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GNRO-2017/00028

April 27, 2017

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 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

Dear Sir or Madam:

Attached is the Grand Gulf Nuclear Station (GGNS) Annual Radioactive Effluent Release Report (ARERR) for period the January 1, 2016 through December 31, 2016. This report is submitted in accordance with the requirements of 10CFR50.36(a)(2) and GGNS Technical Specification 5.6.3. The ARERR also complies with the GGNS Offsite Dose Calculation Manual (ODCM)

This letter does not contain any new commitments. If you have any questions or require additional information concerning this report, please contact Richard Sumrall at (601) 437-2115.

Sincerely,

JJN/sas

Attachment: Grand Gulf Nuclear Station 2016 Annual Radioactive Release Report (ARERR)

cc: (see next page)

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Attachment to GNRO-2017/00028

Grand Gulf Nuclear Station 2016 Radioactive Effluent Release Report (ARERR)

ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION

ANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT

JANUARY 1, 2016 – DECEMBER 31, 2016

Prepared By:	Jim Reese Sr. Chemistry Specialist	4/25/17 Date
Reviewed By:	Darrell Bond ChemStaff Consultant	4/26/2017 Date
Approved By:	Trey Reeves Acting Chemistry Manager	4/26/2017 Date

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I. INTRODUCTION

This Annual Radioactive Effluent Release Report (ARERR) for the period of January 1 through December 31, 2016 is submitted in accordance with Technical Specifications, Section 5.6.3, of Grand Gulf Nuclear Station (GGNS) License Number NPF-29. The monitoring of radioactive effluents is referenced in Offsite Dose Calculation Manual (ODCM) Appendix A, Sections 6.11 and 6.12.

Airborne discharges at GGNS are considered ground-level releases. All liquid and airborne discharges to the environment were analyzed in accordance with ODCM requirements. All effluent releases were within the concentration and total release limits specified by the ODCM. Projected offsite doses were within the dose limits specified by the ODCM.

The summation of all known gaseous releases during the reporting period is reported in Table 1A.

Elevated gaseous releases are not applicable at GGNS as reported in Table 1B.

The summation of all known ground-level gaseous release during the reporting period is reported in Table 1C.

The radioactive gaseous sampling and analysis program implemented at GGNS is described in Table 1D.

The summation of all liquid releases during the reporting period is reported in Table 2A.

The continuous and batch mode liquid releases are reported in Table 2B.

The radioactive liquid waste sampling and analysis program implemented at GGNS is described in Table 2C.

Solid radioactive waste and irradiated fuel shipments during the reporting period are summarized in Table 3.

Groundwater Protection Initiative (GPI) well sample tritium results, which are not included in the AREOR, are included as Attachment I to the ARERR.

The annual summary of meteorological data (joint frequency distribution) will be maintained on site. The option to maintain meteorological data on site is in accordance with ODCM Administrative Controls Section 5.6.3. This data shall be provided to the Nuclear Regulatory Commission (NRC) upon request.

II. DETAILED INFORMATION

A. Regulatory Limits

1. ODCM Control Limits

a. Fission and Activation Gases - The release rate limit at any time for noble gases to areas at or beyond the site boundary shall be such that:

D_{tb} = average total body dose rate in the current year (mrem/yr)

$= \overline{X/Q}\ \Sigma_i\ K_i\ Q_i' \leq 500$ mrem/yr

D_s = average skin dose rate in the current year (mrem/yr)

$= \overline{X/Q}\ \Sigma_i\ (L_i + 1.1\ M_i)\ Q_i' \leq 3000$ mrem/yr

where the terms are defined in the GGNS ODCM.

b. Radioiodines, Tritium and Particulates - The release rate limit for the sampling period for all radioiodines, tritium and radioactive materials in particulate form with half-lives greater than 8 days shall be such that:

D_o = average organ dose rate in current year (mrem/yr)

$= \Sigma_i\ W\ P_i\ \overline{Q'_i} \leq 1500$ mrem/yr

where the terms are defined in the GGNS ODCM.

c. Liquid Effluents - The concentration of radioactive materials released in liquid effluents to unrestricted areas from the site shall not exceed at any time ten times the values specified in 10CFR20, Appendix B, Table 2, Column 2. The concentration of dissolved or entrained noble gases, released in liquid effluents to unrestricted areas from all reactors at the site, shall be limited to 2×10^{-4} microcuries/ml total activity.

II. DETAILED INFORMATION (CONT'D)

2. 10CFR50, Appendix I Limits

a. Fission and Activation Gases - The dose from noble gases in gaseous effluents to areas at or beyond the site boundary shall be such that:

D_γ = air dose due to gamma emissions from noble gases

$= 3.17 \times 10^{-8} \Sigma_i M_i \overline{X/Q'} Q_i \leq 5$ mrad/qtr

≤ 10 mrad/yr

D_β = air dose due to beta emissions from noble gases

$= 3.17 \times 10^{-8} \Sigma_i N_i \overline{X/Q'} Q_i \leq 10$ mrad/qtr

≤ 20 mrad/yr

where the terms are defined in the GGNS ODCM.

b. Radioiodines, Tritium and Particulates - The dose to an individual from tritium, I-131, I-133 and radioactive material in particulate form with half-lives greater than 8 days in gaseous effluents shall be such that:

D_p = dose to an individual from tritium, I-131, I-133 and radionuclides in particulate form with half-lives greater than 8 days (mrem)

$= 3.17 \times 10^{-8} \Sigma_i R_i W' Q_i \leq 7.5$ mrem/qtr Any Organ

≤ 15 mrem/yr Any Organ

where the terms are defined in the GGNS ODCM.

c. Liquid Effluents - The dose from radioactive materials in liquid effluents shall be such that:

$$D_{Tau} = \Sigma_i \left[A_{iTau} \sum_{l=1}^{m} \Delta t_l C_{il} F_l \right] \leq 1.5 \text{ mrem/qtr Total Body}$$

≤ 5 mrem/qtr Any Organ

≤ 3 mrem/yr Total Body

≤ 10 mrem/yr Any Organ

where the terms are defined in the GGNS ODCM.

II. DETAILED INFORMATION (CONT'D)

3. 40CFR190 Limits

Doses are calculated for Fission and Activation Gases; Radioiodines and Particulates; and Liquid Effluents according to equations contained in Sections 2.(a), (b), and (c) respectively, with the exception that the limits applied are:

$\leq$ 25 mrem/yr, Total Body or any Organ except Thyroid

$\leq$ 75 mrem/yr, Thyroid

$\leq$ 10 mrad γ/qtr or $\leq$ 20 mrad γ/yr, Fission and Activation Gases

$\leq$ 20 mrad β/qtr or $\leq$ 40 mrad β/yr, Fission and Activation Gases

$\leq$ 15 mrem/qtr or $\leq$ 30 mrem/yr, any Organ, Iodine and Particulates

$\leq$ 3 mrem/qtr or $\leq$ 6 mrem/yr, Total Body, Liquid Effluents

$\leq$ 10 mrem/qtr or $\leq$ 20 mrem/yr, any Organ, Liquid Effluents

B. Effluent Concentrations

1. Airborne

The Effluent Concentration Limit (ECL) of radioactive materials in gaseous effluents is limited by the dose rate restrictions given in Section II.A.1.a. In this case, the ECLs are actually determined by the dose factors in Table 2.1-1 of the GGNS ODCM.

