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T.S. 5.6.2

GNRO-2018/00022

April 28, 2018

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

SUBJECT: Grand Gulf Nuclear Station Annual Radiological Environmental Report (AREOR)
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

Dear Sir or Madam:

In accordance with the Grand Gulf Nuclear Station Unit 1 Technical Specification 5.6.2, attached is the Annual Radiological Environmental Operating Report (AREOR) for the time period of January 1, 2017 through December 31, 2017.

This letter contains no new commitments. If you have any questions or require additional information, please contact George Wynn at 601-437-1426.

Sincerely,

Douglas A. Neve
Regulatory Assurance Manager
Grand Gulf Nuclear Station
DAN/jw

Attachment: Grand Gulf Nuclear Station 2017 Annual Radiological Environmental Operating Report (AREOR)

cc: see next page

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Attachment to GNRO-2018/00022

Grand Gulf Nuclear Station 2017 Annual Radioactive Environmental Operating Report (AREOR)

ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION

ANNUAL
RADIOLOGICAL ENVIRONMENTAL
OPERATING REPORT

January 1, 2017 - December 31, 2017

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Prepared By

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Reviewed By

| 04/23/18

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Summary

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Grand Gulf Nuclear Station's (GGNS) Radiological Environmental Monitoring Program (REMP) for the period January 1, 2017, through December 31, 2017. This report fulfills the requirements of GGNS Technical Specification 5.6.2.

To supplement the REMP, GGNS personnel installed duplicate TLDs and collected duplicate samples during the reporting period.

Radiological Environmental Monitoring Program

GGNS established the REMP in 1978 prior to the station becoming operational (1985) to provide data on background radiation and radioactivity normally present in the area. GGNS has continued to monitor the environment by sampling air, water, sediment, fish and food products, as well as measuring radiation directly. GGNS also samples milk, if commercial milk production occurs within five miles of the plant.

The REMP includes sampling indicator and control locations within an 18-mile radius of the plant. The REMP utilizes indicator locations near the site to show any increases or buildup of radioactivity that might occur due to station operation and control locations farther away from the site to indicate naturally occurring background radioactivity. GGNS personnel compare indicator results with control and preoperational results to assess any impact GGNS operation might have on the surrounding environment.

In 2017, GGNS personnel collected environmental samples for radiological analysis. The monitoring results for indicator locations when compared to control locations and previous studies show that GGNS has no significant effect on the local environment. The review of 2017 monitoring data, in many cases, showed undetectable radiation levels in the environment and near background levels in potential exposure pathways associated with GGNS.

Harmful Effects or Irreversible Damage

The REMP monitoring did not detect any harmful effects or evidence of irreversible damage in the current year.

Reporting Levels

When averaged over any calendar quarter, no environmental samples equaled or exceeded reporting levels for radioactivity as outlined in Offsite Dose Calculation Manual (ODCM) Specifications Table 6.12.1-2; the analytical results did not trigger any Radiological Monitoring Program Special Reports.

Radioactivity Not Attributable to GGNS

Over previous years, the GGNS REMP detected radioactivity attributable to other sources. These sources included the Chinese nuclear test in 1980 and the accident at the Chernobyl Nuclear Power Plant in 1986. In 2011, the GGNS REMP detected radioactivity released from the Fukushima Dai-ichi Nuclear Power Plant following the March 11, 2011, Tohoku earthquake. In 2017, the GGNS REMP detected no radioactivity attributable to other sources.

Comparison to Federal and State Programs

GGNS personnel compare REMP data to federal and state monitoring programs. Historically, the programs used for comparison included the U.S. Nuclear Regulatory Commission (NRC) Thermoluminescent Dosimeter (TLD) Direct Radiation Monitoring Network and the Mississippi State Department of Health (MSDH), Division of Radiological Health monitoring program.

Although the NRC TLD Network Program was discontinued in 1998, these results compared favorably to those from the GGNS REMP.

The MSDH and the GGNS REMP have similar monitoring requirements. These programs include co-located air sampling and sharing sample media such as water, sediment, fish and food products. Both programs have obtained similar results. The 2017 results of the MSDH monitoring program compared favorably with the GGNS REMP results.

Sample Deviations

- **Milk**

  The GGNS ODCM requires collection of milk samples if there is a commercially available source within 5 miles (8 km) of the plant. In 2017, the REMP did not include milk sampling because no commercial milk production occurred within 5 miles of GGNS. GGNS personnel instead collected vegetation samples to monitor the ingestion pathway, as specified in ODCM Specifications Table 6.12.1-1.

- **Required Lower Limit of Detection (LLD) Values**

  Analytical lower limit of detection (LLD) values required by the ODCM specifications achieved in 2017 were within the limits for all samples.

- **Thermoluminescent Dosimeters**

  TLD M-95 (Sector F, Radius 0.5 Miles), in the northeast property spoils area, was unavailable during 4th quarter, 2017, due to the TLD missing from its location during sample collection.

  TLD M-48 (Sector K, Radius 4.8 Miles), on Mont Gomer Road, was retrieved from the ground at the sample location during 4th quarter, 2017.

- **Air Samples**

  The following air sample locations had reduced run times due to weather-related power outages or mechanical problems. As described in ODCM Specification Table 6.12.1-1, footnote (a), deviations from the required sampling schedule are permitted due to malfunction of sampling equipment and other legitimate reasons.

Table 1.1 Air Sampling Deviations in 2017

Sample Location	Date In	Date Out	Run Time (Hours)	Out-of-Service (Hours)	Comments
AS-7 UH	12/27/16	01/03/17	162.0	5.6	Power Outage
AS-7 UH	01/17/17	01/24/17	160.6	2.3	Power Outage
AS-1 PG	02/07/17	02/14/17	0.0	169.1	Equipment Failure
AS-20 GR	02/28/17	03/07/17	171.1	1.0	Equipment Failure
AS-20 GR	03/07/17	03/14/17	115.4	47.3	Equipment Failure
AS-7 UH	03/28/17	04/04/17	166.2	1.9	Power Outage
AS-1 PG	05/16/17	05/23/17	163.4	4.9	Power Outage
AS-7 UH	05/23/17	05/30/17	142.3	25.5	Power Outage
AS-7 UH	05/30/17	06/06/17	167.3	0.5	Power Outage
AS-7 UH	06/20/17	06/27/17	168.4	1.0	Power Outage
AS-7 UH	08/29/17	09/05/17	164.0	2.8	Power Outage
AS-7 UH	09/19/17	09/26/17	167.7	0.2	Power Outage
AS-7 UH	10/17/17	10/24/17	165.8	4.2	Power Outage
AS-7 UH	10/24/17	10/31/17	140.4	25.5	Power Outage
AS-1 PG	10/24/17	10/31/17	141.9	23.9	Power Outage

Based on the sample collection period reductions, air samples were collected the following percentages of the available time:

AS-1 PG	99.0%
AS-3 61VA	100.0%
AS-7 UH	99.1%
AS-20 GR	99.4%

- **Missed Samples**

  Air sample AS-1 PG was unavailable from 02/07/18 to 02/14/18 due to equipment failure. Remaining air sample locations, including one in the adjacent sector, were reviewed and found consistent with the previous sampling period data, near background.

  TLD M-95 was unavailable for 4th quarter 2017 due to damage from wildlife. Similarly located TLDs were reviewed and found consistent with previous sampling period data, near background.

- **Unavailable Results**

  GGNS received analytical results in adequate time for inclusion in this report.

Program Modifications

No REMP modifications took place during this sampling period.

Attachments

Attachment 1 contains results of TLD, air, water, sediment, fish, food products and special samples collected in the reporting period. TLDs were analyzed by Stanford Dosimetry of Sterling, MA. Other samples were analyzed by Teledyne Brown Engineering of Knoxville, TN. Tables A 9.1 and A 9.2 includes results from Stanford Dosimetry's and Teledyne Brown Engineering's participation in interlaboratory comparison programs.

1.0 Introduction

1.1 Radiological Environmental Monitoring Program

GGNS established the REMP to ensure that plant operating controls properly function to minimize any radiation that could endanger human health or the environment. The REMP is designed to:

- Analyze important pathways for anticipated types and quantities of radionuclides released into the environment,
- Consider the possibility of a buildup of long-lived radionuclides in the environment and identify any physical and biological accumulations that may contribute to human exposures,
- Consider the potential radiation exposure to plant and animal life in the environment surrounding GGNS,
- Correlate levels of radiation and radioactivity in the environment with radioactive releases from the operation of GGNS.

1.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways, as seen in Figure 1-1 are monitored as required by the GGNS ODCM Table 6.12.1-1. A description of the GGNS REMP utilized to monitor the exposure pathways is provided in Table 1.2 and shown in Figures 1-2 and 1-3. GGNS may supplement this program with additional sampling in order to provide a comprehensive and well-balanced program.

Section 2.0 of this report provides a discussion of sampling results, with Section 3.0 providing a summary of results for the monitored exposure pathways.

1.3 Land Use Census

GGNS personnel conduct a biennial land use census, as required by ODCM Specification 6.12.2. The most recent land use census data are included in Table 2.1. The purpose of this census is to identify land use changes within each of the 16 meteorological sectors and within a 5-mile radius of GGNS that would require modifications to the REMP or the ODCM. The census identifies the nearest:

1) Occupied and unoccupied residences
2) Garden of greater than 50 square meters (m^2) [500 square feet (ft^2)] producing broadleaf vegetation
3) Animal milked for human consumption

GGNS personnel conduct the land use census by:

- Conducting field surveys in each meteorological sector out to five miles in order to confirm:

- Nearest occupied residence
- Nearest unoccupied residence
- Nearest garden and approximate size
- Nearest milking animal

- Identifying locations on maps and aerial photographs, measuring distances to GGNS and recording results on surveillance data sheets
- Comparing current land use census results to previous results from the 2014 census
- Contacting the Claiborne County Agent for verification of nearest dairy animals

No significant changes between the biennial land use census performed in 2014 and the most recent census performed in 2016 were identified that would require modifications to the REMP or the ODCM.

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Airborne	**Radioiodine and Particulates** 1 sample close to the SITE BOUNDARY having the highest calculated annual average ground level D/Q.	**AS-7 UH (Sector H, Radius 0.5 Miles)** – South-southeast of GGNS at the IBEW Union Hall.	Continuous sampler operation with sample collection per 7 days or as required by dust loading, whichever is more frequent	Radioiodine Canister – I-131; 7 days Particulate Sampler – Gross beta radioactivity following filter change, composite (by location) for gamma isotopic; 92 days
	Radioiodine and Particulates 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.	**AS-1 PG (Sector G, Radius 5.5 Miles)** – Southeast of GGNS at the Port Gibson City Barn.		
	Radioiodine and Particulates 1 sample from a control location 15 -30 km (10 - 20 miles) distance.	**AS-3 61VA (Sector B, Radius 18 Miles)** – North-northeast of GGNS on Hwy 61, North of the Vicksburg Airport.		
	Radioiodine and Particulates 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.	**AS-20 GR (Sector L, Radius 0.9 Miles)** – Southwest of GGNS on Bald Hill Road, at the Former Glodjo Residence.		
Direct Radiation	**TLDs** An inner ring of stations in the general areas of the SITE BOUNDARY.	**M-16 (Sector A, Radius 0.9 Miles)** – Meteorological Tower. **M-19 (Sector E, Radius 0.5 Miles)** – Eastern SITE BOUNDARY Property line, North-northeast of HWSA.	92 days	Gamma dose; 92 days

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations in the general areas of the SITE BOUNDARY.	**M-21 (Sector J, Radius 0.4 Miles)** – Near Former Training Center Building on Bald Hill Road. **M-22 (Sector G, Radius 0.5 Miles)** – Former RR Entrance Crossing On Bald Hill Road. **M-23 (Sector Q, Radius 0.5 Miles)** – Gin Lake Road 50 Yards North of Heavy Haul Road on Power Pole. **M-25 (Sector N, Radius 1.6 Miles)** – Radial Well Number 1. **M-28 (Sector L, Radius 0.9 Miles)** – Bald Hill Road. **M-94 (Sector R, Radius 0.8 Miles)** – Sector R Near Meteorological Tower.	92 days	Gamma dose; 92 days

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An inner ring of stations in the general areas of the SITE BOUNDARY.	**M-95 (Sector F, Radius 0.5 mi)** – Spoils Area, fence of old storage area, near entrance gate **M-96 (Sector B, Radius 0.7 mi.)** – North Gate Fence **M-97 (Sector D, Radius 0.8 mi.)** – Grand Gulf Road entrance gate to spoils area **M-98 (Sector H, Radius 0.5 mi.)** – Bald Hill Road, across from Union Hall, in curve **M-99 (Sector K, Radius 0.4 mi.)** – North Fence of old Ball Field near utility pole **M-100 (Sector C, Radius 0.6 mi.)** – Grand Gulf Road	92 days	Gamma dose; 92 days
	TLDs An outer ring approximately 3 to 5 miles from the site.	**M-36 (Sector P, Radius 5.0 Miles)** – Curve on HW 608, Point Nearest GGNS at Power Pole. **M-40 (Sector M, Radius 2.3 Miles)** – Headly Drive, Near River Port Entrance.		

