Entergy Operations, Inc.
P.O. Box 756
Port Gibson, Mississippi 39150

Jeffery Hardy
Manager Regulatory Assurance
Grand Gulf Nuclear Station
Tel: 802-380-5124

GGNS TS 5.6.2

GNRO2025-00011

April 23, 2025

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

SUBJECT: Grand Gulf Nuclear Station Annual Radioactive Effluent Release Report (ARERR)

Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

In accordance with Grand Gulf Nuclear Station Unit 1 Technical Specification 5.6.2, attached is the Annual Radioactive Effluent Release Report for the time-period of January 1, 2024 through December 31, 2024.

There are no commitments contained in this submittal. If you have any questions or need additional information, please contact me at 802-380-5124.

Sincerely,

JH/sm

Attachment: 1. Annual Radioactive Effluent Release Report

cc: NRC Senior Resident Inspector
Grand Gulf Nuclear Station
Port Gibson, MS 39150

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

State Health Officer, Mississippi Department of Health

Attachment 1

GNRO2025-00011
Annual Radioactive Effluent Release Report

entergy

Grand Gulf Nuclear Station

Annual Radioactive Effluent Release Report

2024

Document Number: GNRO2025-00011

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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

Grand Gulf Nuclear Station (GGNS) 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, 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 Grand Gulf Nuclear Station is a Child, due to Ground Plane, Inhalation, Garden Vegetation and Grass-Cow-Meat pathways in the southwest sector at 0.89 miles. The maximum Annual Organ Dose calculated for this receptor was 5.58E-02 mrem to the Child Thyroid.

The maximum dose calculated to any organ due to radioactive liquid effluents was 3.64E-01 mrem to the Adult Liver due to liquid releases.

Solid radioactive waste shipped offsite for processing or direct disposal included 6.14E+04 Curies and 9.98E+02 m^3, shipped in 52 shipments.

In addition to monitoring radioactive effluents, GGNS 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 solid, liquid, and gaseous radioactive effluents from Grand Gulf Nuclear Station were well below regulatory limits, as summarized in Table 1 and Table 2.

Table 1, Grand Gulf Nuclear Station Unit 1 Dose Summary[1]

		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual
Liquid Effluents						
	Limit	**1.5 mrem**	**1.5 mrem**	**1.5 mrem**	**1.5 mrem**	**3 mrem**
	Total Body Dose	1.09E-01	5.00E-02	1.39E-02	1.28E-02	1.77E-01
	% Of Limit	7.27E+00	3.33E+00	9.27E-01	8.51E-01	5.90E+00
	Limit	**5 mrem**	**5 mrem**	**5 mrem**	**5 mrem**	**10 mrem**
	Maximum Organ Dose	2.33E-01	9.68E-02	3.08E-02	2.21E-02	3.64E-01[2]
	% Of Limit	4.66E+00	1.94E+00	6.16E-01	4.42E-01	3.64E+00
Gaseous Effluents						
	Limit	**5 mrad**	**5 mrad**	**5 mrad**	**5 mrad**	**10 mrad**
	Gamma Air Dose	8.29E-02	1.09E-01	2.07E-01	8.16E-02	4.81E-01
	% Of Limit	1.66E+00	2.19E+00	4.13E+00	1.63E+00	4.81E+00
	Limit	**10 mrad**	**10 mrad**	**10 mrad**	**10 mrad**	**20 mrad**
	Beta Air Dose	3.53E-02	5.34E-02	8.23E-02	3.95E-02	2.11E-01
	% Of Limit	3.53E-01	5.34E-01	8.23E-01	3.95E-01	1.06E+00
	Limit	**7.5 mrem**	**7.5 mrem**	**7.5 mrem**	**7.5 mrem**	**15 mrem**
	Maximum Organ Dose	1.42E-02	1.30E-02	1.14E-02	1.74E-02	5.58E-02[3]
	% Of Limit	1.89E-01	1.74E-01	1.52E-01	2.33E-01	3.72E-01

[1] Table 1 demonstrates compliance with 10 CFR Part 50, App. I Limits.
[2] Adult Liver
[3] Child Thyroid

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

	Whole Body	**Thyroid**	**Max Other Organ**
Gaseous[1]	5.31E-01	5.58E-02	5.58E-02
Carbon-14	1.07E+00	1.07E+00	5.36E+00
Liquid	1.77E-01	1.23E-03	3.64E-01
Direct Shine	0	0	0
Total Site Dose	1.78E+00	1.13E+00	5.78E+00
Total w/Other Nearby Facility[2]	**N/A**	**N/A**	**N/A**
Limit	**25 mrem**	**75 mrem**	**25 mrem**
% of Limit	7.12E+00	1.50E+00	2.31E+01

[1] Gaseous dose values in Table 2 include organ dose from Noble Gas, Iodine, Tritium, and particulates.
[2] Other fuel cycle sources within 5 miles of the site are considered 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.