Gaseous dose rates rather than Effluent Concentration Limits are used to calculate permissible release rates for gaseous releases. The maximum permissible dose rates for gaseous releases are defined in the GGNS ODCM 6.11.4.a as 500 mrem/yr (Total Body) and 3000 mrem/yr (Skin) and in 6.11.4.b as 1500 mrem/yr (Organ).

2. Liquid

The ECL of radioactive materials in liquid effluents is limited by ten times the values in 10CFR20, Appendix B, Table 2, Column 2. The ECL chosen is the most conservative value of either the soluble or insoluble ECL for each radioisotope.

II. DETAILED INFORMATION (CONT'D)

C. Average Energy

Not applicable for GGNS ODCM Appendix A.

The GGNS ODCM limits the instantaneous dose equivalent rates due to the release of noble gases to less than or equal to 500 mrem/year to the total body and less than or equal to 3000 mrem/year to the skin. The average beta and gamma energies of the radionuclide mixture in releases of fission and activation gases as described in Regulatory Guide 1.21, "Measuring, Evaluation, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," may be used to calculate doses in lieu of more sophisticated software. The GGNS radioactive effluent programs employs the methodologies presented in U.S. NRC Regulatory Guide 1.109 "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977 and NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants, October 1978. Therefore, average energies are not applicable to GGNS.

D. Measurements and Approximations of Total Activity

The following discussion details the methods used to measure and approximate the total activity for the following:

Fission and Activation Gases	Particulates
Radioiodines	Liquid Effluents

Tables 1D and 2C give sampling frequencies and Lower Limit of Detection requirements for the analysis of gaseous and liquid effluent streams, respectively.

Values in the attached tables given as zero do not necessarily imply that the radionuclides were not present. A zero indicates that the radionuclide was not present at levels greater than the sensitivity requirements shown in Tables 1D and 2C. For some radionuclides, lower detection levels than required may be readily achievable; when a radionuclide is measured below its stated detection limits, it is reported.

II. DETAILED INFORMATION (CONT'D)

1. For Fission and Activation Gases

The principal gamma emitters for which the LLD specification in Table 1D applies exclusively are:

Kr-87	Xe-133	Xe-135
Kr-88	Xe-133m	Xe-138

Periodic grab samples from Station effluent streams are analyzed by gamma spectral analysis utilizing high-resolution germanium detectors (see Table 1D for sampling and analytical requirements). Isotopic values thus obtained are used for dose release rate calculations due to effluent releases as given in Section II.A.1 of this report. The radionuclides that are detected are used in this computation. When no radionuclides are detected, a historical default mixture is used. During the period between grab samples, the amount of radioactivity released is based on the effluent monitor readings. Monitors are assigned a calibration factor based upon the last isotopic analysis, using the following relationship:

$$C_i = U_i \div m$$

where:

C_i = isotopic calibration factor for isotope i

U_i = concentration of isotope i in the grab sample in μCi/ml.

m = net monitor reading associated with the effluent stream (determined at the time of grab sampling).

These calibration factors, along with the hourly effluent monitor values and flow rates, are entered into the laboratory computer where the release rates for individual radionuclides are calculated and stored. If no activity is detected in the grab sample, the calibration factor defaults to a historical default mixture of Kr-88, Xe-133, Xe-135m, Xe-135, and Xe-138.

II. DETAILED INFORMATION (CONT'D)

2. For Particulates and Radioiodines

The principal gamma emitters for which the LLD specification in Table 1D applies exclusively are:

Zn-65	Mo-99
Mn-54	Cs-134
Fe-59	Cs-137
Co-58	Ce-141
Co-60	Ce-144
Sr-89	I-131
Sr-90	I-133

3. For Continuous Releases

Continuous sampling is performed on the continuous release points when releasing (i.e., Offgas/Radwaste Building, Containment Building, Fuel Handling Area, Turbine Building, and Turbine Building Occasional Release Point). Particulate material is collected by filtration. Radioiodines are collected by adsorption onto a charcoal filter. Periodically these filters are removed and analyzed by gamma spectral analysis utilizing high-resolution Germanium detectors to identify and quantify radioactive materials collected. Particulate filters are then analyzed for gross alpha and Strontium-89/90 as required. Gross alpha is analyzed using a gas flow proportional detector. Strontium-89/90 values are obtained by chemical separation and subsequent counting analysis using a gas flow proportional detector. Tritium concentrations are determined using distillation and a liquid scintillation detector. During major operational occurrences, the frequency of sampling is increased to satisfy the requirements of footnote "c" of Table 1D, "Radioactive Gaseous Waste Sampling and Analysis," (GGNS ODCM Appendix A, Table 6.11.4-1). Strontium analysis is performed by a qualified contract laboratory. Carbon-14 (C-14) activity of 8.88 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 177.5 full power production days. Carbon-14 curies are reported in Tables 1A and 1C of this report and based on a constant release rate throughout the quarter.

4. For Batch Releases: Gases

Gaseous batch releases are not normally performed at GGNS.

II. DETAILED INFORMATION (CONT'D)

5. For Batch Releases: Liquid Effluents

The principal gamma emitters for which the LLD specification in Table 2C applies exclusively are:

H-3	Sr-90
Mn-54	Mo-99
Fe-55	I-131
Co-58	Cs-134
Co-60	Cs-137
Fe-59	Ce-141
Zn-65	Ce-144
Sr-89	

Representative pre-release grab samples are obtained and analyzed as required by Table 2C. Isotopic analyses are performed by gamma spectral analysis utilizing high-resolution germanium detectors. Aliquots of each pre-released sample, proportional to the waste volume released, are composited in accordance with the requirements of Table 2C. Strontium-89/90 and Iron-55 values are obtained by individual chemical separations. Strontium-89/90 is analyzed using a gas flow proportional detector. Iron-55 is analyzed using a low energy photon detector. Gross alpha is analyzed using a gas flow proportional detector. Tritium is distilled and then analyzed using a liquid scintillation detector. Dissolved gases are determined employing grab sampling techniques and analyzed by gamma spectral analysis utilizing high-resolution germanium detectors. Iron and Strontium analyses are performed by a qualified contract laboratory.

E. Batch Releases

1. Liquid

	1st QTR	2nd QTR	3rd QTR	4th QTR	YEAR
Number of Releases	40	15	36	15	106
Time Period (Minutes)					
Total Release Time	1.32E+04	4.55E+03	1.06E+04	4.48E+03	3.28E+04
Maximum Release Time	4.35E+02	3.65E+02	3.20E+02	3.10E+02	4.35E+02
Average Release Time	3.30E+02	3.03E+02	2.93E+02	2.99E+02	3.09E+02
Minimum Release Time	2.50E+01	2.84E+02	1.15E+02	2.75E+02	2.50E+01
Average Dilution Water Flow (GPM)	8.42E+03	4.94E+03	6.00e+03	3.03e+03	6.42e+03

2. Gaseous

No batch releases occurred during the report period.

