Table 14.

13.1 Voluntary Notification

No voluntary notifications were made in 2025.

14.0 ABNORMAL RELEASES

There were no abnormal gaseous releases in 2025.

PNPP had one abnormal liquid release pathway, and one potential abnormal release pathway present in 2025 as discussed below.

14.1 Nuclear Closed Cooling

Residual radioactivity remains in the Nuclear Closed Cooling (NCC) system due to past leakage from the reactor coolant system. This radioactivity will continue to be monitored, and any detectable activity measured from the NCC system to Emergency Service Water is tracked and recorded as a continuous abnormal release. NCC had no gamma activity detected in 2025 but did have detectable alpha – this was captured in the annual calculations.

Actions to identify and eliminate the release of NCC to Emergency Service Water are in place. Valves that isolate NCC from Emergency Service Water have been identified as leaking and have been scheduled for replacement with a new design. Additionally, heat exchanger tube plugging to eliminate this leakage mechanism is underway.

Since the NCC system has been known to contain tritium activity, it was treated as a continuous abnormal release. Activity was assessed in the monthly effluent surveillance, and exposure is accounted for in Table 2, Table 2a, Table 3, Table 6, Table 7, Table 8, Table 9, and Table 11.

The NCC abnormal releases in 2025 are summarized below in Table 15 and Table 16.

Table 15: Summary of NCC Continuous Releases

NCC Continuous Release	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Total time period for continuous release, min	1.32E+05	1.30E+05	1.32E+05	1.30E+05
Total volume released, liters	1.92E+06	9.80E+05	4.17E+06	1.53E+06
Average SW quarterly flow rate, L/min	1.78E+05	1.65E+05	1.85E+05	1.56E+05

1 – ND denotes no activity detected

Table 16: Summary of Activity Released Via the NCC Abnormal Release Pathway.

NCC Total Activity	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**	**Annual**
A. Fission and Activation Products (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
B. Tritium (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
C. Noble Gases (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
D. Gross Alpha (Ci)	ND [1]	ND [1]	8.69E-06	5.03E-06	1.37E-05

1 – ND denotes no activity detected

14.2 Auxiliary Boiler

The Auxiliary Boilers have periodically been contaminated with tritium at PNPP. Though no activity was detected in this potential release path in 2025, the Auxiliary Boilers continue to be monitored in accordance with an ODCM-compliant methodology as a potential release pathway. If activity was present it would be assessed in the monthly effluent surveillance and would be included in Table 2, Table 2a, and Table 3. Exposure resulting from this release would be accounted for in Table 7, Table 8, Table 9, Table 10, and Table 11.

Auxiliary Boiler abnormal releases in 2025 are summarized below in Table 17 and Table 18.

Table 17: Summary of Auxiliary Boiler Batch Releases

Auxiliary Boiler Batch Release	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Total time period for batch release, min	3.18E+04	1.62E+04	0.00E+00	0.00E+00
Total volume released, liters	1.43E+05	5.35E+04	0.00E+00	0.00E+00
Average quarterly flow rate, L/min	4.49E+00	3.30E+00	0.00E+00	0.00E+00

Table 18: Summary of Activity Released Via the Auxiliary Boiler Abnormal Release Pathway

Auxiliary Boiler Total Activity	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
A. Fission and Activation Products (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
B. Tritium (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
C. Noble Gases (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
D. Gross Alpha (Ci)	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]

[1] – ND denotes no activity detected

15.0 ODCM NON-COMPLIANCE

There were no ODCM non-compliances identified in 2025.

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