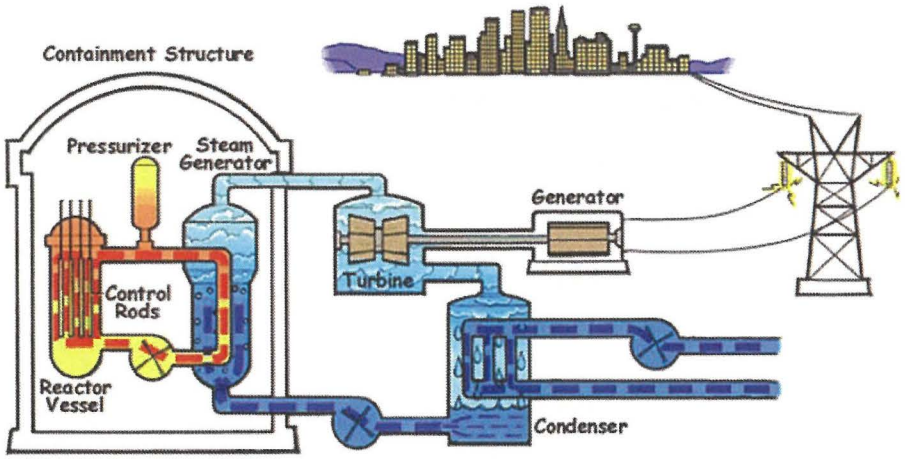

Figure 1, Pressurized Water Reactor (PWR) [1]

3.1 (Continued)

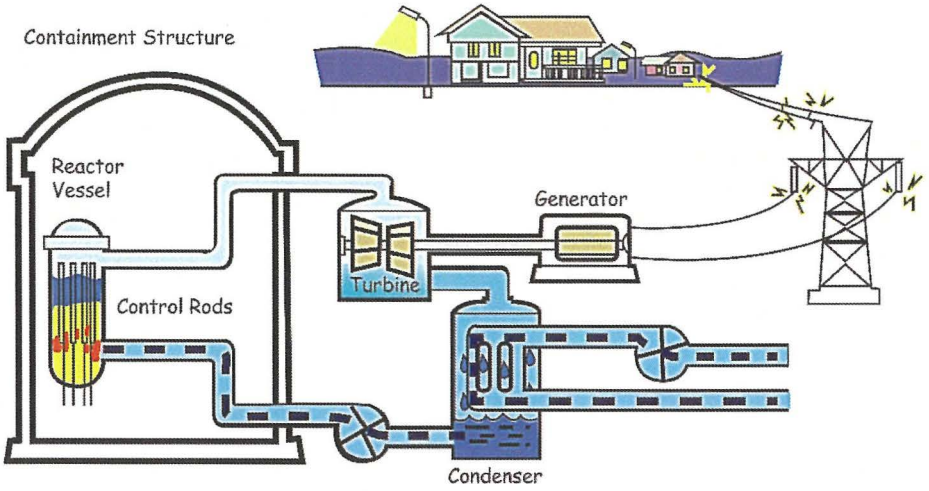

Figure 2, Boiling Water Reactor (BWR) [2]

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.