II. DETAILED INFORMATION (CONT'D)

F. Abnormal Releases

1. Liquid

a. Number of Releases: 0

b. Total Activity Released: 0.00E+00 Ci

No abnormal liquid releases were identified for this reporting period.

2. Gaseous

a. Number of Releases: 0

b. Total Activity Released: 0.00E+00 Ci

No abnormal gaseous releases were identified for this reporting period.

G. Estimate of Total Error

1. Liquid

The maximum errors are collectively estimated to be as follows:

	Fission & Activation Products	Tritium	Dissolved & Entrained Gases	Gross Alpha
Sampling %	2.60E+01	2.60E+01	2.60E+01	2.60E+01
Measurement %	6.80E+01	6.50E+01	6.10E+01	9.20E+01
TOTAL %	7.30E+01	7.00E+01	6.60E+01	9.50E+01

Sampling errors include uncertainty associated with mixing, representative sampling and discharge volume. Measurement errors include uncertainty associated with instrument calibration and the preparation and counting of low-activity samples. Counting errors are based on measurements of blank samples. For germanium detectors, the least-readily-detectable radioisotope is used to determine the counting error. Calibration errors are calculated by summing the errors associated with the calibration of a particular instrument with a radioactive source.

The total error is calculated by taking the square root of the sum of the squares of the individual errors.

II. DETAILED INFORMATION (CONT'D)

2. Gaseous

The maximum errors (not including sample line loss) are collectively estimated to be as follows:

	Fission & Activation Products	Iodine	Particulate	Alpha	Gross Tritium
Sampling %	3.20E+01	2.30E+01	2.20E+01	2.20E+01	2.30E+01
Measurement %	6.10E+01	6.70E+01	6.50E+01	1.01E+02	6.20E+01
TOTAL %	6.90E+01	7.10E+01	6.90E+01	1.03E+02	6.60E+01

Sampling errors include uncertainty associated with sample flow, vent flow and monitor calibration.

Measurement and total errors are calculated by the same methods used for liquid effluents.

3. Solid Radioactive Waste

Estimated Total Error % for all waste types is ± 2.50E+01. Sampling errors include uncertainty associated with mixing and representative sampling.

H. Solid Radioactive Waste Shipments

See Table 3 for shipment information.

I. Meteorological Data

The data recovery for the reporting period was 99.9%. The predominant wind direction was from the east-northeast approximately 10.0% of the time. The predominant stability class was class "D" approximately 29.0% of the time. Average wind speed during the reporting period was approximately 3.8 miles per hour at the 33 foot elevation.

The annual meteorological data (Hourly Average Data or Joint Frequency Distribution) will be maintained on site in a file that shall be provided to the NRC upon request.

J. Radioactive Effluent Monitoring Instrumentation Operability

CR-GGN-2016-2688 – On 3/22/16 the Liquid Radwaste Effluent monitor had been declared inoperable for 30 days due to plant shutdown where normal Circulating Water system blowdown flow was not available as the source for dilution water. The monitor was restored to service upon restoration of Circulating Water system blowdown in preparation for plant startup.

CR-GGN-2016-9435 – On 12/10/16 the Standby Gas Treatment System 'B' effluent monitor had been inoperable for 30 days due to maintenance and installation of a new monitor. The new monitor was declared operable following completion of installation, testing and calibration.

K. Annual Sewage Disposal Summary

There were no sewage disposals in 2016.

III. RADIATION DOSE SUMMARY

Indicated below is the annual summary of offsite doses attributable to GGNS during 2016. Inspection of the values indicates that GGNS releases were within the 10CFR50, Appendix I, design objectives.

Since there are no other fuel cycle facilities within 8 km of GGNS, 40CFR190 limits were also met during this period.

A. Water-Related Exposure Pathways

The values calculated in this section utilize the information provided in Tables 2A and 2B of this report and the calculation methodology of the ODCM.

Liquid Effluents

Total body dose and critical organ doses are computed for the maximum exposed individual. The maximum dose contribution from liquid effluents is considered to occur in the adult age group via consumption of fish.

Table III.A 2016 Liquid Effluent Dose (mrem)

	1st QTR	2nd QTR	3rd QTR	4th QTR	TOTAL
Bone	7.48E-02	2.38E-02	7.96E-03	1.23E-02	1.29E-01
Liver	1.29E-01	3.81E-02	1.59E-02	2.75E-02	2.26E-01
Thyroid	1.97E-02	7.24E-04	1.24E-03	1.09E-03	2.80E-02
Kidney	5.23E-02	1.40E-02	7.78E-03	1.58E-02	9.39E-02
Lung	1.35E-02	4.98E-03	2.70E-03	2.58E-03	2.52E-02
GI-LLI	4.96E-02	5.63E-03	9.29E-03	1.68E-02	8.59E-02
Applicable Limit	5	5	5	5	10
Percent of Limit	2.57E+00	7.61E-01	3.17E-01	5.50E-01	2.26E+00
Whole Body	8.20E-02	2.54E-02	9.28E-03	1.39E-02	1.42E-01
Applicable Limit	1.5	1.5	1.5	1.5	3
Percent of Limit	5.47E+00	1.69E+00	6.18E-01	9.30E-01	4.74E+00

B. Airborne-Related Exposure Pathways

The values presented in this section utilize information provided in Tables 1A and 1C of this report and the calculation methodology of the ODCM. Dose and dose rates are computed for locations at the site boundary or at unrestricted areas within the site boundary. Because members of the public, on occasion, may be found within the site boundary, two fishing lakes, the recreational vehicle laydown area, and the GGNS Energy Services Center locations were also evaluated.

Consideration of site boundary locations as well as unrestricted areas within and beyond the site boundary provides assurance that offsite doses will not be substantially underestimated while attempting to provide an accurate dose calculation.

Doses for a Member of the Public are computed based on 2016 meteorological data and on the most recent land use census, with the most limiting location used.

During normal operations, the dispersion and deposition factors used for dose calculations are from five-year historical annual average meteorological data.

III. RADIATION DOSE SUMMARY (CONT'D)

Organ Dose

The maximum organ dose to a MEMBER OF THE PUBLIC (critical receptor) from radioiodines, tritium, and particulates was calculated for this report using the most recent land use census and dispersion and deposition parameters from 2016 meteorological data. The critical receptor residence was determined to be located in the southwest sector at a distance of 1432 meters (0.89 miles) from the plant. Pathways considered for use in the organ dose calculations are inhalation, ground plane, grass/cow/meat, and vegetation. There is no grass/cow/milk pathway within five miles of GGNS. It was assumed that the age group receiving the maximum dose lived at the residence and that the receptor consumed food products that were raised or produced at the residence. This dose is documented in the following table as two separate entries. The first organ dose entry excludes C-14 while the second entry includes organ dose from tritium, radioiodines, particulates, and C-14.