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** An outer ring approximately 3 to 5 miles from the site.	**M-48 (Sector K, Radius 4.8 Miles)** – 0.4 Miles South on Mont Gomer Road on West Side. **M-49 (Sector H, Radius 4.5 Miles)** – Fork in Bessie Weathers Road/Shaifer Road. **M-50 (Sector B, Radius 5.3 Miles)** – Panola Hunting Club Entrance. **M-55 (Sector D, Radius 5.0 Miles)** – Near Ingelside Karnac Ferry Road/Ashland Road Intersection. **M-57 (Sector F, Radius 4.5 Miles)** – Hwy 61, Behind the Welcome to Port Gibson Sign at Glensdale Subdivision.	92 days	Gamma dose; 92 days
	TLDs 8 stations in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations.	**M-01 (Sector E, Radius 3.5 Miles)** – Across the road from Lake Claiborne Entry Gate. (Special Interest) **M-07 (Sector G, Radius 5.5 Miles)** – AS-1 PG, Port Gibson City Barn. (Special Interest) **M-09 (Sector D, Radius 3.5 Miles)** – Warner Tully Y-Camp. (Special Interest) **M-10 (Sector A, Radius 1.5 Miles)** – Grand Gulf Military Park. (Special Interest)		

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	**TLDs** 8 stations in special interest areas such as population centers, nearby residences, schools, and in 1 or 2 areas to serve as control stations	**M-14 (Sector B, Radius 18.0 Miles)** – AS-3-61VA, Hwy 61, North of Vicksburg Airport. (Control) **M-33 (Sector P, Radius 12.5 Miles)** – Newellton, Louisiana Water Tower. (Special Interest) **M-38 (Sector M, Radius 9.5 Miles)** – Lake Bruin State Park, Entrance Road. (Special Interest) **M-39 (Sector M, Radius 13.0 Miles)** – St. Joseph, Louisiana, Auxiliary Water Tank. (Special Interest)	92 days	Gamma dose; 92 days

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Waterborne	**Surface Water** 1 sample upstream. 1 sample downstream.	**MRUP (Sector R, Radius 1.8 Miles) -** At least 4500 ft upstream of the GGNS discharge point into the Mississippi River to allow adequate mixing of the Mississippi and Big Black Rivers. **MRDOWN (Sector N, Radius 1.6 Miles) -** At least 5000 ft downstream of the GGNS discharge point in the Mississippi River near Radial Well No. 1.	92 days	Gamma isotopic and tritium analyses; 92 days
	1 sample downstream during a Liquid Radwaste Discharge. 1 sample from Outfall 007	**MRDOWN (Sector P, Radius 1.3 Miles)** – Downstream of the GGNS discharge point in the Mississippi River near Radial Well No. 5.	366 days	Gamma isotopic and tritium analyses; 366 days
		OUTFALL 007 (Sector N, Radius 0.2 Miles) – Storm Drain System	31 days	Tritium; 31 days

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Waterborne	**Groundwater** Samples from 2 sources.	**PGWELL (Sector G, Radius 5.0 Miles)** - Port Gibson Wells – Taken from distribution system or one of the five wells. **CONSTWELL (Sector Q, Radius 0.4 Miles)** – GGNS Construction Water Well – Taken from distribution system or the well.	366 days	Gamma isotopic and tritium analyses; 366 days
	Sediment From Shoreline 1 sample from downstream area. 1 sample from upstream area.	**SEDHAM (Sector N, Radius 1.6 Miles)** – Downstream of the GGNS discharge point in the Mississippi River near Hamilton Lake outlet. **SEDCONT (Minimum of 100 yds)** – Upstream of the GGNS discharge point in the Mississippi River.	366 days	Gamma isotopic; 366 days
Ingestion	**Milk** 1 sample from milking animals within 8 km (5 miles) if milk is available commercially. 1 control sample (only if indicator exists) >8 km if milk is available.	Currently, no available milking animals within 8 km of GGNS. **ALCONT (Sector K, Radius 10.5 Miles)** - Located South-southwest of GGNS at Alcorn State University.	92 days when required	Gamma isotopic and I-131; 92 days

Table 1.2
Radiological Environmental Sampling Program

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Ingestion	**Fish** 1 sample in vicinity of GGNS discharge point. 1 sample uninfluenced by GGNS discharge.	**FISHDOWN** – Downstream of the GGNS discharge point into the Mississippi River **FISHUP** – Upstream of the GGNS discharge point into the Mississippi River uninfluenced by plant operations.	366 days	Gamma isotopic on edible portion; 366 days
	Food Products 1 sample of broadleaf vegetation grown in one of two different offsite locations with highest anticipated annual average ground level D/Q if milk sampling is not performed. 1 sample of similar vegetation grown 15 – 30 km distant if milk sampling is not performed.	**VEG-J (Sector J, Radius 0.4 Miles)** – South of GGNS near former Training Center on Bald Hill Road. **VEG-CONT (Sector K, Radius 10.5 Miles)** – Alcorn State University south-southwest of GGNS when available, otherwise a location 15-30 km distant.	92 days when available	Gamma isotopic and I-131; 92 days

Figure 1-1

Exposure Pathways

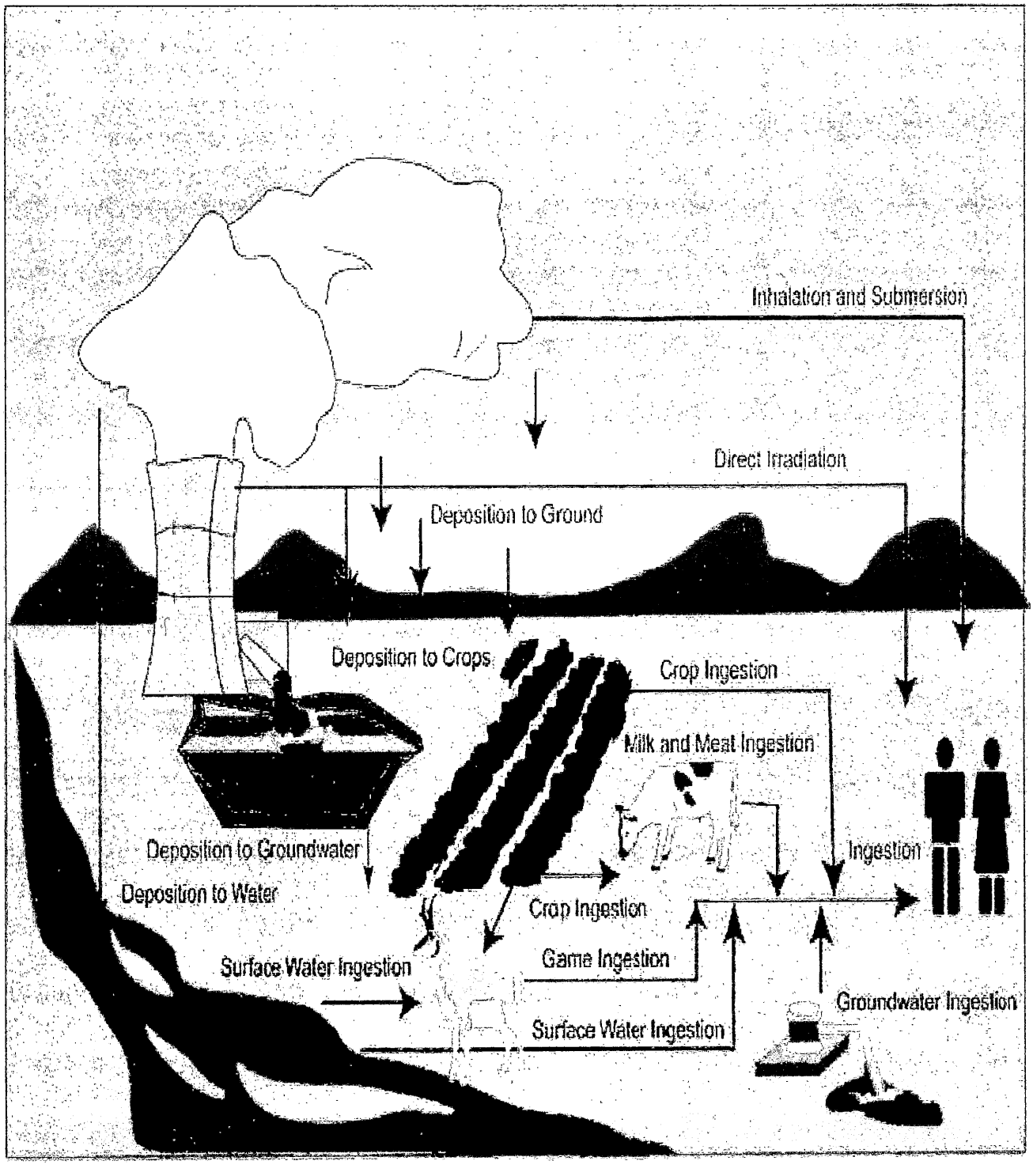


FIGURE 1-2
SAMPLE COLLECTION SITES – NEAR FIELD

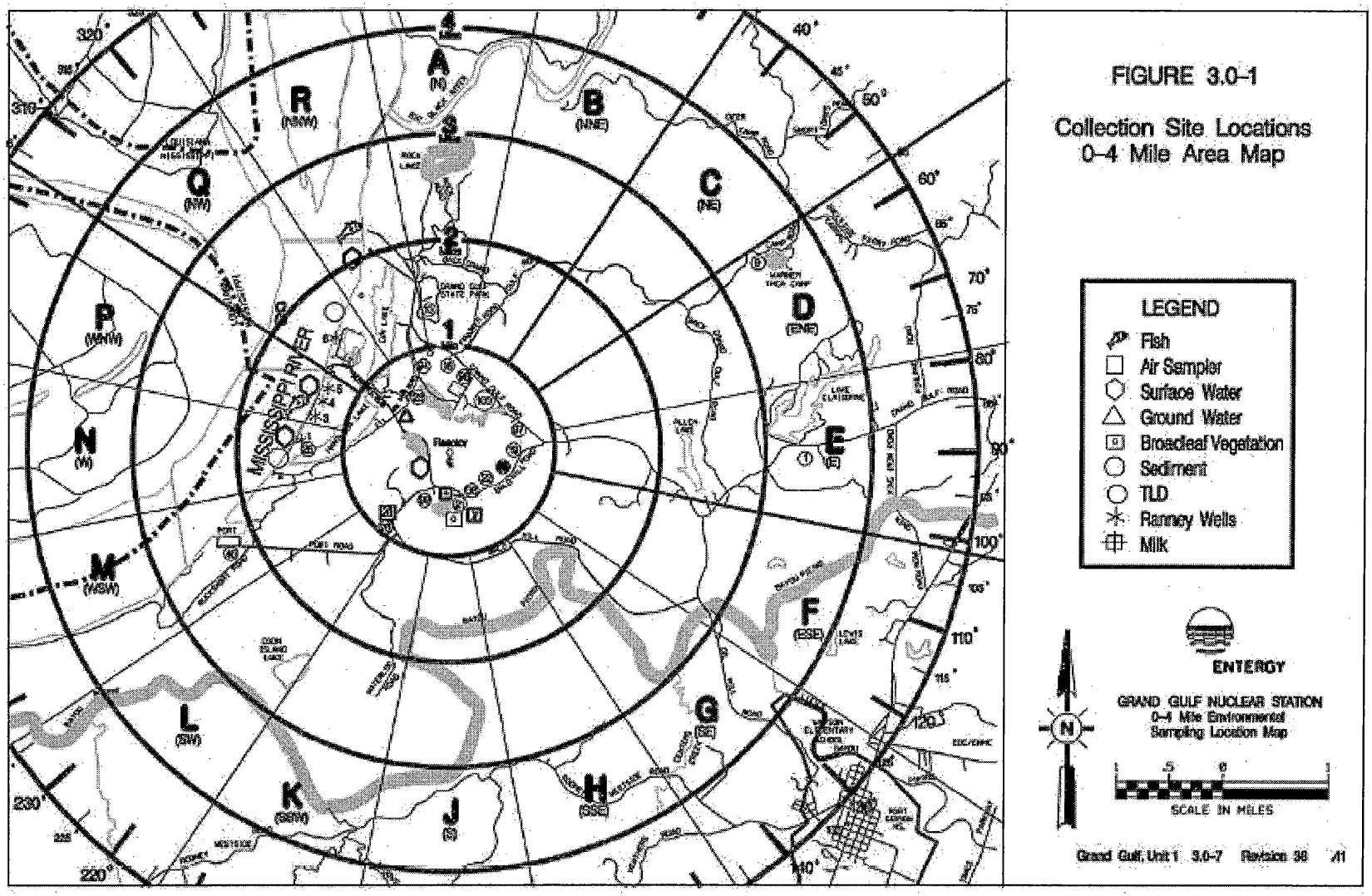
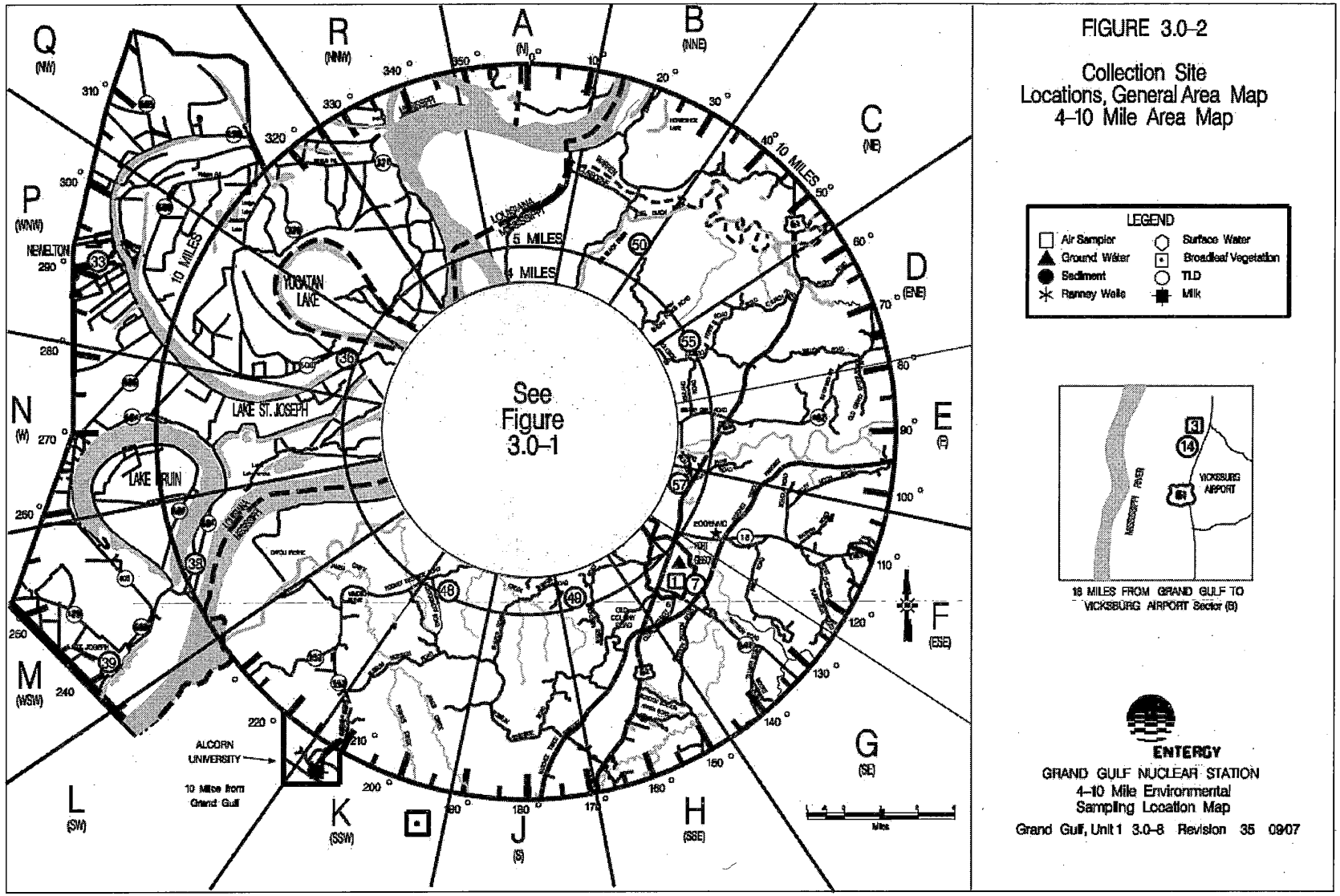