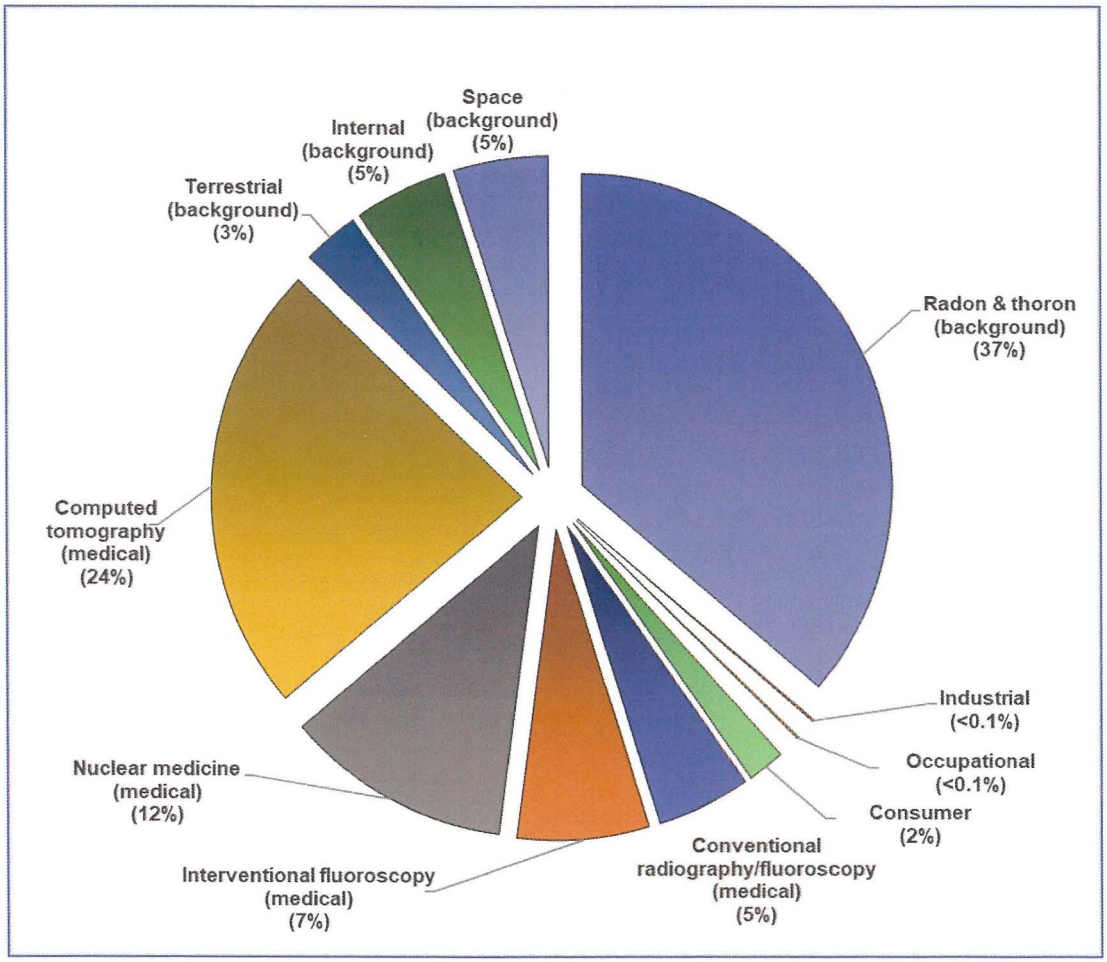

Figure 3, Sources of Radiation Exposure (NCRP Report No. 160) [3]

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.

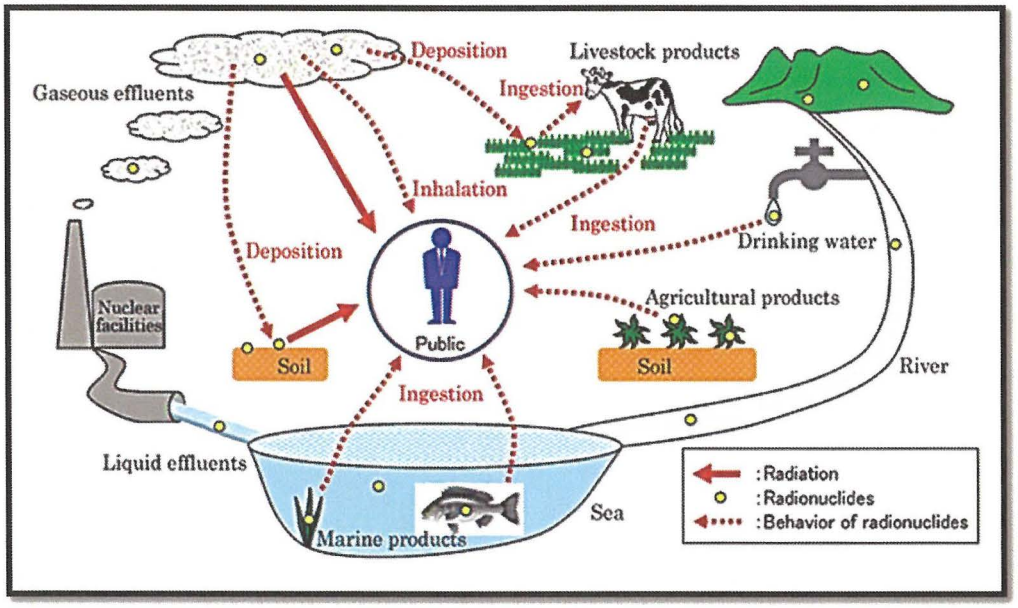

Figure 4, Potential exposure pathways to Members of the Public due to Plant Operations [6]

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.

Every two years 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 (Sections 5.5.1, 5.5.4, 5.6.2, 5.6.3 of GGNS License Number NPF-29) and the Offsite Dose Calculation Manual (ODCM). These documents contain the limits to which GGNS must adhere. GGNS 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 GGNS 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, Grand Gulf Nuclear Station Unit 1 Dose Summary and Table 2, Total Annual Offsite-Dose Comparison to 40 CFR 190 Limits for GGNS.

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)

GGNS 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 Access Control personnel and Credit Union employees. Use of a conservative assumption of 2000 hours/year 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 (Miles)	Occupancy (Hours)	Dose (mrem)	
				Total Body	Organ
Energy Service Centers	NNW	0.5	2000	1.58E-02	2.48E-02
Credit Union	NW	0.18	2000	1.19E-01	1.88E-01

Doses calculated using GASPARII, NRCDose3, Version 1.1.3. Adult working 2000 hours per year. 2024 Daytime X/Q and D/Q was used. Plume, Ground Plane and Inhalation doses were considered. C-14 is included.

5.0 SUPPLEMENTAL INFORMATION

5.1 Gaseous Batch Releases

5.1.1 GGNS Unit 1

Number of batch releases	0	
Total time period for a batch release	0	minutes
Maximum time period for a batch release	0	minutes
Average time period for a batch release	0	minutes
Minimum time period for a batch release	0	minutes

5.2 Liquid Batch Releases

5.2.1 GGNS Unit 1

Number of batch releases	50	
Total time period for a batch release	1.34E+04	minutes
Maximum time period for a batch release	3.15E+02	minutes
Average time period for a batch release	2.68E+02	minutes
Minimum time period for a batch release	1.10E+02	minutes
Average total flow during period of release	5.61E+03	gpm

5.3 Abnormal Releases

5.3.1 Gaseous Abnormal Releases

There were no Abnormal Gaseous Releases from the site in 2024.