Average Total Body and Skin Dose Rate

Individual total body and skin dose rates from exposure to a semi-infinite cloud of noble gas was calculated for a location in the west-northwest sector at a distance of 1207 meters (0.75 miles) from the plant. This location corresponds to the highest annual average atmospheric dispersion factor for a location at or within the site boundary based on historical 5-year average meteorological data.

The total body and skin dose rates reported are the quarterly average of the maximum instantaneous dose rates determined daily during the reporting period and represent the maximum possible dose rate received by members of the public.

Air Dose from Gamma and Beta Emissions

Air doses from gaseous effluents were calculated for this report using dispersion parameters from historical 5-year average meteorological data. The highest dispersion factor for an unrestricted area was in the west-northwest sector at the site boundary, 1207 meters (0.75 miles) from the plant.

Direct Radiation

Direct radiation dose is calculated by subtracting average doses measured by thermoluminescent dosimeter (TLD) badges located at control locations from average doses measured by TLD badges located near the site boundary. GGNS reported measured doses in 2016 as net exposure normalized to 92 days.

III. RADIATION DOSE SUMMARY (CONT'D)

Carbon-14

Carbon-14 (C-14) is a naturally occurring isotope of carbon. 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. In recent years, the analytical methods for determining C-14 have improved. Coincidentally the radioactive effluents from commercial nuclear power plants have also decreased to the point that C-14 has emerged as a principal radionuclide in gaseous effluents.

The only significant dose pathway to a member of the public from C-14 release is through consumption of vegetation. Vegetation incorporates C-14 in form of carbon dioxide (CO_2) during photosynthesis so doses are calculated based on the CO_2 fraction of the carbon released in gaseous form. A CO_2 fraction of 95% is used based on EPRI Technical Report 1021106, "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents." The highest atmospheric dispersion factor for an actual garden based on the land use census was used to determine dose from C-14. Carbon-14 is dispersed as a gas (CO_2) to the garden location, where it is then incorporated into plant material.

Carbon-14 dose is calculated to a MEMBER OF THE PUBLIC for the most age restrictive group (Child) and organ (bone) at the garden location. This dose is then added to dose for the same organ from tritium, iodine, and particulates. This organ dose is recorded and compared to the limit in the following table.

Table III.B 2016 Airborne Effluent Dose (mrem)

	1st QTR	2nd QTR	3rd QTR	4th QTR	TOTAL
Iodine, Tritium & Particulates (excluding Carbon-14)					
Child (mrem)	8.75E-03	4.48E-03	8.76E-03	9.97E-04	2.30E-02
Organ	Thyroid	Thyroid	Thyroid	Thyroid	Thyroid
Applicable Limit	7.5	7.5	7.5	7.5	15
Percent of Limit	1.17E-01	5.97E-02	1.17E-01	1.33E-02	1.53E-01
Iodine, Tritium & Particulates (including Carbon-14)					
Child (mrem)	1.92E+00	3.14E+00	1.88E+00	8.51E-08	6.94E+00
Organ	Bone	Bone	Bone	Bone	Bone
Applicable Limit	7.5	7.5	7.5	7.5	15
Percent of Limit	2.56E+01	4.19E+01	2.51E+01	1.13E-06	4.63E+01
Total Body Dose Rate (mrem/yr)	6.19E+00	8.03E-01	1.86E+00	3.24E-02	
Applicable Limit	500	500	500	500	
Percent of Limit	1.24E+00	1.61E-01	3.72E-01	6.48E-03	
Skin Dose Rate (mrem/yr)	1.27E+01	1.53E+00	3.13E+00	6.18E-02	
Applicable Limit	3000	3000	3000	3000	
Percent of Limit	4.23E-01	5.10E-02	1.04E-01	2.06E-03	
Gamma Air Dose*	5.55E-02	2.56E-02	1.80E-02	3.29E-03	1.02E-01
Applicable Limit	5	5	5	5	10
Percent of Limit	1.11E+00	5.12E-01	3.59E-01	6.59E-02	1.02E+00
Beta Air Dose*	2.96E-02	2.37E-02	1.60E-02	3.56E-03	7.29E-02
Applicable Limit	10	10	10	10	20
Percent of Limit	2.96E-01	2.37E-01	1.60E-01	3.56E-02	3.65E-01
Direct Radiation (mrem)	0.0	0.1	0.0	0.0	0.1

* Measurement units are mrad

IV. OFFSITE DOSE CALCULATION MANUAL/ RADIOACTIVE WASTE TREATMENT SYSTEM CHANGES

A. Offsite Dose Calculation Manual (ODCM)

No revisions to the ODCM were issued during the reporting period.

B. Radioactive Waste Treatment Systems

No major changes were made to the liquid or gaseous radwaste treatment systems during this reporting period.

TABLE 1A
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
GASEOUS EFFLUENTS – SUMMATION OF ALL RELEASES

REPORT FOR 2016	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
1. Total Release	Ci	1.21E+02	9.59E+01	6.32E+01	1.50E+01	2.95E+02
2. Avg. Release Rate	uCi/sec	1.54E+01	1.22E+01	7.95E+00	1.88E+00	9.34E+00
3. Percent of TS Limit						
a. Gamma Air	%	N/A	N/A	N/A	N/A	N/A
b. Beta Air	%	N/A	N/A	N/A	N/A	N/A
Iodine-131						
1. Total Release	Ci	2.12E-04	1.10E-04	3.55E-04	3.35E-06	6.81E-04
2. Avg. Release Rate	uCi/sec	2.70E-05	1.40E-05	4.47E-05	4.21E-07	2.15E-05
3. Percent of TS Limit	%	N/A	N/A	N/A	N/A	N/A
Particulates Half Life ≥ 8 days						
1. Total Release	Ci	1.13E-05	1.16E-05	2.38E-05	3.40E-06	5.01E-05
2. Avg. Release Rate	uCi/sec	1.43E-06	1.47E-06	3.00E-06	4.28E-07	1.58E-06
3. Percent of TS Limit	%	N/A	N/A	N/A	N/A	N/A
Tritium						
1. Total Release	Ci	8.23E+00	4.12E+00	4.91E+00	1.46E+00	1.87E+01
2. Avg. Release Rate	uCi/sec	1.05E+00	5.24E-01	6.18E-01	1.84E-01	5.92E-01
3. Percent of TS Limit	%	N/A	N/A	N/A	N/A	N/A
Carbon 14						
1. Total Release	Ci	2.46E+00	4.02E+00	2.41E+00	0.00E+00	8.88E+01
2. Avg. Release Rate	uCi/sec	3.13E-01	5.11E-01	3.03E-01	0.00E+00	2.81E-01
Gross Alpha						
1. Total Release	Ci	6.11E-09	3.05E-11	0.00E+00	0.00E+00	6.14E-09
2. Avg. Release Rate	uCi/sec	7.78E-10	3.88E-12	0.00E+00	0.00E+00	1.94E-10

NOTE: Limits are applicable to dose, not concentration. See Table III.B on page 16 for percentage of dose limits.