FIGURE 1-3
SAMPLE COLLECTION SITES – FAR FIELD



2.0 Interpretation and Trends of Results

2.1 Air Particulate and Radioiodine Sample Results

GGNS did not detect any plant related gamma emitting radionuclides in the quarterly air particulate composites.

The REMP had previously detected airborne radioactivity attributable to other sources in this pathway. These sources include the Chinese nuclear test in 1980 and the accident at the Chernobyl Nuclear Power Plant in 1986. The GGNS REMP detected radioactivity released from the Fukushima Dai-ichi Nuclear Power Plant following the March 11, 2011, Tohoku earthquake. No radioiodine was detected in 2015.

Table 3.1, which also includes gross beta activity, provides a comparison of the indicator and control means and ranges, further emphasizing that the airborne pathway remains at background levels. In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. Similar trends are present for control and indicator locations, which support the presence of naturally occurring radioactivity.

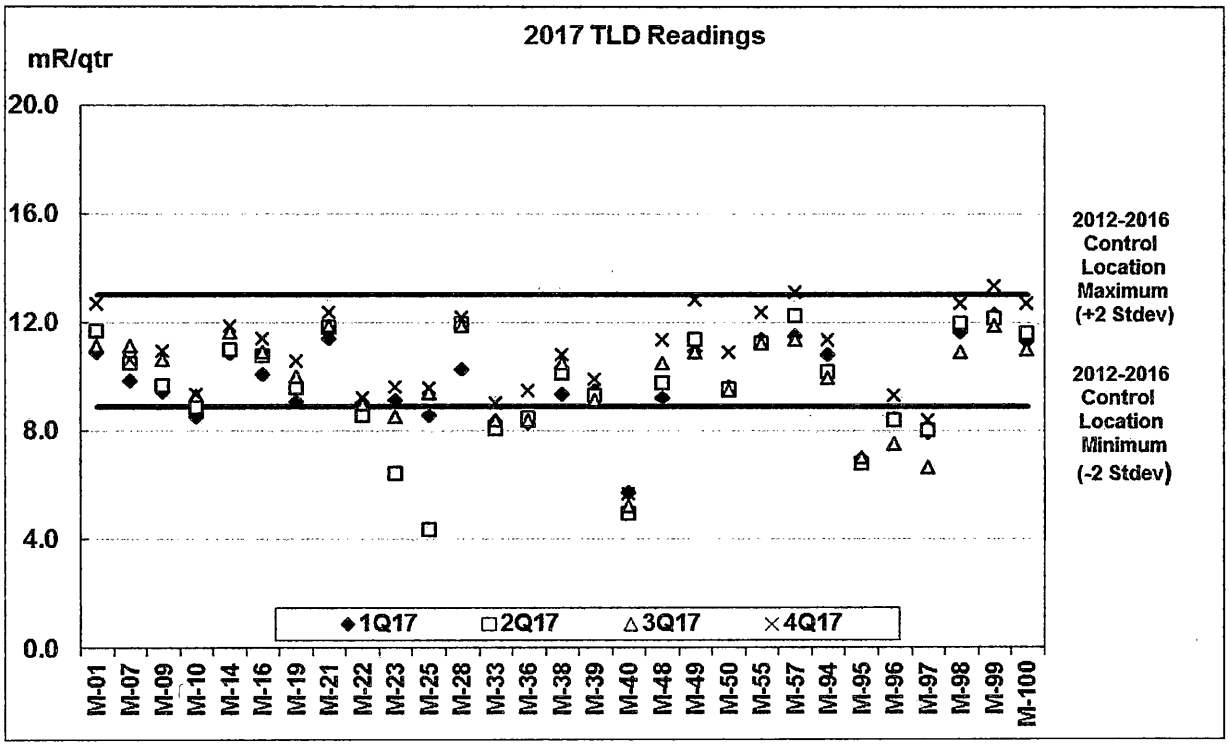
2.2 Thermoluminescent Dosimetry Sample Results

GGNS calculates dose by subtracting shield readings from control and indicator location readings and reports measured dose as net exposure, normalized to 92 days. GGNS relies on the comparison of the indicator locations to the control location as an indication of plant impact. Gamma radiation dose in the reporting period is compared to control location readings for previous years as shown in Figure 2-1.

The comparison of the indicator results to the control, and to previous indicator results, as seen in Figure 2-1 and Table 3.1, indicates that plant operation has had no significant impact on ambient radiation levels during the reporting period.

In previous years, TLD locations M-21 (Sector J, 0.4 miles), M-98 (Sector H, 0.5 miles), and M-99 (Sector K, 0.4 miles) were above background. The dose rates at these three locations were the result of Nitrogen-16 (N-16) associated with the injection of hydrogen and subsequent N-16 production. Hydrogen injection into the feedwater system provides protection against Intergranular Stress Corrosion of plant components. Since November 2010, the hydrogen injection rate has been reduced and the dose rates at TLD locations M-21, M-98, and M-99 have returned to near background levels.

Figure 2-1



2.3 Water Sample Results

Surface water samples were collected from three indicator locations (Outfall 007, MRDOWN, and MRDOWN During Discharge) and one control location (MRUP) and analyzed for gamma emitting radionuclides and tritium. Plant related gamma emitting radionuclides and tritium remained undetectable in the upstream and downstream Mississippi River locations, which is consistent with preoperational and previous operational years. Storm waters contribute to Outfall 007 and can include tritium as a result of washout and entrainment of normal, previously monitored gaseous effluents. As a result, tritium is occasionally observed. Tritium was measured during March (780 ± 684 pCi/L) and August (1030 ± 650 pCi/L) at the Outfall 007 (indicator) location. Tritium was also measured in the duplicate sample collected during August (828 ± 615 pCi/L). Tritium was not observed in the remaining Outfall 007 samples collected during 2017.

In addition to the tritium samples required by the REMP, five special surface water samples for gamma emitting radionuclides were collected at the Outfall 007 location (Table A 8.1). Plant related gamma emitting radionuclides remained undetectable in these samples.

Based on review of results and historical data, plant operations had no significant impact on this pathway during the reporting period.

Groundwater samples were collected from two locations (indicator and control) and analyzed for gamma emitting radionuclides and tritium (Tables A 4.1 and A 4.2). In addition to the samples required by the REMP, an extra sample from the locations was

analyzed for Iodine-131 (Table A 4.3). GGNS did not detect any plant related gamma emitting radionuclides or tritium in groundwater samples during the reporting period.

Based on review of results and historical data, plant operations had no significant impact on this pathway during the reporting period.

2.4 Sediment Sample Results

Sediment samples were collected from two locations (indicator and control) and analyzed for gamma emitting radionuclides. GGNS did not detect any plant related gamma emitting radionuclides in sediment samples during the reporting period.

Based on review of results and historical data, plant operations had no significant impact on this pathway during the reporting period.

2.5 Milk Sample Results

Milk samples were not collected within five miles of the site in the reporting period due to the absence of milking animals. Since there are no dairies within five miles of GGNS, and based on non-detectable radioiodine and gamma radionuclides in air and vegetation samples, plant operations had no impact on this pathway during the reporting period.

2.6 Fish Sample Results

Fish samples were collected from two locations (indicator and control) and analyzed for gamma emitting radionuclides. GGNS did not detect any plant related gamma emitting radionuclides in fish samples (edible portions) during the reporting period, as has been the case in preoperational and previous operational years. These results indicate that this pathway has not been affected by plant operations.

2.7 Food Product (Vegetation) Sample Results

Food product samples were collected from two locations (indicator and control) and analyzed for Iodine-131 and gamma emitting radionuclides. GGNS did not detect any plant related Iodine-131 or gamma emitting radionuclides in vegetation samples during the reporting period. These results indicate that this pathway has not been affected by plant operations.

2.8 Land Use Census Results

Results from the most recent Land Use Census performed in 2016 are included in this report. Methods utilized to perform the Land Use Census include: visual surveys, door to door surveys, telephone interviews, Global Positioning System (GPS), Aerial Photography, and consultation with the local county agent concerning dairy production in Claiborne County.