5.3.2 Liquid Abnormal Releases

There were no Abnormal Liquid Releases from the site in 2024.

5.4 Non-routine Planned Discharge

Number of releases	9
Total activity released	2.22E-01 Ci

The Grand Gulf Nuclear Station (GGNS) Unit 2 is a partially constructed facility that was abandoned in December 1979. This unit was never completed or operated. Due to ambient environmental conditions and the unfinished status of the Unit 2 turbine building sub-structure high conductivity rainwater is routinely observed to collect in sumps, tunnels and condenser bay. Sample analysis indicates there are fission and activation products in the sump water. Condition Report, CR-GGN-2022-10783, was initiated to discharge the Unit 2 sump water due to the concern if the contaminated water is not removed and the area not remediated appropriately, the potential would exist to release contaminated water to the surrounding environment should the Unit 2 structure degrade, overflow out of the building or become compromised. In 2024 GGNS began collecting water in a 15,000-gallon tank, mixed and sampled in accordance with site procedures, and if within the ODCM limits, discharged through the site approved discharge pathway. The radionuclides detected and average concentrations are listed in Figure 5, Non-Routine Batch Release. The resulting dose to the Total Body was 1.09E-01 mrem and the maximum organ dose was 2.33E-01 mrem. Activity and dose are included in Table 1, Table 8 and Table 9 of this report.

LIQUID RELEASE AND DOSE SUMMARY REPORT
---------- (PERMIT BASIS) ----------

Release ID: 4 Non-Routine Batch Release Thru 001

=== RELEASE DATA ==========

Period Start Date/Time	01/01/2024 00:00
Period End Date/Time	01/01/2025 00:00
Total Release Duration (minutes)	1.29E+03
Total Undiluted Volume Released (gallons)	1.17E+05
Average Undiluted Flowrate (gpm)	9.03E+01
Total Dilution Volume (gallons)	8.02E+06
Average Dilution Flowrate (gpm)	6.22E+03

=== NUCLIDE DATA ==========

		Undiluted		Diluted	
Nuclide	uCi	Average uCi/ml	Percent of 10*EC	Average uCi/ml	Percent of 10*EC
CO-60	1.10E+02	2.49E-07	8.31E-01	3.57E-09	1.19E-02
CS-137	6.60E+01	1.50E-07	1.50E+00	2.14E-09	2.14E-02
Gamma	1.76E+02	3.99E-07	2.33E+00	5.71E-09	3.33E-02
H-3	2.22E+05	5.03E-04	5.03E+00	7.20E-06	7.20E-02
Beta	2.22E+05	5.03E-04	5.03E+00	7.20E-06	7.20E-02
Total	2.22E+05	5.04E-04	7.36E+00	7.21E-06	1.05E-01

Figure 5, Non-Routine Batch Release

5.5 Land Use Census Changes

The last land use census performed did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated. No milk-producing animals were identified within a five-mile radius of the plant site.

5.6 Meteorological Data

1. Data recovery for reporting period: 99%
2. Predominant wind direction: From North-Northeast 14.5% of the reporting period
3. Predominant stability class: D (44.7%)
4. Average wind speed: 4.1 miles per hour at the 33-foot level
5. The annual meteorological data (Hourly Average Data or Joint Frequency Distribution) is maintained on site in a file that will be provided to the NRC upon request

5.7 Effluent Radiation Monitors Out of Service Greater Than 30 Days

There were no effluent radiation monitors listed in ODCM Table 6.3.9-1 and 6.3.10-1 that were out of service greater than 30 days in 2024.

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)
N/A	N/A	N/A	N/A	N/A

5.8 Offsite Dose Calculation Manual (ODCM) Changes

There were no changes to the ODCM in 2024.

5.9 Process Control Program (PCP) Changes

There were no changes to the PCP in 2024.

5.10 Radioactive Waste Treatment System Changes

There were no changes to the Radioactive Waste Treatment System in 2024.

5.11 Other Supplemental Information

5.11.1 Temporary Outside Tanks

No temporary outside tanks exceeded ODCM or Technical Specification Limit of 10 curies not including tritium.

5.11.2 Independent Spent Fuel Storage Installation (ISFSI) Monitoring Program

The ISFSI annual report on radioactive releases is submitted as a separate report.

5.11.3 Sewage Disposal Summary

There were no sewage disposals during the reporting period.

5.11.4 Carbon-14

Carbon-14 activity of 1.59E+01 Curies released this year in gaseous form was obtained by estimation using EPRI spreadsheet BWR Source Term Calculation (MAL-1)_r1 and the information in NEAD-NS-11-0060-REV1-EC42519 and adjusted by 315.35 full power production days. Carbon-14 activity reported in the tables of this report are based on a constant release rate. Public dose estimates were performed using methodology from the ODCM which is based on Regulatory Guide 1.109 methodology. C-14 dose is included in dose calculation results in Table 2.