TABLE 1B
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
GASEOUS EFFLUENTS – ELEVATED RELEASES

JANUARY – DECEMBER 2016

(Not Applicable – GGNS Releases Are Considered Ground-Level)

TABLE 1C
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
GASEOUS EFFLUENTS – GROUND-LEVEL RELEASE-CONTINUOUS

REPORT FOR 2016	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
AR-41	Ci	6.41E+00	4.50E+00	3.18E+00	0.00E+00	1.41E+01
KR-85	Ci	1.31E+00	0.00E+00	0.00E+00	0.00E+00	1.31E+00
KR-85M	Ci	1.68E+01	6.66E-01	4.05E+01	0.00E+00	1.79E+01
KR-87	Ci	4.02E-02	0.00E+00	6.39E-02	0.00E+00	1.04E-01
KR-88	Ci	1.70E+01	1.79E+00	1.17E+00	2.99E-01	2.02E+01
XE-131M	Ci	2.57E-01	0.00E+00	0.00E+00	0.00E+00	2.57E-01
XE-133	Ci	5.74E+01	4.30E+01	2.75E+01	7.00E+00	1.35E+02
XE-133M	Ci	3.15E-01	0.00E+00	0.00E+00	0.00E+00	3.15E-01
XE-135	Ci	1.87E+01	4.01E+01	2.63E+01	6.69E+00	9.18E+01
XE-135M	Ci	2.68E+00	4.73E+00	3.28E+00	7.90E-01	1.15E+01
XE-138	Ci	3.77E-01	1.07E+00	1.34E+00	1.79E-01	2.97E+00
Totals for Period...	Ci	1.21E+02	9.59E+01	6.32E+01	1.50E+01	2.95E+02
Iodines						
I-131	Ci	2.12E-04	1.10E-04	3.55E-04	3.35E-06	6.81E-04
I-133	Ci	2.25E-04	1.73E-04	1.63E-04	0.00E+00	5.61E-04
I-135	Ci	3.42E-05	0.00E+00	0.00E+00	0.00E+00	3.42E-05
Totals for Period...	Ci	4.71E-04	2.83E-04	5.19E-04	3.35E-06	1.28E-03
Particulates Half Life ≥ 8 days						
AG-110M	Ci	3.32E-07	5.62E-07	0.00E+00	0.00E+00	8.94E-07
CO-58	Ci	1.27E-06	1.06E-06	8.06E-06	8.96E-07	1.13E-05
CO-60	Ci	6.09E-06	3.88E-06	7.49E-06	2.31E-06	1.98E-05
Mn-54	Ci	1.34E-06	2.27E-06	5.77E-06	1.80E-07	9.56E-06
Ru-106	Ci	2.23E-06	3.78E-06	2.52E-06	0.00E+00	8.53E-06
Se-75	Ci	0.00E+00	0.00E+00	0.00E+00	1.93E-08	1.93E-08
Totals for Period...	Ci	1.13E-05	1.16E-05	2.38E-05	3.40E-06	5.01E-05
Other						
H-3	Ci	8.23E+00	4.12E+00	4.91E+00	1.46E+00	1.87E+01
C-14	Ci	2.46E+00	4.02E+00	2.41E+00	0.00E+00	8.88E+01
Gross Alpha	Ci	6.11E-09	3.05E-11	0.00E+00	0.00E+00	6.14E-09

NOTE: Only radionuclides with positive results were reported.

TABLE 1D
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
Radioactive Gaseous Waste Sampling and Analysis Program

JANUARY – DECEMBER 2016

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/ml) (a)
A. (1) Radwaste Building Ventilation Exhaust (2) Fuel Handling Area Ventilation Exhaust (3) Containment Ventilation Exhaust (4A) Turbine Building Ventilation Exhaust (4B) Turbine Building Occasional Release Point (g) (when in service)	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (b,e)	1.0E-04
			H-3	1.0E-06
	Continuous (d) (f)	7 Days (c) Charcoal Sample	I-131	1.0E-12
			I-133	1.0E-10
	Continuous (d) (f)	7 Days (c) Particulate Sample	Principal Gamma Emitters (e) (I-131, Others)	1.0E-11
	Continuous (d) (f)	31 Days Composite Particulate Sample	Gross Alpha	1.0E-11
	Continuous (d) (f)	92 Days Composite Particulate Sample	Sr-89, Sr-90	1.0E-11
	Continuous (f)	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1.0E-06
B. (1) Offgas Post Treatment Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1.0E-04
(2) Standby Gas Treatment A Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1.0E-04
(3) Standby Gas Treatment B Exhaust, whenever there is flow	31 Days Grab Sample (f)	31 Days	Principal Gamma Emitters (e)	1.0E-04

NOTE: Footnotes indicated are listed in GGNS ODCM, Appendix A, Table 6.11.4-1.

TABLE 2A
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
LIQUID EFFLUENTS – SUMMATION OF ALL RELEASES

REPORT FOR 2016	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Products						
1. Total Release	Ci	2.72E-02	6.91E-03	1.01E-02	6.35E-03	5.06E-02
2. Avg. Diluted Conc.	uCi/ml	6.41E-08	7.98E-08	4.15E-08	1.20E-07	6.26E-08
3. Percent of Limit	%	N/A	N/A	N/A	N/A	N/A
Tritium						
1. Total Release	Ci	3.25E+01	7.29E+00	1.53E+01	6.83E+00	6.19E+01
2. Avg. Diluted Conc.	uCi/ml	7.64E-05	8.42E-05	6.25E-05	1.29E-04	7.65E-05
3. Percent of Limit	%	N/A	N/A	N/A	N/A	N/A
Dissolved and Entrained Gases						
1. Total Release	Ci	6.17E-04	1.35E-05	0.00E+00	0.00E+00	6.30E-04
2. Avg. Diluted Conc.	uCi/ml	1.45E-09	1.56E-10	0.00E+00	0.00E+00	7.79E-10
3. Percent of Limit	%	N/A	N/A	N/A	N/A	N/A
Gross Alpha Radioactivity						
1. Total Release	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Volume of liquid waste	liters	4.50E+06	1.59E+06	3.71E+06	1.58E+06	1.14E+07
Volume of dil. water	liters	4.21E+08	8.50E+07	2.41E+08	5.13E+07	7.98E+08

NOTE: Limits are applicable to dose, not concentration. See Table III.A on page 14 for percentage of dose limits.