During the survey the following information was obtained:

1) nearest location of occupied and unoccupied residences
2) nearest location of dairy production
3) nearest location of gardens

Changes from the previous Land Use Census were evaluated in accordance with GGNS surveillance "Land Use Census", 06-EN-S000-O-0002. The differences were compared to the locations and assumptions used in calculations for compliance with the ODCM Limiting Condition for Operation 6.11.6 and 6.12.2. The locations and assumptions currently used in ODCM were determined more conservative than any of the changes. Determinations from the most recent Land Use Census results are:

- Because of downwind location and/or distance from the site, in no case will the occupancy of an existing unoccupied residence cause any existing ODCM critical receptor calculation results to be less conservative.
- No additional sampling locations are required as the onsite vegetation sampling location (Sector J, 0.4 miles) is more conservative than changes identified in the land use census.
- Cattle are raised for human consumption (most notably in Sectors F, H, J, and K). GGNS uses the Grass/Cow/Meat pathway.
- The milk pathway does not need to be activated because no commercial dairy production is occurring within 5 miles, as referenced by ODCM Table 6.12.1-1.
- Sectors M, N, P, and Q are remote areas in which the primary use is hunting. Areas were surveyed by vehicle, aerial photographs, and interviews.
- Gardens, regardless of size, were included in the census data

Table 2.1
2016 Land Use Census

Parameter		Sector A*	Sector B	Sector C*	Sector D*
I. Nearest Occupied Residence	a. Distance (mile) b. Degrees from true north	1.02 355.4	1.51 23.7	0.70 42.3	2.60 60.8
II. Nearest Unoccupied Residence (closer than occupied residence)	a. Distance (mile) b. Degrees from true north	0.94 8.0	0.83 15.1	None	None
III. Nearest Milk Animal	a. Distance	None	None	None	None
IV. Nearest Broadleaf Garden	a. Distance (mile) b. Garden size (ft^2) c. Degrees from true north	1.02 ≈ 400 355.4	1.52 ≈ 4050 21.9	4.14 ≈ 100 47.6	4.50 ≈ 2000 64.8
V. Census Comparison	a. Is nearest occupied residence in same location as last census? b. Is nearest milk animal in same location as last census? c. Is nearest broadleaf garden in same location as last census?	No N/A Yes[1]	Yes N/A Yes[1]	Yes N/A No	Yes N/A No

1 Retained previous garden location. Located no other gardens in the sector.

* Change from last census. See table of Land Use Census Changes

Table 2.1
2016 Land Use Census, continued.

Parameter		Sector E*	Sector F*	Sector G	Sector H*
I. Nearest Occupied Residence	a. Distance (miles) b. Degrees from true north	0.83 94.5	2.25 101.3	3.72 134.1	1.10 151.4
II. Nearest Unoccupied Residence (closer than occupied residence)	a. Distance (miles) b. Degrees from true north	None	None	3.71 131.8	1.07 151.0
III. Nearest Milk Animal	a. Distance	None	None	None	None
IV. Nearest Broadleaf Garden	a. Distance (miles) b. Garden size (ft^2) c. Degrees from true north	0.89 ≈ 1000 86.9	4.49 ≈ 400 113.5	4.20 ≈ 1600 130.1	4.31 ≈ 200 146.6
V. Census Comparison	a. Is nearest occupied residence in same location as last census? b. Is nearest milk animal in same location as last census? c. Is nearest broadleaf garden in same location as last census?	No N/A Yes	Yes N/A No	Yes N/A Yes	Yes N/A No

* - Change from last census. See table of Land Use Census Changes

Table 2.1
2016 Land Use Census, continued.

Parameter		Sector J	Sector K	Sector L	Sector M
I. Nearest Occupied Residence	a. Distance (miles) b. Degrees from true north	3.14 174.2	2.20 197.0	0.89 219.7	None
II. Nearest Unoccupied Residence (closer than occupied residence)	a. Distance (miles) b. Degrees from true north	None	1.70 203.3 (Hunting Lodge-Info Only)	None	None
III. Nearest Milk Animal	a. Distance (miles)	None	None	None	None
IV. Nearest Broadleaf Garden	a. Distance (miles) b. Garden size (ft^2) c. Degrees from true north	3.16 ≈ 500 174.0	2.18 ≈ 2500 196.3	0.89 ≈ 400 219.5	None
V. Census Comparison	a. Is nearest occupied residence in same location as last census? b. Is nearest milk animal in same location as last census? c. Is nearest broadleaf garden in same location as last census?	Yes N/A Yes	Yes N/A Yes	Yes N/A Yes	N/A N/A N/A

Table 2.1
2016 Land Use Census, continued.

Parameter		Sector N	Sector P	Sector Q	Sector R*
I. Nearest Occupied Residence	a. Distance (miles) b. Degrees from true north	None	None	None	1.44 348.4
II. Nearest Unoccupied Residence (closer than occupied residence)	a. Distance (miles) b. Degrees from true north	None	None	None	1.11 346.1
III. Nearest Milk Animal	a. Distance (miles)	None	None	None	None
IV. Nearest Broadleaf Garden	a. Distance (miles) b. Garden size (ft^2) c. Degrees from true north	None	None	None	None
V. Census Comparison	a. Is nearest occupied residence in same location as last census? b. Is nearest milk animal in same location as last census? c. Is nearest broadleaf garden in same location as last census?	N/A N/A N/A	N/A N/A N/A	N/A N/A N/A	No N/A N/A

* - Change from last census. See table of Land Use Census Changes

2016 Land Use Census Changes

SECTOR	PARAMETER	Reason for Change
A	Nearest Occupied Residence	New nearest occupied residence identified in 2016.
C	Nearest Broadleaf Garden	New nearest garden location identified in 2016.
D	Nearest Broadleaf Garden	Garden location identified in 2014 census no longer active. New nearest garden location identified in 2016.
E	Nearest Occupied Residence	New nearest occupied residence identified in 2016.
F	Nearest Broadleaf Garden	New nearest garden location identified in 2016.
H	Nearest Broadleaf Garden	New nearest garden location identified in 2016.
R	Nearest Occupied Residence	Nearest occupied residence from 2014 census no longer occupied. New nearest occupied residence identified in 2016.

2.9 Interlaboratory Comparison Results

Stanford Dosimetry Company analyzed interlaboratory comparison thermoluminescent dosimeters to fulfill the requirements of ODCM Specification 6.12.1. The results are shown in Table A.9.1.

Teledyne Brown Engineering analyzed interlaboratory comparison samples to fulfill the requirements of ODCM Specification 6.12.1. The results are shown in Table A.9.2.

3.0 Radiological Environmental Monitoring Program Summary

3.1 Program Results Summary

Table 3.1 summarizes the REMP results. Values reported as less than the lower limit of detection (<LLD) were not used when determining ranges and means for indicator and control locations.

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Grand Gulf Nuclear Station **Docket No:** 50-416
Location of Facility: Claiborne County, Mississippi **Reporting Period:** January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Air Particulates (pCi/m^3)	GB 206	0.01	0.01611 (154/154) [0.00570 - 0.04220]	AS-1 PG (Sector G, 5.5 mi)	0.01726 (50/50) [0.00674-0.03580]	0.01850 (52/52) [0.00688-0.04220]	0
	GS 16						
	Cs-134	0.05	<LLD	N/A	N/A	<LLD	0
	Cs-137	0.06	<LLD	N/A	N/A	<LLD	0
Airborne Iodine (pCi/m^3)	I-131 206	0.07	<LLD	N/A	N/A	<LLD	0
Inner Ring TLDs (mR/Qtr)	Gamma 55	f	10.0 (55/55) [4.3 – 13.3]	M-99 (Sector J, 0.4 mi.)	12.4 (4/4) [11.8 – 13.3]	N/A	0
Outer Ring TLDs (mR/Qtr)	Gamma 28	f	9.9 (28/28) [4.9 – 13.1]	M-57 (Sector F, 4.5 mi.)	12.0 (4/4) [11.3 – 13.1]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma 28	f	9.9 (28/28) [8.1 – 12.7]	M-01 (Sector E, 3.5 mi.)	11.6 (4/4) [10.9 – 12.7]	N/A	0
Control TLDs (mR/Qtr)	Gamma 4	f	N/A	N/A	N/A	11.3 (4/4) [10.9 – 11.9]	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Grand Gulf Nuclear Station Docket No: 50-416
Location of Facility: Claiborne County, Mississippi Reporting Period: January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Surface Water (pCi/l)	H-3 35	3000	879 (3/28) [780 - 1030]	Outfall 007 (Sector N, Radius 0.2 mi.)	879 (3/19) [780 - 1030]	<LLD	0
	GS 16						
	Mn-54	15	<LLD	N/A	N/A	<LLD	0
	Co-58	15	<LLD	N/A	N/A	<LLD	0
	Fe-59	30	<LLD	N/A	N/A	<LLD	0
	Co-60	15	<LLD	N/A	N/A	<LLD	0
	Zn-65	30	<LLD	N/A	N/A	<LLD	0
	Nb-95	15	<LLD	N/A	N/A	<LLD	0
	Zr-95	30	<LLD	N/A	N/A	<LLD	0
	I-131	15	<LLD	N/A	N/A	<LLD	0
	Cs-134	15	<LLD	N/A	N/A	<LLD	0
	Cs-137	18	<LLD	N/A	N/A	<LLD	0
	Ba-140	60	<LLD	N/A	N/A	<LLD	0
	La-140	15	<LLD	N/A	N/A	<LLD	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Grand Gulf Nuclear Station Docket No: 50-416
Location of Facility: Claiborne County, Mississippi Reporting Period: January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Locations Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Groundwater (pCi/l)	H-3 6	2000	<LLD	N/A	N/A	<LLD	0
	I-131 3	1	<LLD	N/A	N/A	<LLD	0
	GS 3						
	Mn-54	15	<LLD	N/A	N/A	<LLD	0
	Co-58	15	<LLD	N/A	N/A	<LLD	0
	Fe-59	30	<LLD	N/A	N/A	<LLD	0
	Co-60	15	<LLD	N/A	N/A	<LLD	0
	Zn-65	30	<LLD	N/A	N/A	<LLD	0
	Nb-95	15	<LLD	N/A	N/A	<LLD	0
	Zr-95	30	<LLD	N/A	N/A	<LLD	0
	Cs-134	15	<LLD	N/A	N/A	<LLD	0
	Cs-137	18	<LLD	N/A	N/A	<LLD	0
	Ba-140	60	<LLD	N/A	N/A	<LLD	0
	La-140	15	<LLD	N/A	N/A	<LLD	0
Sediment (pCi/kg)	GS 4						
	Cs-134	150	<LLD	N/A	N/A	<LLD	0
	Cs-137	180	<LLD	N/A	N/A	<LLD	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Grand Gulf Nuclear Station Docket No: 50-416
Location of Facility: Claiborne County, Mississippi Reporting Period: January - December 2017

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Fish (pCi/kg)	GS 4						
	Mn-54	130	<LLD	N/A	N/A	<LLD	0
	Co-58	130	<LLD	N/A	N/A	<LLD	0
	Fe-59	260	<LLD	N/A	N/A	<LLD	0
	Co-60	130	<LLD	N/A	N/A	<LLD	0
	Zn-65	260	<LLD	N/A	N/A	<LLD	0
	Cs-134	130	<LLD	N/A	N/A	<LLD	0
	Cs-137	150	<LLD	N/A	N/A	<LLD	0
Food Products/Vegetation (pCi/kg)	I-131 8	60	<LLD	N/A	N/A	<LLD	0
	GS 8						
	Cs-134	60	<LLD	N/A	N/A	<LLD	0
	Cs-137	80	<LLD	N/A	N/A	<LLD	0

TABLE 3.1

Radiological Environmental Monitoring Program Summary

Name of Facility: Grand Gulf Nuclear Station **Docket No: 50-416**
Location of Facility: Claiborne County, Mississippi **Reporting Period: January - December 2017**

Sample Type (Units)	Type & Number of Analyses [a]	LLD [b]	Indicator Location Mean (F) [c] [Range]	Location with Highest Annual Mean		Control Locations Mean (F) [c] [Range]	Number of Nonroutine Results [e]
				Location [d]	Mean (F) [c] [Range]		
Surface Water (Special) (pCi/l)	GS 5						
	Mn-54	15	<LLD	N/A	N/A	<LLD	0
	Co-58	15	<LLD	N/A	N/A	<LLD	0
	Fe-59	30	<LLD	N/A	N/A	<LLD	0
	Co-60	15	<LLD	N/A	N/A	<LLD	0
	Zn-65	30	<LLD	N/A	N/A	<LLD	0
	Nb-95	15	<LLD	N/A	N/A	<LLD	0
	Zr-95	30	<LLD	N/A	N/A	<LLD	0
	I-131	15	<LLD	N/A	N/A	<LLD	0
	Cs-134	15	<LLD	N/A	N/A	<LLD	0
	Cs-137	18	<LLD	N/A	N/A	<LLD	0
	Ba-140	60	<LLD	N/A	N/A	<LLD	0
	La-140	15	<LLD	N/A	N/A	<LLD	0
Meat (Special) (pCi/kg)	GS 1						
	Mn-54	130	<LLD	N/A	N/A	<LLD	0
	Co-58	130	<LLD	N/A	N/A	<LLD	0
	Fe-59	260	<LLD	N/A	N/A	<LLD	0
	Co-60	130	<LLD	N/A	N/A	<LLD	0
	Zn-65	260	<LLD	N/A	N/A	<LLD	0
	Cs-134	130	<LLD	N/A	N/A	<LLD	0
	Cs-137	150	<LLD	N/A	N/A	<LLD	0

[a] GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.

[b] LLD = Required lower limit of detection based on ODCM Table 6.12.1-3.

[c] Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).

[d] Where applicable, locations are specified by name, distance from reactor site and meteorological sector.

[e] Non-routine results are those which exceed ten times the control station value. If no control station value is available, the result is considered non-routine if it exceeds ten times the preoperational value for the location.

[f] LLD is not defined in ODCM Table 6.12.1-3.