5.11.5 Errata/Corrections to Previous ARERRs

There were no errata issued or corrections to previous ARERRs for the 2024 reporting period.

6.0 NEI 07-07 ONSITE RADIOLOGICAL GROUNDWATER MONITORING PROGRAM

Grand Gulf Nuclear Station has developed a Groundwater Protection Initiative (GPI) program in accordance with NEI 07-07, Industry Ground Water Protection Initiative – Final Guidance Document [9]. The purpose of the GPI is to ensure timely detection and an effective response to situations involving inadvertent radiological releases to groundwater to prevent migration of licensed radioactive material off-site and to quantify impacts on decommissioning. During 2024, GGNS collected and analyzed groundwater samples in accordance with the requirements of EN-CY-111, Radiological Groundwater Protection Program.

This section is included in this report to communicate results of NEI 07-07 Radiological Groundwater Monitoring Program. Monitoring wells installed as part of GPI program are sampled and analyzed as summarized in Table 4, Groundwater Protection Program Monitoring Well Sample Schedule. In addition to reporting results from NEI 07-07 monitoring wells, voluntary communications to offsite governmental agencies for onsite leaks or spills per NEI 07-07 Objective 2.2, are also reported as part of this report. It is important to note, samples and results taken in support of NEI 07-07 groundwater monitoring program are not part of the Radiological Environmental Monitoring Program (REMP) but should be reported as part of ARERR.

GPI Ground Water samples were collected from onsite Dewatering Wells (DW), Monitoring Wells (MW), and Sentinel Wells (SW). Samples were analyzed for Tritium and gamma and selected samples were analyzed for hard-to-detect (HTD) radionuclides (Americium-241, Curium-242, Curium-243/244, Iron-55, Nickel-63, Plutonium-238, Strontium-89 and Strontium-90). Analyses are to the Lower Level of Detection (LLD) values for the GGNS Radiological Environmental Monitoring Program.

No dose to the public is attributed to ground water since wells with results above Minimum Detectable Activity (MDA) are bounded by wells which are less than MDA. Tritium and gamma results are shown in the table below. HTD analyses performed on MW-114B indicated < MDA for all HTD radionuclides.

Radiological Groundwater Monitoring Program tritium results are summarized in Table 5, Groundwater Protection Program Monitoring Well Tritium Results. No groundwater monitoring locations had detectable gamma or HTD in 2024.

Table 4, Groundwater Protection Program Monitoring Well Sample Schedule

Installation ID	Installation Type	Quarterly Sampling	Annual Sampling	Rationale
DW-01	Dewatering Well	X		DW-01 plume
DW-02	Dewatering Well	X		M&E sampling
DW-03	Dewatering Well	X		M&E sampling
DW-04	Dewatering Well	X		General detection monitoring
DW-05	Dewatering Well	X		General detection monitoring
DW-07	Dewatering Well	X		DW-07 plume
MW-01	Monitoring Well	X		M&E sampling, DW-01 plume
MW-04	Monitoring Well	X		General detection monitoring
MW-06	Monitoring Well	X		DW-07 plume
MW-100B	Monitoring Well		X	General detection monitoring - perimeter well
MW-101B	Monitoring Well	X		DW-01 plume
MW-102B	Monitoring Well		X	General detection monitoring - perimeter well
MW-103B	Monitoring Well		X	General detection monitoring - perimeter well
MW-104B	Monitoring Well		X	General detection monitoring - perimeter well
MW-105B	Monitoring Well	X		DW-01 plume
MW-106B	Monitoring Well	X		DW-01 plume
MW-107B	Monitoring Well	X		DW-07 plume
MW-108B	Monitoring Well	X		DW-07 plume
MW-109B	Monitoring Well	X		DW-07 plume
MW-110B	Monitoring Well	X		DW-07 plume
MW-111B	Monitoring Well	X		DW-01 plume
MW-112B	Monitoring Well	X		M&E sampling, DW-01 plume
MW-113B	Monitoring Well	X		M&E sampling, perimeter well
MW-114B	Monitoring Well	X		DW-01 plume

Table 4, Groundwater Protection Program Monitoring Well Sample Schedule

Installation ID	Installation Type	Quarterly Sampling	Annual Sampling	Rationale
MW-115B	Monitoring Well	X		DW-01 plume
MW-116B	Monitoring Well	X		DW-01 plume
MW-118B	Monitoring Well	X		DW-01 plume
MW-119B	Monitoring Well		X	General detection monitoring - perimeter well
MW-120B	Monitoring Well		X	General detection monitoring - perimeter well
MW-121B	Monitoring Well		X	General detection monitoring - perimeter well
MW-122B	Monitoring Well	X		8 quarterly requirement, M&E sampling
MW-123B	Monitoring Well	X		8 quarterly requirement, M&E sampling
MW1007C	Monitoring Well		X	General detection monitoring
MW1009C	Monitoring Well		X	General detection monitoring
MW1012C	Monitoring Well		X	General detection monitoring
MW1020C	Monitoring Well		X	General detection monitoring
MW1024C	Monitoring Well		X	General detection monitoring
MW1027C	Monitoring Well		X	General detection monitoring
MW1042C	Monitoring Well		X	General detection monitoring
MW1082C	Monitoring Well		X	General detection monitoring
MW1134C	Monitoring Well		X	General detection monitoring
P-05	Piezometer		X	General detection monitoring
SW-103A	Monitoring Well	X		Discharge pipeline sentinel well
SW-101	Sump	X		Discharge pipeline sentinel well
SW-102	Sump	X		Discharge pipeline sentinel well