TABLE 2B
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
LIQUID EFFLUENTS – CONTINUOUS AND BATCH MODES

REPORT FOR 2016	Units	QTR 1	QTR 2	QTR 3	QTR 4	YEAR
Fission and Activation Gases						
AG-110M	Ci	2.21E-03	1.02E-04	4.47E-05	6.99E-05	2.43E-03
AS-76	Ci	0.00E+00	8.50E-05	1.13E-04	0.00E+00	1.98E-04
AU-199	Ci	3.97E-05	0.00E+00	0.00E+00	0.00E+00	3.97E-05
CE-141	Ci	1.37E-05	0.00E+00	0.00E+00	0.00E+00	1.37E-05
CO-58	Ci	7.61E-04	2.57E-05	1.26E-04	2.24E-05	9.35E-04
CO-60	Ci	4.30E-03	4.25E-04	1.07E-03	6.43E-04	6.44E-03
CR-51	Ci	4.45E-03	1.04E-04	0.00E+00	0.00E+00	4.55E-03
CS-134	Ci	1.11E-04	2.79E-05	8.47E-06	0.00E+00	1.47E-04
CS-137	Ci	5.74E-04	1.04E-04	2.23E-05	1.46E-05	7.15E-04
FE-55	Ci	9.20E-03	5.71E-03	8.24E-03	4.89E-03	2.80E-02
I-131	Ci	9.84E-04	0.00E+00	0.00E+00	0.00E+00	9.84E-04
LA-140	Ci	5.78E-05	0.00E+00	0.00E+00	0.00E+00	5.78E-05
MN-54	Ci	2.06E-03	8.72E-05	2.41E-04	4.03E-05	2.43E-03
NA-24	Ci	8.20E-06	1.62E-05	0.00E+00	0.00E+00	2.44E-05
NB-95	Ci	3.76E-05	0.00E+00	0.00E+00	0.00E+00	3.76E-05
PT-195M	Ci	3.19E-05	2.37E-05	1.87E-05	4.34E-05	1.18E-04
RU-106	Ci	2.11E-04	0.00E+00	0.00E+00	0.00E+00	2.11E-04
SB-124	Ci	1.37E-04	7.86E-06	0.00E+00	6.75E-06	1.51E-04
SB-125	Ci	1.23E-04	5.91E-05	0.00E+00	2.52E-04	4.34E-04
SE-75	Ci	0.00E+00	5.61E-06	0.00E+00	0.00E+00	5.61E-06
SR-92	Ci	1.08E-04	0.00E+00	5.51E-06	1.08E-06	1.15E-04
Y-88	Ci	0.00E+00	1.69E-05	0.00E+00	0.00E+00	1.69E-05
ZN-65	Ci	1.32E-03	1.08E-04	2.43E-04	3.69E-04	2.04E-03
ZR-95	Ci	1.20E-05	0.00E+00	0.00E+00	0.00E+00	1.20E-05
ZR-97	Ci	3.60E-05	0.00E+00	0.00E+00	0.00E+00	3.60 -05
Totals for Period...	Ci	2.72E-02	6.91E-03	1.01E-02	6.35E-03	5.06E-02
Tritium						
H-3	Ci	3.25E+01	7.29E+00	1.53E+01	6.83E+00	6.19E+01
Totals for Period...	Ci	3.25E+01	7.29E+00	1.53E+01	6.83E+00	6.19E+01
Dissolved and Entrained Gases						
XE-133	Ci	6.17E-04	3.87E-06	0.00E+00	0.00E+00	6.21E-04
XE-135	Ci	0.00E+00	9.65E-06	0.00E+00	0.00E+00	9.65E-06
Totals for Period...	Ci	6.17E-04	1.35E-05	0.00E+00	0.00e+00	6.30E-04
Gross Alpha Radioactivity						
ALPHA	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Totals for Period...	Ci	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 2C
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

JANUARY – DECEMBER 2016

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (µCi/ml) (a)
A. Batch Waste Release Tanks (c)	Prior to Release Each Batch	Prior to Release Each Batch	Principal Gamma Emitters (d)	5.0E-07
			I-131	1.0E-06
	Prior to Release One Batch/Month	31 Days	Dissolved and Entrained Gases (Gamma Emitters)	1.0E-05
	Prior to Release Each Batch	31 Days Composite (b)	H-3	1.0E-05
			Gross Alpha	1.0E-07
	Prior to Release Each Batch	92 Days Composite (b)	Sr-89, Sr-90	5.0E-08
			Fe-55	1.0E-06
B. SSW Basin (Before Blowdown)	Prior to Release Each Blowdown	Prior to Release Each Batch	Principal Gamma Emitters (d)	5.0E-07
			I-131	1.0E-06

NOTE: Footnotes indicated are listed in GGNS ODCM, Appendix A Table 6.11.1-1.

TABLE 3
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

JANUARY – DECEMBER 2016

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

1. **Type of Waste**	**Unit**	**Class A**	**Class B**	**Class C**	**Estimated Total Error**
a. Spent resins, filter sludges, evaporator bottoms, etc.	m^3 Ci	1.22E+02 2.22E+02	2.86E+00 4.79E+02	0.00E+00 0.00E+00	± 25%
b. Dry compressible waste, contaminated equipment, etc.	m^3 Ci	1.33E+03 2.02E-00	0.00E+00 0.00E+00	0.00E+00 0.00E+00	± 25%
c. Irradiated components, control rods, etc.	m^3 Ci	0.00E+00 0.00E+00	0.00E+00 0.00E+00	0.00E+00 0.00E+00	± 25%
d. Other: Oily waste drums	m^3 Ci	3.14E+01 1.09E-02	0.00E+00 0.00E+00	0.00E+00 0.00E+00	± 25%

2. Estimate of Major Nuclide Composition (by type of waste)

a. Spent resins, filter sludges, evaporator bottoms, etc.

Isotope (greater than 0.1%)	**Percent**	**Curies**
Cr-51	2.03	1.42E+01
Mn-54	6.90	4.83E+01
Fe-55	67.45	4.72E+02
Fe-59	0.58	4.08E+00
Co-58	2.39	1.67E+01
Co-60	15.01	1.05E+02
Ni-63	0.31	2.19E+00
Zn-65	4.37	3.05E+01
Nb-95	0.12	8.36E-01
Ag-110m	0.31	2.13E+00
Cs-137	0.13	8.89E-01

TABLE 3 - Continued
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

JANUARY – DECEMBER 2016

b. Dry compressible waste, contaminated equipment, etc.

Isotope (greater than 0.1%)	Percent	Curies
H-3	2.34	4.74E-02
Mn-54	7.64	1.55E-01
Fe-55	43.19	8.76E-01
Fe-59	0.11	2.16E-03
Co-60	39.36	7.98E-01
Ni-63	0.67	1.35E-02
Zn-65	2.72	5.52E-02
Zr-95	0.70	1.42E-02
Nb-95	1.25	2.53E-02
Tc-99	0.30	6.00E-03
Ag-110m	0.20	2.96E-03
Cs-137	0.70	1.41E-02
Ce-144	0.62	1.26E-02

c. Irradiated components, control rods, etc.