Attachment 1

Radiological Monitoring Report

Summary of Monitoring Results

TABLE OF CONTENTS

Table A1.1
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-1 PG

LLD (pCi/m3) LAB ID	START DATE	END DATE	0.07 I-131	0.01 GROSS BETA	
L71147-1/5	12/27/16	01/03/17	<0.03967	0.00999	±0.00293
L71340-1/5	01/03/17	01/10/17	<0.03508	0.02330	±0.00557
L71370-1/5	01/10/17	01/17/17	<0.04076	0.00909	±0.00420
L71424-1/5	01/17/17	01/24/17	<0.03899	0.01470	±0.00492
L71534-1/5	01/24/17	01/31/17	<0.03390	0.02040	±0.00540
L71613-1/5	01/31/17	02/07/17	<0.02680	0.01880	±0.00560
L71709-1/5	02/07/17	02/14/17	No Sample		
L71746-1/5	02/14/17	02/21/17	<0.04582	0.01340	±0.00450
L71801-1/5	02/21/17	02/28/17	<0.03582	0.00826	±0.00326
L71910-1/5	02/28/17	03/07/17	<0.02653	0.01450	±0.00417
L71994-1/5	03/07/17	03/14/17	No Sample		
L72083-1/5	03/14/17	03/21/17	<0.04578	0.02110	±0.00543
L72167-1/5	03/21/17	03/28/17	<0.03243	0.02450	±0.00582
L72281-1/5	03/28/17	04/04/17	<0.03829	0.01360	±0.00542
L72399-1/5	04/04/17	04/11/17	<0.03251	0.01630	±0.00477
L72503-1/5	04/11/17	04/18/17	<0.06431	0.01560	±0.00480
L72575-1/5	04/18/17	04/25/17	<0.04579	0.01340	±0.00473
L72658-1/5	04/25/17	05/02/17	<0.01467	0.01570	±0.00489
L72778-1/5	05/02/17	05/09/17	<0.05505	0.01730	±0.00501
L72855-1/5	05/09/17	05/16/17	<0.03619	0.01820	±0.00515
L72953-1/5	05/16/17	05/23/17	<0.01843	0.01120	±0.00464
L73042-1/5	05/23/17	05/30/17	<0.05705	0.01170	±0.00441
L73189-1/5	05/30/17	06/06/17	<0.06720	0.01070	±0.00444
L73258-1/5	06/06/17	06/13/17	<0.05354	0.01230	±0.00462
L73328-1/5	06/13/17	06/20/17	<0.04101	0.01370	±0.00488
L73407-1/5	06/20/17	06/27/17	<0.04064	0.01230	±0.00453
L73532-1/5	06/27/17	07/05/17	<0.06057	0.01570	±0.00489
L73591-1/5	07/05/17	07/11/17	<0.04799	0.01100	±0.00495
L73756-1/5	07/11/17	07/18/17	<0.04242	0.00688	±0.00365
L73876-1/5	07/18/17	07/25/17	<0.05775	0.01520	±0.00497
L73949-1/5	07/25/17	08/01/17	<0.03728	0.01850	±0.00495
L74047-1/5	08/01/17	08/08/17	<0.03921	0.01900	±0.00545
L74139-1/5	08/08/17	08/15/17	<0.03596	0.00891	±0.00404
L74225-1/5	08/15/17	08/22/17	<0.04176	0.01210	±0.00455
L71340-1/5	01/03/17	01/10/17	<0.04578	0.02110	±0.00543

Table A1.1
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-1 PG

LLD (pCi/m3) LAB ID	START DATE	END DATE	0.07 I-131	0.01 GROSS BETA	
L74303-1/5	08/22/17	08/29/17	<0.04578	0.02120	±0.00564
L74369-1/5	08/29/17	09/05/17	<0.04431	0.01770	±0.00507
L74485-1/5	09/05/17	09/12/17	<0.02693	0.02420	±0.00561
L74615-1/5	09/12/17	09/19/17	<0.06705	0.02180	±0.00560
L74654-1/5	09/19/17	09/26/17	<0.04364	0.02160	±0.00578
L74776-1/5	09/26/17	10/03/17	<0.03235	0.02400	±0.00567
L74867-1/5	10/03/17	10/10/17	<0.04399	0.01270	±0.00509
L74981-1/5	10/10/17	10/17/17	<0.04450	0.02390	±0.00585
L75115-1/5	10/17/17	10/24/17	<0.06315	0.01930	±0.00555
L75194-1/5	10/24/17	10/31/17	<0.05707	0.01810	±0.00542
L75293-1/5	10/31/17	11/07/17	<0.03553	0.01550	±0.00486
L75329-1/5	11/07/17	11/14/17	<0.04815	0.02590	±0.00620
L75454-1/5	11/14/17	11/21/17	<0.06703	0.02960	±0.00626
L75504-1/5	11/21/17	11/28/17	<0.03468	0.02620	±0.00603
L75579-1/5	11/28/17	12/05/17	<0.02685	0.04220	±0.00722
L75662-1/5	12/05/17	12/12/17	<0.03883	0.01970	±0.00531
L75754-1/5	12/12/17	12/19/17	<0.02589	0.01790	±0.00497
L75804-1/5	12/19/17	12/26/17	<0.05678	0.01420	±0.00453
Average:				0.01726	
Maximum:				0.04220	
Minimum:				0.00688	

Table A1.2
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-3 61VA

LLD (pCi/m3)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L71147-2/6	12/27/16	01/03/17	<0.03970	0.00890	±0.00284
L71340-2/6	01/03/17	01/10/17	<0.03513	0.02490	±0.00428
L71370-2/6	01/10/17	01/17/17	<0.04249	0.00786	±0.00408
L71424-2/6	01/17/17	01/24/17	<0.03843	0.01450	±0.00537
L71534-2/6	01/24/17	01/31/17	<0.03386	0.01900	±0.00542
L71613-2/6	01/31/17	02/07/17	<0.02689	0.02030	±0.00533
L71709-2/6	02/07/17	02/14/17	<0.06749	0.01480	±0.00476
L71746-2/6	02/14/17	02/21/17	<0.04587	0.01270	±0.00516
L71801-2/6	02/21/17	02/28/17	<0.04138	0.00849	±0.00486
L71910-2/6	02/28/17	03/07/17	<0.03079	0.01190	±0.00473
L71994-2/6	03/07/17	03/14/17	<0.03417	0.00860	±0.00488
L72083-2/6	03/14/17	03/21/17	<0.04587	0.02050	±0.00530
L72167-2/6	03/21/17	03/28/17	<0.03249	0.02020	±0.00482
L72281-2/6	03/28/17	04/04/17	<0.03838	0.01270	±0.00506
L72399-2/6	04/04/17	04/11/17	<0.03223	0.01650	±0.00399
L72503-2/6	04/11/17	04/18/17	<0.06466	0.01870	±0.00441
L72575-2/6	04/18/17	04/25/17	<0.04520	0.01500	±0.00449
L72658-2/6	04/25/17	05/02/17	<0.04231	0.01380	±0.00435
L72778-2/6	05/02/17	05/09/17	<0.05522	0.01610	±0.00494
L72855-2/6	05/09/17	05/16/17	<0.03727	0.01900	±0.00527
L72953-2/6	05/16/17	05/23/17	<0.01795	0.01350	±0.00395
L73042-2/6	05/23/17	05/30/17	<0.05708	0.01730	±0.00453
L73189-2/6	05/30/17	06/06/17	<0.06733	0.00708	±0.00506
L73258-2/6	06/06/17	06/13/17	<0.05355	0.01060	±0.00549
L73328-2/6	06/13/17	06/20/17	<0.04107	0.01050	±0.00432
L73407-2/6	06/20/17	06/27/17	<0.04071	0.01080	±0.00449
L73532-2/6	06/27/17	07/05/17	<0.06065	0.01620	±0.00546
L73591-2/6	07/05/17	07/11/17	<0.04873	0.01310	±0.00428
L73756-2/6	07/11/17	07/18/17	<0.04341	0.00893	±0.00408
L73876-2/6	07/18/17	07/25/17	<0.05460	0.01330	±0.00537
L73949-2/6	07/25/17	08/01/17	<0.03839	0.01870	±0.00542
L74047-2/6	08/01/17	08/08/17	<0.04044	0.01850	±0.00533
L74139-2/6	08/08/17	08/15/17	<0.03762	0.01010	±0.00476
L74225-2/6	08/15/17	08/22/17	<0.04189	0.01170	±0.00516

Table A1.2
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-3 61VA

LLD (pCi/m3)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L74369-2/6	08/29/17	09/05/17	<0.04628	0.02120	±0.00557
L74485-2/6	09/05/17	09/12/17	<0.05475	0.02060	±0.00543
L74615-2/6	09/12/17	09/19/17	<0.06949	0.02600	±0.00614
L74654-2/6	09/19/17	09/26/17	<0.04507	0.01920	±0.00567
L74776-2/6	09/26/17	10/03/17	<0.06150	0.02500	±0.00585
L74867-2/6	10/03/17	10/10/17	<0.04431	0.01030	±0.00483
L74981-2/6	10/10/17	10/17/17	<0.04450	0.02140	±0.00560
L75115-2/6	10/17/17	10/24/17	<0.06339	0.01750	±0.00537
L75194-2/6	10/24/17	10/31/17	<0.04890	0.01360	±0.00440
L75293-2/6	10/31/17	11/07/17	<0.03564	0.01830	±0.00516
L75329-2/6	11/07/17	11/14/17	<0.02021	0.02370	±0.00600
L75454-2/6	11/14/17	11/21/17	<0.06715	0.03150	±0.00642
L75504-2/6	11/21/17	11/28/17	<0.03478	0.02420	±0.00585
L75579-2/6	11/28/17	12/05/17	<0.02690	0.03610	±0.00675
L75662-2/6	12/05/17	12/12/17	<0.03941	0.01880	±0.00527
L75754-2/6	12/12/17	12/19/17	<0.02597	0.02020	±0.00521
L75804-2/6	12/19/17	12/26/17	<0.05694	0.01610	±0.00474
Average:				0.01668	
Maximum:				0.03610	
Minimum:				0.00708	

Table A1.3
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-7 UH

LLD (pCi/m3)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L71147-3/7	12/27/16	01/03/17	<0.04102	0.00948	±0.00297
L71340-3/7	01/03/17	01/10/17	<0.03503	0.02380	±0.00561
L71370-3/7	01/10/17	01/17/17	<0.04072	0.00679	±0.00389
L71424-3/7	01/17/17	01/24/17	<0.03977	0.01600	±0.00513
L71534-3/7	01/24/17	01/31/17	<0.03374	0.01800	±0.00515
L71613-3/7	01/31/17	02/07/17	<0.02676	0.01900	±0.00563
L71709-3/7	02/07/17	02/14/17	<0.06730	0.01520	±0.00537
L71746-3/7	02/14/17	02/21/17	<0.04550	0.01310	±0.00444
L71801-3/7	02/21/17	02/28/17	<0.04257	0.01100	±0.00404
L71910-3/7	02/28/17	03/07/17	<0.03140	0.01740	±0.00498
L71994-3/7	03/07/17	03/14/17	<0.03410	0.01320	±0.00468
L72083-3/7	03/14/17	03/21/17	<0.04560	0.02020	±0.00533
L72167-3/7	03/21/17	03/28/17	<0.03243	0.01990	±0.00539
L72281-3/7	03/28/17	04/04/17	<0.03865	0.01230	±0.00531
L72399-3/7	04/04/17	04/11/17	<0.03201	0.01620	±0.00473
L72503-3/7	04/11/17	04/18/17	<0.06546	0.01450	±0.00476
L72575-3/7	04/18/17	04/25/17	<0.04517	0.01100	±0.00440
L72658-3/7	04/25/17	05/02/17	<0.04215	0.01450	±0.00480
L72778-3/7	05/02/17	05/09/17	<0.05482	0.01420	±0.00464
L72855-3/7	05/09/17	05/16/17	<0.03669	0.01570	±0.00491
L72953-3/7	05/16/17	05/23/17	<0.01788	0.01300	±0.00476
L73042-3/7	05/23/17	05/30/17	<0.06722	0.01350	±0.00518
L73189-3/7	05/30/17	06/06/17	<0.06733	0.00746	±0.00405
L73258-3/7	06/06/17	06/13/17	<0.05337	0.00960	±0.00429
L73328-3/7	06/13/17	06/20/17	<0.04099	0.01010	±0.00446
L73407-3/7	06/20/17	06/27/17	<0.01697	0.01160	±0.00443
L73532-3/7	06/27/17	07/05/17	<0.06086	0.01180	±0.00452
L73591-3/7	07/05/17	07/11/17	<0.04775	0.01070	±0.00491
L73756-3/7	07/11/17	07/18/17	<0.04178	0.00908	±0.00392
L73876-3/7	07/18/17	07/25/17	<0.05565	0.01320	±0. 00462
L73949-3/7	07/25/17	08/01/17	<0.03834	0.01850	±0.00504
L74047-3/7	08/01/17	08/08/17	<0.04025	0.02190	±0.00585
L74139-3/7	08/08/17	08/15/17	<0.03882	0.01050	±0.00449
L74225-3/7	08/15/17	08/22/17	<0.04293	0.00967	±0.00434
L74303-3/7	08/22/17	08/29/17	<0.04774	0.01680	±0.00536