Table 5, Groundwater Protection Program Monitoring Well Tritium Results

Well Name	Number of Positive Detections	Number of Analyses	Average Concentration[1] (pCi/L)	Maximum Concentration (pCi/L)
DW-01	2	5	1026	1090
DW-02	2	5	986	1070
DW-03	2	4	855	962
DW-04	4	4	893	1150
DW-05	0	4	<MDA	<MDA
DW-07	5	5	1085	1290
MW-01	2	4	636	641
MW-04	0	4	<MDA	<MDA
MW-06	7	7	1239	1720
MW-100B	0	1	<MDA	<MDA
MW-101B	0	4	<MDA	<MDA
MW-102B	0	1	<MDA	<MDA
MW-103B	0	1	<MDA	<MDA
MW-104B	0	1	<MDA	<MDA
MW-105B	2	4	641	653
MW-106B	0	4	<MDA	<MDA
MW-107B	0	4	<MDA	<MDA
MW-108B	3	4	776	935
MW-109B	5	5	2780	5350
MW-110B	2	5	2925	3160
MW-111B	3	4	2171	3060
MW-112B	1	4	953	953
MW-113B	0	4	<MDA	<MDA
MW-114B	4	4	1835	2040
MW-115B	2	4	1580	1660
MW-116B	0	4	<MDA	<MDA
MW-118B	2	4	842	845
MW-119B	0	1	<MDA	<MDA
MW-120B	0	1	<MDA	<MDA
MW-121B	0	1	<MDA	<MDA
MW-122B	0	4	<MDA	<MDA
MW-123B	0	4	<MDA	<MDA

[1] Results <MDA should not be included in the average concentration calculation.

Table 5, Groundwater Protection Program Monitoring Well Tritium Results

Well Name	Number of Positive Detections	Number of Analyses	Average Concentration[1] (pCi/L)	Maximum Concentration (pCi/L)
MW-1007C	0	1	<MDA	<MDA
MW-1009C	0	1	<MDA	<MDA
MW-1012C	0	1	<MDA	<MDA
MW-1020C	0	2	<MDA	<MDA
MW-1024C	0	1	<MDA	<MDA
MW-1027B	0	1	<MDA	<MDA
MW-1027C	0	1	<MDA	<MDA
MW-1042C	0	1	<MDA	<MDA
MW-1134B	0	1	<MDA	<MDA
MW-1134C	0	1	<MDA	<MDA
MW-1082C	0	1	<MDA	<MDA
P-05	0	1	<MDA	<MDA
SW-103A	0	4	<MDA	<MDA

6.1 Voluntary Notification

During 2024, Grand Gulf Nuclear Station 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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Attachment 1, ARERR Release Summary Tables (RG-1.21 Tables)

1.0 GASEOUS EFFLUENTS

Table 6, Gaseous Effluents Summation of All Releases GGNS [1]

A. Fission & Activation Gases	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual	Est. Total Error %
1. Total Release	Ci	3.57E+01	7.46E+01	8.03E+01	4.31E+01	2.34E+02	6.90E+01
2. Average release rate for the period	µCi/sec	4.55E+00	9.49E+00	1.01E+01	5.42E+00	7.39E+00	
B. Iodine							
1. Total I-131 Release	Ci	7.95E-05	3.65E-06	8.85E-06	6.76E-05	1.60E-04	7.10E+01
2. Average release rate for the period	µCi/sec	1.01E-05	4.64E-07	1.11E-06	8.50E-06	5.05E-06	
C. Particulates							
1. Total Release	Ci	6.97E-06	1.13E-05	6.14E-06	5.18E-05	7.62E-05	6.90E+01
2. Average release rate for the period	µCi/sec	8.86E-07	1.44E-06	7.72E-07	6.52E-06	2.41E-06	
D. Tritium							
1. Total Release	Ci	6.70E+00	7.57E+00	6.58E+00	8.86E+00	2.97E+01	6.60E+01
2. Average release rate for the period	µCi/sec	8.52E-01	9.62E-01	8.28E-01	1.11E+00	9.39E-01	
E. Gross Alpha							
1. Total Release	Ci	4.17E-08	0.00E+00	3.06E-08	0.00E+00	7.22E-08	1.03E+02
2. Average release rate for the period	µCi/sec	5.30E-09	0.00E+00	3.85E-09	0.00E+00	2.28E-09	
F. Carbon-14							
1. Total Release	Ci	2.89E+00	4.39E+00	4.61E+00	3.96E+00	1.59E+01	
2. Average release rate for the period	µCi/sec	3.67E-01	5.59E-01	5.81E-01	4.98E-01	5.01E-01	