None

d. Other: Oil Drum Sealand

Isotope (greater than 0.1%)	Percent	Curies
H-3	2.72	2.98E-04
Mn-54	5.30	5.80E-04
Fe-55	47.34	5.19E-03
Co-60	40.08	4.39E-03
Ni-63	0.73	7.96E-05
Zn-65	2.29	2.50E-04
Tc-99	0.29	3.12E-05
Cs-137	0.64	7.04E-05
Ce-144	0.50	5.48E-05

TABLE 3 - Continued
ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION UNIT 1

RADIOACTIVE EFFLUENT AND WASTE DISPOSAL ANNUAL REPORT
SOLID RADIOACTIVE WASTE AND IRRADIATED FUEL SHIPMENTS

JANUARY – DECEMBER 2016

3. Solid Waste Disposition

Number of Shipments	Destination Name	City	State	Mode of Transportation
30	Energy*Solutions* (Bear Creek), LLC	Oak Ridge	TN	Hittman
5	Energy*Solutions* Gallaher Road Facility	Oak Ridge	TN	Hittman
1	Erwin Resin Solution, LLC	Erwin	TN	Hittman
1	EnergySolutions LLC Containerized Waste Facility	Clive	UT	Hittman
4	EnergySolutions, LLC Bulk Waste Facility	Clive	UT	Hittman
1	ALARON Corporation	Wampum	PA	Hittman
1	Unitech/Babcock Services, Inc.	Oak Ridge	TN	Hittman

NRC Class	Disposal Volume (ft^3)	Description	Number of Containers	Waste Type Description
B	120.3	8/120 HIC	1	Poly HIC – RWCU-A
A	205.8	215 liner	15	Poly Liner – SRT
A	90.0	B-25	20	Metal/DAW
A	1180.0	20' SEALAND	46	DAW/GIC/Oil
A	680.0	20' Intermodal	1	GIC
A	199.4	ES-210 (solidification)	9	Stainless Steel Liner - CPS/RWCU-B
A	75.7	Small PAC Tec Bag	2	High Rad DAW

B. Irradiated Fuel Shipments (Disposition)

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

ATTACHMENT I

Nuclear Energy Institute, NEI, Groundwater Protection Initiative Sample Results

JANUARY – DECEMBER 2016

GPI Ground Water samples were collected from onsite Dewatering Wells (DW), Monitoring Wells (MW), Observation Wells (OW), and Sump Wells (SW). Samples were analyzed for Tritium and selected samples were analyzed for gamma and/or hard to detect (HTD) isotopes (Gross Alpha, Iron-55, Nickel-63, 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 MDA are bounded by wells which are less than minimum detectable activity (<MDA). Tritium, gamma and/or HTD results are shown in the table below.

All results were less than Reporting Levels of GGNS-ODCM table 6.12.1-2.

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
DW-01	02/17/16	3020	<MDA
DW-01	05/26/16	4820	<MDA
DW-01	09/08/16	3680	<MDA
DW-01	12/07/16	2750	<MDA
DW-02	01/21/16	<563	<MDA
DW-02	02/18/16	<545	<MDA
DW-02 DUPLICATE	02/18/16	<556	<MDA
DW-02	03/14/16	<498	<MDA
DW-02	04/18/16	<465	<MDA
DW-02	05/24/16	572	<MDA
DW-02	06/15/16	1520	<MDA
DW-02	07/19/16	1630	<MDA
DW-02	08/09/16	817	<MDA
DW-02	09/07/16	1800	<MDA
DW-02 DUPLICATE	09/07/16	1790	<MDA
DW-02	10/18/16	730	<MDA
DW-02	11/09/16	608	<MDA
DW-02	12/07/16	549	<MDA
DW-03	01/21/16	870	<MDA
DW-03	02/18/16	612	<MDA
DW-03	03/14/16	960	<MDA
DW-03 DUPLICATE	03/14/16	631	<MDA
DW-03	04/18/16	597	<MDA
DW-03	05/24/16	<521	<MDA
DW-03	06/15/16	920	<MDA
DW-03	07/19/16	1020	<MDA
DW-03 DUPLICATE	07/19/16	580	<MDA

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
DW-03	08/09/16	<484	<MDA
DW-03 DUPLICATE	08/09/16	565	<MDA
DW-03	09/07/16	<585	<MDA
DW-03	10/18/16	<529	<MDA
DW-03 DUPLICATE	10/18/16	748	<MDA
DW-03	11/09/16	<572	<MDA
DW-03 DUPLICATE	11/09/16	<552	<MDA
DW-03	12/07/16	<498	<MDA
DW-04	01/20/16	621	<MDA
DW-04 DUPLICATE	01/20/16	702	<MDA
DW-04	02/18/16	<543	<MDA
DW-04	03/14/16	<425	<MDA
DW-04	04/19/16	544	<MDA
DW-04	05/24/16	<501	<MDA
DW-04	06/15/16	697	<MDA
DW-04	07/19/16	1280	<MDA
DW-04	08/09/16	<489	<MDA
DW-04	09/07/16	745	<MDA
DW-04	10/18/16	722	<MDA
DW-04	11/11/16	615	<MDA
DW-04	12/07/16	555	<MDA
DW-05	01/20/16	<563	<MDA
DW-05	02/18/16	<548	<MDA
DW-05	03/15/16	<493	<MDA
DW-05	04/19/16	<462	<MDA
DW-05	05/25/16	<510	<MDA
DW-05	06/15/16	<482	<MDA
DW-05	07/19/16	<509	<MDA
DW-05	08/09/16	<485	<MDA
DW-05	09/07/16	<589	<MDA
DW-05	10/18/16	<524	<MDA
DW-05	11/10/16	<566	<MDA
DW-05	12/08/16	<502	<MDA
DW-07	02/16/16	4230	<MDA
DW-07	05/26/16	3270	<MDA
DW-07	09/06/16	3530	<MDA
DW-07 DUPLICATE	09/06/16	3320	<MDA
DW-07	12/06/16	3220	<MDA
DW-07 DUPLICATE	12/06/16	3050	<MDA

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
MW-01	01/21/16	<561	<MDA
MW-01	02/18/16	<552	<MDA
MW-01	03/14/16	<497	<MDA
MW-01	04/18/16	<447	<MDA
MW-01	05/24/16	<514	<MDA
MW-01	06/15/16	777	<MDA
MW-01	07/19/16	941	<MDA
MW-01	08/09/16	648	<MDA
MW-01	09/07/16	1080	<MDA
MW-01	10/18/16	644	<MDA
MW-01	11/09/16	791	<MDA
MW-01	12/07/16	<501	<MDA
MW-04	01/20/16	<560	<MDA
MW-04	02/18/16	<548	<MDA
MW-04	03/15/16	<493	<MDA
MW-04	04/19/16	<463	<MDA
MW-04	05/25/16	<510	<MDA
MW-04	06/15/16	<484	<MDA
MW-04	07/19/16	<520	<MDA
MW-04	08/09/16	<494	<MDA
MW-04	09/07/16	<585	<MDA
MW-04	10/19/16	<528	<MDA
MW-04	11/11/16	<570	<MDA
MW-04	12/08/16	<501	<MDA
MW-05	01/20/16	<500	<MDA
MW-05	02/17/16	765	<MDA
MW-05 RECOUNT	02/17/16	1370	-
MW-05 REANALYSIS	02/17/16	999	-
MW-05	03/15/16	691	<MDA
MW-05	04/19/16	<457	<MDA
MW-05	05/25/16	<522	<MDA
MW-05	06/16/16	721	<MDA
MW-05	07/20/16	569	<MDA
MW-05	08/10/16	<483	<MDA
MW-05	09/07/16	<561	<MDA
MW-05	10/19/16	<530	<MDA
MW-05	11/11/16	<585	<MDA
MW-05	12/08/16	<500	<MDA
MW-06	02/17/16	1180	<MDA
MW-06	05/26/16	1770	<MDA
MW-06	09/08/16	1890	<MDA