Table A1.3
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-7 UH

LLD (pCi/m3)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L74369-3/7	08/29/17	09/05/17	<0.04826	0.02130	±0.00575
L74485-3/7	09/05/17	09/12/17	<0.05690	0.02120	±0.00561
L74615-3/7	09/12/17	09/19/17	<0.06987	0.01980	±0.00554
L74654-3/7	09/19/17	09/26/17	<0.04556	0.01900	±0.00570
L74776-3/7	09/26/17	10/03/17	<0.06413	0.02460	±0.00597
L74867-3/7	10/03/17	10/10/17	<0.04562	0.01020	±0.00495
L74981-3/7	10/10/17	10/17/17	<0.04521	0.01960	±0.00551
L75115-3/7	10/17/17	10/24/17	<0.06666	0.01620	±0.00545
L75194-3/7	10/24/17	10/31/17	<0.05764	0.01480	±0.00504
L75293-3/7	10/31/17	11/07/17	<0.03549	0.01520	±0.00482
L75329-3/7	11/07/17	11/14/17	<0.04881	0.02210	±0.00591
L75454-3/7	11/14/17	11/21/17	<0.06684	0.02620	±0.00594
L75504-3/7	11/21/17	11/28/17	<0.03516	0.02530	±0.00600
L75579-3/7	11/28/17	12/05/17	<0.02759	0.03870	±0.00707
L75662-3/7	12/05/17	12/12/17	<0.03992	0.01620	±0.00504
L75754-3/7	12/12/17	12/19/17	<0.02656	0.01520	±0.00474
L75804-3/7	12/19/17	12/26/17	<0.05718	0.01370	±0.00449
Average:				0.01593	
Maximum:				0.03870	
Minimum:				0.00679	

Table A1.4
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-20 GR

LLD (pCi/m3)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L71147-4/8	12/27/16	01/03/17	<0.04102	0.00961	±0.00298
L71340-4/8	01/03/17	01/10/17	<0.03503	0.01720	±0.00495
L71370-4/8	01/10/17	01/17/17	<0.04072	0.00570	±0.00372
L71424-4/8	01/17/17	01/24/17	<0.01668	0.01130	±0.00459
L71534-4/8	01/24/17	01/31/17	<0.03374	0.01510	±0.00483
L71613-4/8	01/31/17	02/07/17	<0.02677	0.01530	±0.00524
L71709-4/8	02/07/17	02/14/17	<0.06732	0.01590	±0.00545
L71746-4/8	02/14/17	02/21/17	<0.04554	0.01580	±0.00476
L71801-4/8	02/21/17	02/28/17	<0.04221	0.01110	±0.00404
L71910-4/8	02/28/17	03/07/17	<0.03386	0.01710	±0.00519
L71994-4/8	03/07/17	03/14/17	<0.04772	0.00884	±0.00525
L72083-4/8	03/14/17	03/21/17	<0.04562	0.02020	±0.00533
L72167-4/8	03/21/17	03/28/17	<0.03245	0.01660	±0.00504
L72281-4/8	03/28/17	04/04/17	<0.03824	0.00661	±0.00465
L72399-4/8	04/04/17	04/11/17	<0.03201	0.01480	±0.00456
L72503-4/8	04/11/17	04/18/17	<0.06549	0.01140	±0.00437
L72575-4/8	04/18/17	04/25/17	<0.04582	0.00890	±0.00419
L72658-4/8	04/25/17	05/02/17	<0.04216	0.01380	±0.00473
L72778-4/8	05/02/17	05/09/17	<0.05484	0.01810	±0.00509
L72855-4/8	05/09/17	05/16/17	<0.03671	0.01680	±0.00504
L72953-4/8	05/16/17	05/23/17	<0.01841	0.00890	±0.00434
L73042-4/8	05/23/17	05/30/17	<0.05868	0.01370	±0.00474
L73189-4/8	05/30/17	06/06/17	<0.06803	0.00862	±0.00423
L73258-4/8	06/06/17	06/13/17	<0.05495	0.01170	±0.00464
L73328-4/8	06/13/17	06/20/17	<0.04221	0.00871	±0.00437
L73407-4/8	06/20/17	06/27/17	<0.04060	0.00931	±0.00417
L73532-4/8	06/27/17	07/05/17	<0.06088	0.01440	±0.00479
L73591-4/8	07/05/17	07/11/17	<0.04921	0.01040	±0.00498
L73756-4/8	07/11/17	07/18/17	<0.04181	0.00635	±0.00354
L73876-4/8	07/18/17	07/25/17	<0.05485	0.01250	±0.00449
L73949-4/8	07/25/17	08/01/17	<0.03674	0.01640	±0.00470
L74047-4/8	08/01/17	08/08/17	<0.03919	0.01820	±0.00537
L74139-4/8	08/08/17	08/15/17	<0.03642	0.00998	±0.00422
L74225-4/8	08/15/17	08/22/17	<0.04112	0.01010	±0.00425
L74303-4/8	08/22/17	08/29/17	<0.04575	0.02160	±0.00567

Table A1.4
Sample Type: Air Particulate Filter and Radioiodine Cartridge
Analysis: Gross Beta and I-131
Units: pCi/m3
AIR SAMPLE AS-20 GR

LLD (pCi/m3)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L74369-4/8	08/29/17	09/05/17	<0.04480	0.01970	±0.00531
L74485-4/8	09/05/17	09/12/17	<0.05291	0.02130	±0.00539
L74615-4/8	09/12/17	09/19/17	<0.06790	0.02350	±0.00582
L74654-4/8	09/19/17	09/26/17	<0.04422	0.01540	±0.00522
L74776-4/8	09/26/17	10/03/17	<0.06051	0.02170	±0.00549
L74867-4/8	10/03/17	10/10/17	<0.04376	0.01280	±0.00509
L74981-4/8	10/10/17	10/17/17	<0.04454	0.02010	±0.00549
L75115-4/8	10/17/17	10/24/17	<0.06315	0.01670	±0.00530
L75194-4/8	10/24/17	10/31/17	<0.04878	0.01240	±0.00425
L75293-4/8	10/31/17	11/07/17	<0.03550	0.01790	±0.00512
L75329-4/8	11/07/17	11/14/17	<0.04813	0.02350	±0.00599
L75454-4/8	11/14/17	11/21/17	<0.06688	0.02600	±0.00591
L75504-4/8	11/21/17	11/28/17	<0.03467	0.02730	±0.00614
L75579-4/8	11/28/17	12/05/17	<0.02682	0.03230	±0.00644
L75662-4/8	12/05/17	12/12/17	<0.03936	0.02120	±0.00551
L75754-4/8	12/12/17	12/19/17	<0.02585	0.01460	±0.00459
L75804-4/8	12/19/17	12/26/17	<0.05674	0.01260	±0.00432
Average:				0.01519	
Maximum:				0.03230	
Minimum:				0.00570	

Table A1.5
Sample Type: Air Particulate Filter
Analysis: Gamma Isotopic
Units: pCi/m3
AIR PARTICULATE FILTER SAMPLES (GAMMA)

LLD (pCi/m3) LAB ID	LOCATION	DATE	0.05 CS-134	0.06 CS-137
L72614-1	AS-1 PG	02/14/17	<0.003502	<0.003141
L72614-2	AS-3 61VA	02/14/17	<0.002925	<0.003098
L72614-3	AS-7 UH	02/14/17	<0.002592	<0.002168
L72614-4	AS-20 UH	02/14/17	<0.003214	<0.003178
L73573-1	AS-1 PG	05/12/17	<0.002043	<0.001786
L73573-2	AS-3 61VA	05/12/17	<0.002606	<0.001684
L73573-3	AS-7 UH	05/12/17	<0.001478	<0.001714
L73573-4	AS-20 GR	05/12/17	<0.003314	<0.002946
L74849-1	AS-1 PG	08/15/17	<0.001598	<0.001360
L74849-2	AS-3 61VA	08/15/17	<0.002531	<0.001634
L74849-3	AS-7 UH	08/15/17	<0.002401	<0.001771
L74849-4	AS-20 GR	08/15/17	<0.002768	<0.002397
L75910-1	AS-1 PG	11/17/17	<0.003302	<0.002485
L75910-2	AS-3 61VA	11/17/17	<0.001964	<0.001666
L75910-3	AS-7 UH	11/17/17	<0.003058	<0.002653
L75910-4	AS-20 GR	11/17/17	<0.001651	<0.001524

Table A 2.1
Sample Type: **Thermoluminescent Dosimeters**
Analysis: Gamma Dose
Units: mrem/Qtr

Inner Ring - Within General Area of Site Boundary					
Station	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**Annual Mean**
M-16	10.1	10.8	10.9	11.4	10.8
M-19	9.1	9.6	10.0	10.6	9.8
M-21	11.4	11.8	11.9	12.4	11.9
M-22	9.0	8.6	9.0	9.2	8.9
M-23	9.1	6.4	8.5	9.6	8.4
M-25	8.6	4.3	9.4	9.5	8.0
M-28	10.3	12.0	11.8	12.2	11.6
M-94	10.8	10.2	9.9	11.4	10.6
M-95	6.9	6.8	7.0	Not Available	6.9
M-96	8.4	8.4	7.5	9.3	8.4
M-97	7.9	8.0	6.6	8.4	7.7
M-98	11.6	12.0	10.9	12.7	11.8
M-99*	12.3	12.1	11.8	13.3	12.4
M-100	11.3	11.6	11.0	12.7	11.6

*Location with highest annual mean

Outer Ring – Approximately Three (3) to Five (5) Miles from the Site					
Station	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**Annual Mean**
M-36	8.3	8.5	8.4	9.5	8.6
M-40	5.7	4.9	5.2	5.7	5.4
M-48	9.2	9.8	10.5	11.4	10.2
M-49	11.0	11.3	10.9	12.8	11.5
M-50	9.6	9.5	9.5	10.9	9.9
M-55	11.3	11.2	11.2	12.4	11.5
M-57*	11.5	12.2	11.3	13.1	12.0

*Location with highest annual mean

Table A 2.2
Sample Type: **Thermoluminescent Dosimeters**
Analysis: Gamma Dose
Units: mrem/Qtr

Special Interest Areas – Population Centers & Schools					
Station	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**Annual Mean**
M-01*	10.9	11.7	11.1	12.7	11.6
M-07	9.8	10.5	11.1	10.6	10.5
M-09	9.4	9.6	10.6	10.9	10.2
M-10	8.5	8.8	9.3	9.3	9.0
M-33	8.3	8.1	8.4	9.0	8.4
M-38	9.4	10.1	10.5	10.8	10.2
M-39	9.5	9.3	9.1	9.9	9.4

*Location with highest annual mean

Table A 2.3
Sample Type: **Thermoluminescent Dosimeters**
Analysis: Gamma Dose
Units: mrem/Qtr

Special Interest Areas – Control					
Station	**1st Qtr**	**2nd Qtr**	**3rd Qtr**	**4th Qtr**	**Annual Mean**
M-14	10.9	11.0	11.6	11.9	11.3

Table A3.1

Sample Type: Surface Water

Analysis: Gamma Isotopic

Units: pCi/L

SURFACE WATER SAMPLES (GAMMA)