[1] % of limit is provided in Table 1, Grand Gulf Nuclear Station Unit 1 Dose Summary

Table 7, Gaseous Effluents – Ground Level Release Continuous Mode GGNS

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission Gases						
Ar 41	Ci	4.44E+00	8.08E+00	1.60E+01	5.62E+00	3.41E+01
Kr-85m	Ci	6.14E+00	6.07E+00	1.42E+01	5.15E+00	3.16E+01
Kr-87	Ci	3.57E+00	1.69E+00	8.16E+00	2.14E+00	1.56E+01
Kr-88	Ci	1.22E+01	1.32E+01	2.90E+01	1.05E+01	6.49E+01
Xe-133	Ci	5.80E+00	2.27E+01	1.13E+01	9.74E+00	4.96E+01
Xe-135	Ci	3.10E+00	2.00E+01	1.46E+00	6.87E+00	3.14E+01
Xe-135m	Ci	3.60E-01	2.36E+00	1.68E-01	9.84E-01	3.87E+00
Xe-138	Ci	8.17E-02	5.35E-01	3.82E-02	1.11E+00	1.77E+00
Total for Period	Ci	3.57E+01	7.46E+01	8.03E+01	4.31E+01	2.34E+02
Iodines						
I-131	Ci	7.95E-05	3.65E-06	8.85E-06	6.76E-05	1.60E-04
I-133	Ci	1.01E-04	4.29E-05	4.87E-05	1.63E-04	3.56E-04
Total for Period	Ci	1.81E-04	4.65E-05	5.76E-05	2.31E-04	5.16E-04
Particulates						
Co-58	Ci	1.86E-07	ND	ND	3.95E-06	4.13E-06
Co-60	Ci	6.10E-06	2.19E-06	8.07E-07	1.13E-05	2.04E-05
Cr-51	Ci	ND	ND	ND	2.15E-05	2.15E-05
Mn-54	Ci	9.25E-08	ND	ND	1.33E-06	1.43E-06
Ru-106	Ci	3.21E-08	8.84E-06	5.28E-06	1.37E-05	2.79E-05
Se-75	Ci	5.62E-07	3.06E-07	5.38E-08	2.79E-08	9.50E-07
Total for Period	Ci	6.97E-06	1.13E-05	6.14E-06	5.18E-05	7.62E-05
Tritium						
H-3	Ci	6.70E+00	7.57E+00	6.58E+00	8.86E+00	2.97E+01
Gross Alpha						
Alpha	Ci	4.17E-08	ND	3.06E-08	ND	7.22E-08
Carbon-14						
C-14	Ci	2.89E+00	4.39E+00	4.61E+00	3.96E+00	1.59E+01

2.0 LIQUID EFFLUENTS

Table 8, Liquid Effluents – Summation of All Releases GGNS [1]

A. Fission & Activation Products	Unit	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Annual	Est. Total Error %
1. Total Release	Ci	1.70E-02	4.56E-03	4.76E-03	6.61E-03	3.29E-02	7.30E+01
2. Average diluted concentration	µCi/mL	1.39E-07	1.13E-07	1.32E-07	7.54E-08	1.17E-07	
B. Tritium							
1. Total Release	Ci	5.01E+00	2.77E+00	3.10E+00	2.78E+00	1.36E+01	7.00E+01
2. Average diluted concentration	µCi/mL	4.09E-05	6.87E-05	8.57E-05	3.18E-05	4.87E-05	
C. Dissolved & Entrained Gases							
1. Total Release	Ci	ND	ND	7.53E-06	ND	7.53E-06	6.60E+01
2. Average diluted concentration	µCi/mL	ND	ND	2.08E-10	ND	2.69E-11	
D. Gross Alpha Activity							
1. Total Release	Ci	ND	ND	ND	ND	ND	9.50E+01
2. Average diluted concentration	µCi/mL	ND	ND	ND	ND	ND	
E. Volume of Waste Released (prior to dilution)	Liters	2.23E+06	7.45E+05	6.37E+05	1.19E+06	4.80E+06	
F. Volume of Dilution Water Used During Period	Liters	1.20E+08	3.96E+07	3.55E+07	8.48E+07	2.80E+08	

[1] % of limit is provided in Table 1, Grand Gulf Nuclear Station Unit 1 Dose Summary