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
MW-06	12/09/16	1330	<MDA
MW-100B	09/07/16	<577	<MDA
MW-101B	02/17/16	<584	<MDA
MW-101B	05/25/16	<509	<MDA
MW-101B	09/07/16	<567	<MDA
MW-101B	12/07/16	<497	<MDA
MW-102B	09/07/16	<571	<MDA
MW-103B	09/08/16	<572	<MDA
MW-104B	09/08/16	<574	<MDA
MW-105B	02/17/16	<576	<MDA
MW-105B	05/25/16	<529	<MDA
MW-105B	09/07/16	<540	<MDA
MW-105B	12/07/16	<501	<MDA
MW-106B	02/17/16	<576	<MDA
MW-106B	05/25/16	<516	<MDA
MW-106B	09/07/16	<563	<MDA
MW-106B	12/06/16	<504	<MDA
MW-107B	02/16/16	1920	<MDA
MW-107B	05/25/16	1210	<MDA
MW-107B	09/06/16	1670	<MDA
MW-107B	12/06/16	1560	<MDA
MW-108B	02/17/16	1500	<MDA
MW-108B	05/26/16	1220	<MDA
MW-108B	09/07/16	1360	<MDA
MW-108B	12/08/16	971	<MDA
MW-109B	02/17/16	712	<MDA
MW-109B RECOUNT	02/17/16	970	-
MW-109B REANALYSIS	02/17/16	1220	-
MW-109B	05/26/16	<514	<MDA
MW-109B	09/07/16	818	<MDA
MW-109B	12/08/16	1080	<MDA
MW-110B	02/16/16	<583	<MDA
MW-110B	05/24/16	<512	<MDA

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
MW-110B	09/07/16	<578	<MDA
MW-110B	12/06/16	<502	<MDA
MW-111B	02/17/16	1690	<MDA
MW-111B	05/25/16	3200	<MDA
MW-111B DUPLICATE	05/25/16	3180	<MDA
MW-111B	09/08/16	<579	<MDA
MW-111B	12/07/16	962	<MDA
MW-112B	01/21/16	<563	<MDA
MW-112B	02/18/16	<550	<MDA
MW-112B DUPLICATE	02/18/16	<547	<MDA
MW-112B	03/14/16	<497	<MDA
MW-112B	04/18/16	<446	<MDA
MW-112B	05/25/16	<504	<MDA
MW-112B	06/15/16	<487	<MDA
MW-112B	07/19/16	<425	<MDA
MW-112B	08/09/16	<487	<MDA
MW-112B	09/07/16	<545	<MDA
MW-112B	10/18/16	<532	<MDA
MW-112B	11/09/16	<571	<MDA
MW-112B	12/07/16	<509	<MDA
MW-113B	01/21/16	<569	<MDA
MW-113B	02/17/16	<573	<MDA
MW-113B DUPLICATE	02/17/16	<579	<MDA
MW-113B	03/15/16	<495	<MDA
MW-113B	04/18/16	<459	<MDA
MW-113B DUPLICATE	04/18/16	<451	<MDA
MW-113B	05/24/16	<514	<MDA
MW-113B DUPLICATE	05/24/16	<515	<MDA
MW-113B	06/20/16	<500	<MDA
MW-113B	07/20/16	<511	<MDA
MW-113B	08/10/16	<480	<MDA
MW-113B	09/08/16	<577	<MDA
MW-113B DUPLICATE	09/08/16	<581	<MDA
MW-113B	10/19/16	<530	<MDA
MW-113B	11/11/16	<566	<MDA
MW-113B	12/06/16	<499	<MDA
MW-113B DUPLICATE	12/06/16	<490	<MDA
MW-114B	02/17/16	2960	<MDA
MW-114B	05/24/16	2160	<MDA
MW-114B	09/08/16	1850	<MDA

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
MW-114B	12/06/16	2530	<MDA
MW-115B	02/17/16	685	<MDA
MW-115B	05/24/16	2040	<MDA
MW-115B	09/08/16	675	<MDA
MW-115B	12/07/16	<508	<MDA
MW-116B	02/17/16	<578	<MDA
MW-116B	05/24/16	<517	<MDA
MW-116B	09/08/16	<580	<MDA
MW-116B	12/06/16	<509	<MDA
MW-116B DUPLICATE	12/06/16	<490	<MDA
MW-118B	02/17/16	<580	<MDA
MW-118B	05/25/16	772	<MDA
MW-118B DUPLICATE	05/25/16	584	<MDA
MW-118B	09/08/16	711	<MDA
MW-118B	12/06/16	<498	<MDA
MW-119B	09/07/16	<588	<MDA
MW-119B DUPLICATE	09/07/16	<578	<MDA
MW-120B	09/08/16	<565	<MDA
MW-121B	09/08/16	<577	<MDA
MW-122B	01/20/16	<558	<MDA
MW-122B	02/18/16	<555	<MDA
MW-122B	03/15/16	<495	<MDA
MW-122B	04/19/16	<463	<MDA
MW-122B	05/25/16	<507	<MDA
MW-122B	06/16/16	<505	<MDA
MW-122B	07/20/16	<509	<MDA
MW-122B	08/10/16	<482	<MDA
MW-122B	09/07/16	<582	<MDA
MW-122B	10/19/16	<530	<MDA
MW-122B	11/11/16	<579	<MDA
MW-122B	12/08/16	<502	<MDA
MW-123B	01/21/16	<563	<MDA
MW-123B	02/18/16	<540	<MDA
MW-123B	03/15/16	<486	<MDA
MW-123B	04/19/16	<449	<MDA
MW-123B	05/25/16	<522	<MDA

LOCATION	DATE	TRITIUM (pCi/L)	GAMMA (pCi/L)
MW-123B	06/16/16	<510	<MDA
MW-123B DUPLICATE	06/16/16	<499	<MDA
MW-123B	07/20/16	<425	<MDA
MW-123B	08/09/16	<482	<MDA
MW-123B	09/07/16	<582	<MDA
MW-123B	10/19/16	<525	<MDA
MW-123B	11/10/16	<570	<MDA
MW-123B	12/07/16	<498	<MDA
MW-1007C	09/07/16	<570	<MDA
MW-1009C	09/07/16	<568	<MDA
MW-1012C	09/08/16	<576	<MDA
MW-1020C	09/07/16	<565	<MDA
MW-1020C DUPLICATE	09/07/16	<568	<MDA
MW-1024C	09/07/16	<573	<MDA
MW-1027C	09/08/16	<582	<MDA
MW-1042C	09/08/16	<579	<MDA
MW-1082C	09/08/16	<568	<MDA
MW-1134C	09/09/16	<564	<MDA
SW-102	05/24/16	<520	<MDA
SW-103A	02/18/16	<569	<MDA
SW-103A	05/24/16	<519	<MDA
SW-103A	09/08/16	<567	<MDA
SW-103A	12/06/16	<502	<MDA

<MDA - Less than Minimum Detectable Activity

DUPLICATE - Duplicate sample collected and analyzed

RECOUNT - Re-performed same sample count

REANALYSIS - Re-performed same sample analysis and counting