LLD (pCi/L)			15	15	30	15	30	15	30	15	15	18	60	15
LAB ID	LOCATION	DATE	MN-54	CO-58	FE-59	CO-60	ZN-65	NB-95	ZR-95	I-131	CS-134	CS-137	BA-140	LA-140
L71724-1	MRDOWN	02/13/17	<5.878	<7.380	<12.83	<6.272	<12.18	<7.723	<11.79	<14.33	<5.877	<6.729	<29.43	<12.04
L71724-3	MRUP	02/13/17	<4.412	<6.198	<10.33	<4.699	<10.75	<6.562	<10.40	<13.75	<4.696	<4.768	<31.23	<6.894
L71724-5	MRDOWN GG	02/13/17	<5.645	<4.589	<12.44	<4.718	<12.08	<6.264	<10.34	<12.97	<6.316	<5.558	<34.68	<14.50
L71724-7	MRUP GG	02/13/17	<6.278	<6.202	<11.96	<6.145	<15.92	<6.172	<12.62	<13.89	<5.791	<7.218	<32.33	<11.10
L72822-1	MRDOWN	05/10/17	<3.969	<4.557	<8.293	<4.991	<7.821	<5.758	<9.441	<8.326	<5.630	<4.837	<21.28	<7.119
L72822-3	MRUP	05/10/17	<4.972	<4.408	<11.55	<4.884	<11.22	<5.364	<10.51	<8.929	<6.857	<5.183	<25.69	<8.526
L72822-5	MRDOWN GG	05/10/17	<6.144	<5.229	<10.57	<6.005	<13.35	<5.973	<9.056	<8.343	<5.823	<6.435	<24.40	<8.100
L72822-7	MRUP GG	05/10/17	<6.201	<6.249	<13.70	<5.996	<10.42	<5.974	<9.338	<9.91	<6.149	<6.481	<30.93	<5.147
L73981-1	MRDOWN	08/01/17	<7.161	<6.628	<15.48	<7.976	<17.25	<7.798	<14.05	<12.32	<8.131	<6.782	<34.73	<14.34
L73981-3	MRUP	08/01/17	<7.952	<7.691	<14.50	<8.053	<19.24	<7.447	<12.46	<13.81	<7.349	<7.977	<36.03	<11.58
L75388-1	MRDOWN	11/13/17	<4.208	<4.999	<12.61	<5.856	<11.47	<5.994	<7.654	<11.33	<5.468	<5.902	<31.00	<6.516
L75388-3	MRUP	11/13/17	<6.004	<5.241	<12.19	<6.685	<11.74	<5.606	<9.438	<10.10	<5.843	<4.675	<24.79	<8.302
L75388-5	MRDOWN GG	11/13/17	<7.918	<7.668	<20.00	<8.401	<20.98	<8.400	<16.05	<13.78	<7.893	<5.910	<37.00	<14.91
L75388-7	MRUP GG	11/13/17	<6.133	<6.175	<12.82	<6.022	<12.70	<6.265	<10.18	<11.63	<7.209	<6.379	<33.68	<14.26
L75389-1	MRDOWN*	11/13/17	<6.726	<5.228	<11.25	<6.232	<12.32	<6.181	<10.37	<10.43	<7.363	<5.855	<30.91	<11.21
L75389-3	MRDOWN GG*	11/13/17	<6.465	<5.055	<14.33	<6.448	<12.15	<6.025	<11.61	<11.04	<8.153	<6.760	<30.98	<12.00

"GG" – indicates duplicate sample

* Annual Sample collected during liquid discharge

Table A3.2
Sample Type: Surface Water
Analysis: Tritium
Units: pCi/L
SURFACE WATER SAMPLES (TRITIUM)

LLD (pCi/L) LAB ID	LOCATION	DATE	3000 H-3	
L71228-1	OUTFALL 007	01/05/17	<474	
L71560-1	OUTFALL 007	02/01/17	<562	
L71560-2	OUTFALL 007 GG	02/01/17	<557	
L71724-2	MRDOWN	02/13/17	<571	
L71724-4	MRUP	02/13/17	<552	
L71724-6	MRDOWN GG	02/13/17	<558	
L71724-8	MRUP GG	02/13/17	<561	
L71952-1	OUTFALL 007	03/08/17	780	±684
L72419-1	OUTFALL 007	04/12/17	<559	
L72821-1	OUTFALL 007	05/11/17	<519	
L72821-2	OUTFALL 007 GG	05/11/17	<539	
L72822-2	MRDOWN	05/10/17	<536	
L72822-4	MRUP	05/10/17	<520	
L72822-6	MRDOWN GG	05/10/17	<542	
L72822-8	MRUP GG	05/10/17	<537	
L73190-1	OUTFALL 007	06/12/17	<526	
L73531-1	OUTFALL 007	07/06/17	<479	
L73531-2	OUTFALL 007 GG	07/06/17	<480	
L73590-1	OUTFALL 007	07/11/17	<473	
L73981-2	MRDOWN	08/01/17	<510	
L73981-4	MRUP	08/01/17	<506	
L74063-1	OUTFALL 007	08/09/17	1030	±650
L74063-2	OUTFALL 007 GG	08/09/17	828	±615
L74478-1	OUTFALL 007	09/06/17	<512	
L74478-2	OUTFALL 007 GG	09/06/17	<509	
L74868-1	OUTFALL 007	10/11/17	<573	
L75294-1	OUTFALL 007	11/08/17	<580	
L75294-2	OUTFALL 007 GG	11/08/17	<576	
L75388-2	MRDOWN	11/13/17	<552	
L75388-4	MRUP	11/13/17	<546	
L75388-6	MRDOWN GG	11/13/17	<550	
L75388-8	MRUP GG	11/13/17	<544	
L75389-2	MRDOWN*	11/13/17	<557	
L75389-4	MRDOWN GG*	11/13/17	<550	
L75613-1	OUTFALL 007	12/07/17	<504	

* Annual Sample collected during liquid discharge
"GG" – indicates duplicate sample

Table A4.1
Sample Type: Ground Water
Analysis: Gamma Isotopic
Units: pCi/L
GROUND WATER SAMPLES (GAMMA)

LLD (pCi/L)			15	15	30	15	30	15	30	15	18	60	15
LAB ID	LOCATION	DATE	MN-54	CO-58	FE-59	CO-60	ZN-65	NB-95	ZR-95	CS-134	CS-137	BA-140	LA-140
L75408-1	PGWELL	11/17/17	<6.991	<6.898	<12.43	<8.757	<12.14	<7.25	<13.1	<7.523	<7.262	<28.34	<10.19
L75408-5	CONSTWELL 3	11/17/17	<7.183	<7.958	<15.94	<4.856	<15.04	<8.455	<10.6	<7.02	<6.631	<26.23	<4.362
L75408-9	CONSTWELL 4	11/17/17	<4.882	<4.625	<13.26	<6.676	<14.13	<3.919	<11.04	<6.439	<6.291	<25.62	<8.37

Table A4.2
Sample Type: Ground Water
Analysis: Tritium
Units: pCi/L
GROUND WATER SAMPLES (TRITIUM)

LLD (pCi/L) LAB ID	LOCATION	DATE	2000 H-3
L75408-3	PGWELL	11/17/17	<511
L75408-4	PGWELL GG	11/17/17	<507
L75408-7	CONSTWELL 3	11/17/17	<497
L75408-8	CONSTWELL 3 GG	11/17/17	<508
L75408-11	CONSTWELL 4	11/17/17	<511
L75408-12	CONSTWELL 4 GG	11/17/17	<507

"GG" – indicates duplicate sample.

Table A4.3
Sample Type: Ground Water
Analysis: Iodine-131
Units: pCi/L
GROUND WATER SAMPLES (IODINE-131)

LLD (pCi/L) LAB ID	LOCATION	DATE	1 I-131
L75408-2	PGWELL	11/17/17	<0.511
L75408-6	CONSTWELL 3	11/17/17	<0.459
L75408-10	CONSTWELL 4	11/17/17	<0.471

Table A5.1
Sample Type: Sediment
Analysis: Gamma Isotopic
Units: pCi/kg
SEDIMENT SAMPLES (GAMMA)

LLD (pCi/kg) LAB ID	LOCATION	DATE	150 CS-134	180 CS-137
L74537-1	SEDHAM	09/13/17	<71.02	<61.73
L74537-2	SEDCONT	09/13/17	<48.24	<48.8
L74537-3	SEDHAM GG	09/13/17	<87.24	<63.49
L74537-4	SEDCONT GG	09/13/17	<46.2	<31.56

"GG" – indicates duplicate sample.

Table A6.1
Sample Type: Fish
Analysis: Gamma Isotopic
Units: pCi/kg
FISH SAMPLES (GAMMA)

LLD (pCi/kg) LAB ID	LOCATION	DATE	130 MN-54	130 CO-58	260 FE-59	130 CO-60	260 ZN-65	130 CS-134	150 CS-137
L74616-1	FISHUP	09/15/17	<43.60	<46.07	<89.51	<50.38	<101.7	<48.94	<38.28
L74616-2	FISHDOWN	09/15/17	<36.25	<45.13	<104.5	<41.9	<97.86	<44.52	<46.7
L74616-3	FISHUP GG	09/15/17	<71.94	<89.67	<127.8	<70.33	<160.7	<79.53	<80.55
L74616-4	FISHDOWN GG	09/15/17	<74.45	<58.66	<184.3	<71.02	<159.2	<75.28	<72.97

"GG" – indicates duplicate sample.

Table A7.1
Sample Type: Vegetation
Analysis: Gamma Isotopic
Units: pCi/kg
VEGETATION SAMPLES (GAMMA)

LLD (pCi/kg) LAB ID	LOCATION	DATE	60 I-131	60 CS-134	80 CS-137
L71758-1	VEG-CONT	02/22/17	<59.43	<36.19	<48.42
L71758-2	VEG-J	02/22/17	<57.13	<37.29	<38.17
L72971-1	VEG-CONT	05/25/17	<41.83	<31.02	<22.84
L72971-2	VEG-J	05/25/17	<44.88	<29.07	<25.08
L74209-1	VEG-CONT	08/17/17	<55.69	<34.73	<29.14
L74209-2	VEG-J	08/17/17	<53.91	<33.25	<28.6
L75382-1	VEG-CONT	11/16/17	<25.94	<26.48	<22.79
L75382-2	VEG-J	11/16/17	<29.11	<19.24	<28.64

Table A 8.1
Sample Type: Special Samples
Analysis: Gamma Isotopic
Units: pCi/L, pCi/kg

SPECIAL SURFACE WATER SAMPLES (GAMMA)

LLD (pCi/L) LAB ID	LOCATION	DATE	15 MN-54	15 CO-58	30 FE-59	15 CO-60	30 ZN-65	15 NB-95	30 ZR-95	15 I-131	15 CS-134	18 CS-137	60 BA-140	15 LA-140
L72088-1	OUTFALL 007	03/16/17	<5.044	<6.220	<10.79	<6.782	<11.64	<6.176	<10.39	<14.27	<4.956	<4.803	<30.38	<9.151
L73345-1	OUTFALL 007	06/21/17	<8.072	<6.231	<11.39	<9.341	<11.48	<6.398	<9.304	<11.14	<7.913	<7.760	<32.19	<12.41
L74565-1	OUTFALL 007	09/06/17	<2.435	<2.822	<6.553	<2.366	<5.452	<2.818	<4.878	<14.84	<2.746	<2.566	<26.34	<7.988
L74565-2	OUTFALL 007 GG	09/06/17	<2.346	<2.604	<6.299	<2.304	<5.067	<2.908	<4.408	<12.99	<2.697	<2.523	<24.12	<7.755
L75624-1	OUTFALL 007	12/07/17	<6.120	<5.570	<11.11	<6.367	<14.38	<7.599	<9.833	<10.88	<6.704	<6.117	<29.16	<11.92

"GG" – indicates duplicate sample.

SPECIAL MEAT SAMPLES (GAMMA)

LLD (pCi/kg) LAB ID	LOCATION	DATE	130 MN-54	130 CO-58	260 FE-59	130 CO-60	260 ZN-65	130 CS-134	150 CS-137
L76168-1	Meat 1	12/31/17	<48.62	<77.51	<122.4	<41.92	<104.6	<79.74	<63.87

Table A 9.1
Sample Type: Quality Assurance Report
Analysis: Environmental Dosimeters

STANFORD DOSIMETRY

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2017

Prepared By: _____ Date: 3/7/18

Approved By: _____ Date: 3/7/18

Environmental Dosimetry Company
10 Ashton Lane
Sterling, MA 01564

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EXECUTIVE SUMMARY

Routine quality control (QC) testing was performed for dosimeters issued by the Environmental Dosimetry Company (EDC) .

During this annual period100% (72/72) of the individual dosimeters, evaluated against the EDC internal performance acceptance criteria (high-energy photons only), met the criterion for accuracy and 100% (72/72) met the criterion for precision (Table 1). In addition, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance limits met EDC acceptance criteria (Table 2) and 100% (6/6) of independent testing passed the performance criteria (Table 3). Trending graphs, which evaluate performance statistic for high-energy photon irradiations and co-located stations are given in Appendix A.

One internal assessment and one external audit were performed in 2017.There were no findingsidentified.

I. INTRODUCTION

The TLD systems at the Environmental Dosimetry Company (EDC) are calibrated and operated to ensure consistent and accurate evaluation of TLDs. The quality of the dosimetric results reported to EDC clients is ensured by in-house performance testing and independent performance testing by EDC clients, and both internal and client directed program assessments.

The purpose of the dosimetry quality assurance program is to provide performance documentation of the routine processing of EDC dosimeters. Performance testing provides a statistical measure of the bias and precision of dosimetry processing against a reliable standard, which in turn points out any trends or performance changes. Two programs are used:

A. QC Program

Dosimetry quality control tests are performed on EDC Panasonic 814 Environmental dosimeters. These tests include: (1) the in-house testing program coordinated by the EDC QA Officer and (2) independent test perform by EDC clients. In-house test are performed using six pairs of 814 dosimeters, a pair is reported as an individual result and six pairs are reported as the mean result.Results of these tests are described in this report.

Excluded from this report are instrumentation checks. Although instrumentation checks represent an important aspect of the quality assurance program, they are not included as process checks in this report. Instrumentation checks represent between 5-10% of the TLDs processed.

B. QA Program

An internal assessment of dosimetry activities is conducted annually by the Quality Assurance Officer (Reference 1). The purpose of the assessment is to review procedures, results, materials or components to identify opportunities to improve or enhance processes and/or services.