Table 9, Batch Mode Liquid Effluents GGNS

Radionuclide Released	Units	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total for year
Fission and Activation Products						
Ag-110m	Ci	3.36E-04	ND	ND	5.73E-06	3.42E-04
Co-58	Ci	9.44E-04	8.32E-05	6.99E-05	6.68E-04	1.77E-03
Co-60	Ci	5.03E-03	7.71E-04	6.16E-04	4.27E-03	1.07E-02
Cr-51	Ci	2.34E-04	ND	ND	4.35E-05	2.77E-04
Cs-134	Ci	7.01E-06	4.10E-06	ND	ND	1.11E-05
Cs-137	Ci	7.13E-05	1.29E-04	ND	6.60E-05	2.66E-04
Fe-55	Ci	ND	8.56E-04	2.55E-03	ND	3.41E-03
Fe-59	Ci	9.55E-05	ND	ND	ND	9.55E-05
La-140	Ci	5.35E-05	ND	ND	ND	5.35E-05
Mn-54	Ci	2.62E-03	4.66E-04	4.31E-04	1.21E-03	4.72E-03
Na-24	Ci	ND	3.21E-05	ND	1.13E-05	4.35E-05
Pt-195m	Ci	2.77E-05	ND	ND	ND	2.77E-05
Ru-106	Ci	7.85E-04	7.09E-05	9.14E-05	ND	9.47E-04
Sr-92	Ci	4.35E-05	ND	ND	ND	4.35E-05
W-187	Ci	9.96E-06	ND	ND	ND	9.96E-06
Y-88	Ci	ND	5.99E-05	2.10E-05	ND	8.09E-05
Zn-65	Ci	6.69E-03	2.08E-03	9.76E-04	3.40E-04	1.01E-02
Zn-69m	Ci	3.64E-06	ND	ND	ND	3.64E-06
Total for Period	Ci	1.70E-02	4.56E-03	4.76E-03	6.61E-03	3.29E-02
Tritium						
H-3	Ci	5.01E+00	2.77E+00	3.10E+00	2.78E+00	1.36E+01
Gross Alpha						
Alpha	Ci	ND	ND	ND	ND	ND
Entrained Gases						
Xe-135	Ci	ND	ND	7.53E-06	ND	7.53E-06
Total for Period	Ci	ND	ND	7.53E-06	ND	7.53E-06

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 GGNS

Types of Waste	Total Volume (m3)	Total Activity (Ci)	Est. Total Error (%)
a. Spent resins, filter sludges, evaporator bottoms, etc.	1.40E+02	6.17E+02	25
b. Dry compressible waste, contaminated equip, etc.	8.50E+02	4.70E-01	25
c. Irradiated components, control rods, etc.	1.11E+00	6.08E+04	25
d. Other (Oil and aqueous liquid)	7.65E+00	6.65E-03	25

2.0 ESTIMATE OF MAJOR NUCLIDE COMPOSITION (BY WASTE TYPE)

Table 11, Major Nuclides GGNS

Major Nuclide Composition (>0.1%)	%	Curies
a. Spent resins, filter sludges, evaporator bottoms, etc.		
Cr-51	6.29%	3.88E+01
Mn-54	9.60%	5.93E+01
Fe-55	24.59%	1.52E+02
Fe-59	1.31%	8.12E+00
Co-58	5.10%	3.15E+01
Co-60	45.52%	2.81E+02
Ni-63	0.44%	2.74E+00
Zn-65	6.23%	3.85E+01
Cs-137	0.34%	2.10E+00
Ce-144	0.35%	2.18E+00

Table 11, Major Nuclides GGNS

b. Dry compressible waste, contaminated equip, etc.		
Cr-51	4.53%	2.13E-02
Mn-54	12.73%	5.98E-02
Fe-55	5.07%	2.38E-02
Fe-59	1.38%	6.47E-03
Co-58	4.10%	1.92E-02
Co-60	67.81%	3.18E-01
Zn-65	3.30%	1.55E-02
Cs-137	0.29%	1.35E-03
Ce-144	0.61%	2.86E-03
c. Irradiated components, control rods, etc.		
Cr-51	0.15%	9.27E+01
Mn-54	1.65%	1.00E+03
Fe-55	41.64%	2.53E+04
Co-58	0.32%	1.95E+02
Co-60	46.46%	2.82E+04
Ni-63	9.65%	5.87E+03
d. Other (Oil and aqueous liquid)		
Cr-51	14.46%	9.62E-04
Mn-54	9.73%	6.47E-04
Fe-55	7.87%	5.23E-04
Fe-59	2.61%	1.74E-04
Co-58	4.25%	2.83E-04
Co-60	57.24%	3.81E-03
Ni-63	0.19%	1.28E-05

Table 11, Major Nuclides GGNS

Zn-65	2.06%	1.37E-04
Nb-95	0.67%	4.44E-05
Cs-137	0.45%	3.00E-05
Ce-144	0.46%	3.07E-05

3.0 SOLID WASTE DISPOSITION

Table 12, Solid Waste Disposition GGNS

Number of Shipments	Mode of Transportation	Destination
1	Hittman Transport Services Inc	EnergySolutions Clive Disposal Site (Bulk Waste Facility) – Clive, UT
11	Hittman Transport Services Inc	EnergySolutions Clive Disposal Site (Containerized Waste Facility) – Clive, UT
31	Hittman Transport Services Inc	EnergySolutions Bear Creek Road – Oak Ridge, TN
1	Hittman Transport Services Inc	Erwin ResinSolutions T.C. Runion Road
8	Hittman Transport Services Inc	Waste Control Specialists Compact Waste Disposal Facility

4.0 IRRADIATED FUEL DISPOSITION

Table 13, Irradiated Fuel Shipments Disposition GGNS

Number of Shipments	Mode of Transportation	Destination
None	N/A	N/A