II. PERFORMANCE EVALUATION CRITERIA

A. Acceptance Criteria for Internal Evaluations

1. Bias

For each dosimeter tested, the measure of bias is the percent deviation of the reported result relative to the delivered exposure. The percent deviation relative to the delivered exposure is calculated as follows:

$$\frac{(H_i' - H_i)}{H_i} 100$$

where:

H_i' = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated dosimeter (i.e., the delivered exposure)

2. Mean Bias

For each group of test dosimeters, the mean bias is the average percent deviation of the reported result relative to the delivered exposure. The mean percent deviation relative to the delivered exposure is calculated as follows:

$$\sum\left(\frac{(H_i' - H_i)}{H_i}\right)100\left(\frac{1}{n}\right)$$

where:

H_i' = the corresponding reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

H_i = the exposure delivered to the i^{th} irradiated test dosimeter (i.e., the delivered exposure)

n = the number of dosimeters in the test group

3. Precision

For a group of test dosimeters irradiated to a given exposure, the measure of precision is the percent deviation of individual results relative to the mean reported exposure. At least two values are required for the determination of precision. The measure of precision for the i^{th} dosimeter is:

$$\left(\frac{(H_i' - \bar{H})}{\bar{H}}\right)100$$

where:

H_i' = the reported exposure for the i^{th} dosimeter (i.e., the reported exposure)

$\bar{H}$ = the mean reported exposure; i.e., $\bar{H} = \sum H_i'\left(\frac{1}{n}\right)$

n = the number of dosimeters in the test group

4. EDC Internal Tolerance Limits

All evaluation criteria are taken from the "EDC Quality System Manual," (Reference 2). These criteria are only applied to individual test dosimeters irradiated with high-energy photons (Cs-137) and are as follows for Panasonic Environmental dosimeters: ± 15% for bias and ± 12.8% for precision.

B. QC Investigation Criteria and Result Reporting

EDC Quality System Manual (Reference 2) specifies when an investigation is required due to a QC analysis that has failed the EDC bias criteria. The criteria are as follows:

1. No investigation is necessary when an individual QC result falls outside the QC performance criteria for accuracy.

2. Investigations are initiated when the mean of a QC processing batch is outside the performance criterion for bias.

C. Reporting of Environmental Dosimetry Results to EDC Customers

1. All results are to be reported in a timely fashion.

2. If the QA Officer determines that an investigation is required for a process, the results shall be issued as normal. If the QC results prompting the investigation have a mean bias from the known of greater than ±20%, the results shall be issued with a note indicating that they may be updated in the future, pending resolution of a QA issue.

3. Environmental dosimetry results do not require updating if the investigation has shown that the mean bias between the original results and the corrected results, based on applicable correction factors from the investigation, does not exceed ±20%.

III. DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2017

A. General Discussion

Results of performance tests conducted are summarized and discussed in the following sections. Summaries of the performance tests for the reporting period are given in Tables 1 through 3 and Figures 1 through 4.

Table 1 provides a summary of individual dosimeter results evaluated against the EDC internal acceptance criteria for high-energy photons only. During this period100% (72/72) of the individual dosimeters, evaluated against these criteria, met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision. A graphical interpretation is provided in Figures 1 and 2.

Table 2 provides the biasand standard deviation results for each group (N=6) of dosimeters evaluated against the internal tolerance criteria. Overall,100% (12/12) of the dosimeter sets, evaluated against the internal tolerance performance criteria, met these criteria. A graphical interpretation is provided in Figure 3.

Table 3 presents the independent blind spike results for dosimeters processed during this annual period. All results passed the performance acceptance criterion. Figure 4 is a graphical interpretation of Seabrook Station blind co-located station results.

B. Result Trending

One of the main benefits of performing quality control tests on a routine basis is to identify trends or performance changes. The results of the Panasonic environmental dosimeter performance tests are presented in Appendix A. The results are evaluated against each of the performance criteria listed in Section II, namely: individual dosimeter accuracy, individual dosimeter precision, and mean bias.

All of the results presented in Appendix A are plotted sequentially by processing date.

IV. STATUS OF EDC CONDITION REPORTS (CR)

No condition reports were issued during this annual period.

V. STATUS OF AUDITS/ASSESSMENTS

1. Internal

EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2017. There were no findings identified.

2. External

The DTE Energy and NextEra Energy Audit 17-007 was conducted on August 8-9, 2017. There were no findings identified.

VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2017

Two procedures and the Quality System Manual were reissued with no changes as part of the 5 year review cycle.

VII. CONCLUSION AND RECOMMENDATIONS

The quality control evaluations continue to indicate the dosimetry processing programs at the EDC satisfy the criteria specified in the Quality System Manual. The EDC demonstrated the ability to meet all applicable acceptance criteria.

VIII. REFERENCES

1. EDC Quality Control and Audit Assessment Schedule, 2017.

2. EDC Manual 1, Quality System Manual, Rev. 3, August 1, 2017.

TABLE 1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2017[1], [2]

Dosimeter Type	Number Tested	% Passed Bias Criteria	% Passed Precision Criteria
Panasonic Environmental	72	100	100

[1]This table summarizes results of tests conducted by EDC.
[2]Environmental dosimeter results are free in air.

TABLE 2

MEAN DOSIMETER ANALYSES (N=6) JANUARY – DECEMBER 2017[1], [2]

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/- 15%
5/01/2017	31	1.0	0.9	Pass
5/08/2017	57	-0.4	1.0	Pass
5/08/2017	85	0.8	2.4	Pass
7/25/2017	36	-2.5	1.7	Pass
07/29/2017	67	5.5	1.0	Pass
8/8/2017	123	-3.8	0.9	Pass
10/23/2017	44	3.8	2.8	Pass
10/31/2017	74	1.7	1.2	Pass
11/12/2017	94	0.5	1.0	Pass
2/01/2018	27	2.6	1.4	Pass
2/06/2018	50	3.0	0.6	Pass
2/08/2018	105	0.5	2.0	Pass

[1]This table summarizes results of tests conducted by EDC for TLDs issued in 2017.
[2]Environmental dosimeter results are free in air.

TABLE 3
SUMMARY OF INDEPENDENT DOSIMETER TESTING JANUARY – DECEMBER 2017[1], [2]

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2017	Millstone	2.9	1.5	Pass
2nd Qtr.2017	Millstone	2.8	1.2	Pass
3rd Qtr. 2017	Millstone	1.1	2.7	Pass
4th Qtr.2017	Millstone	-3.5	2.4	Pass
4th Qtr.2017	Seabrook	8.6	1.6	Pass

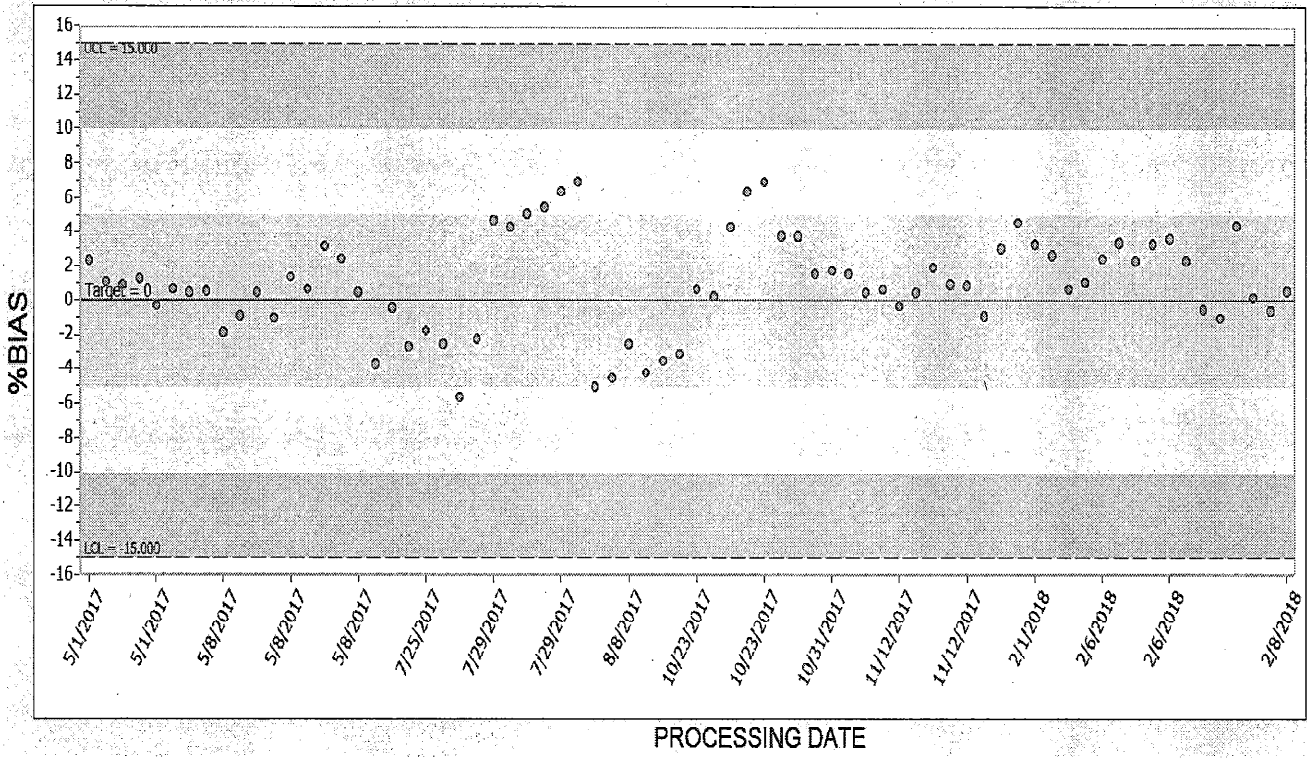
[1]Performance criteria are +/- 30%.
[2]Blind spikeirradiations using Cs-137

APPENDIX A

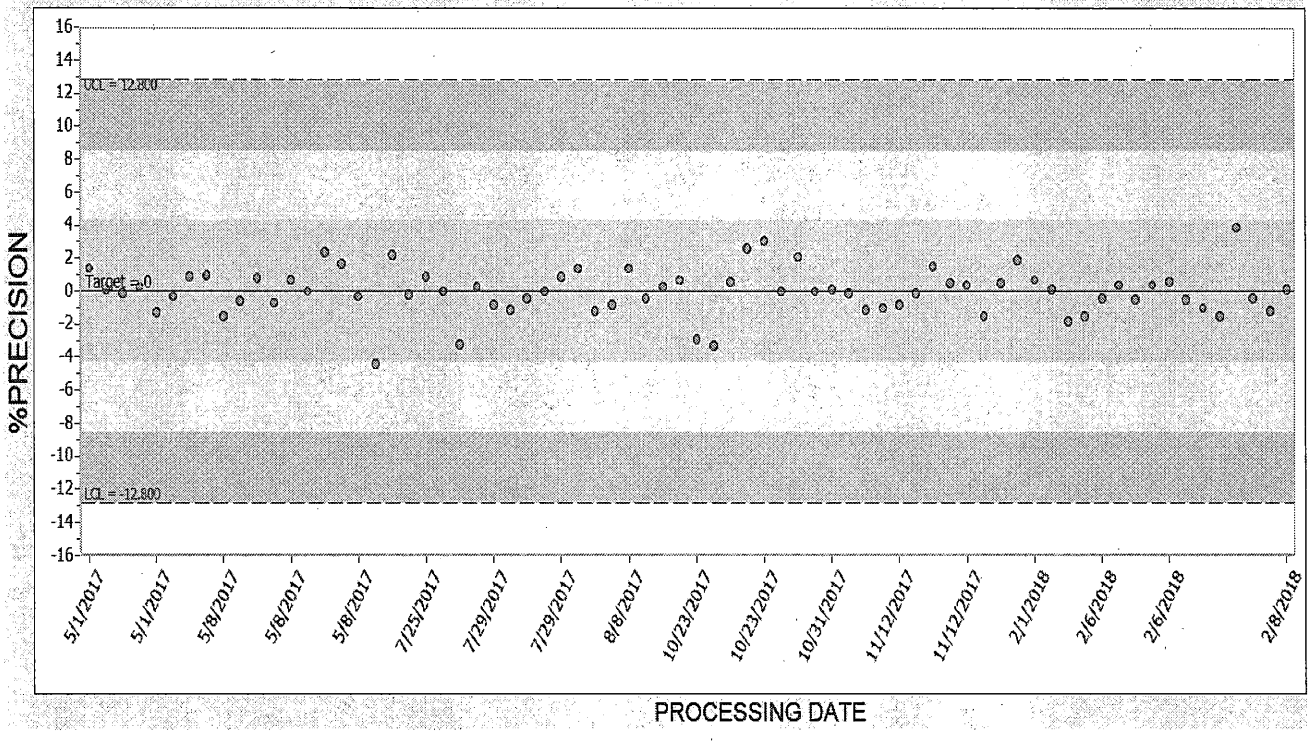
DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

ISSUE PERIOD JANAURY - DECEMBER 2017

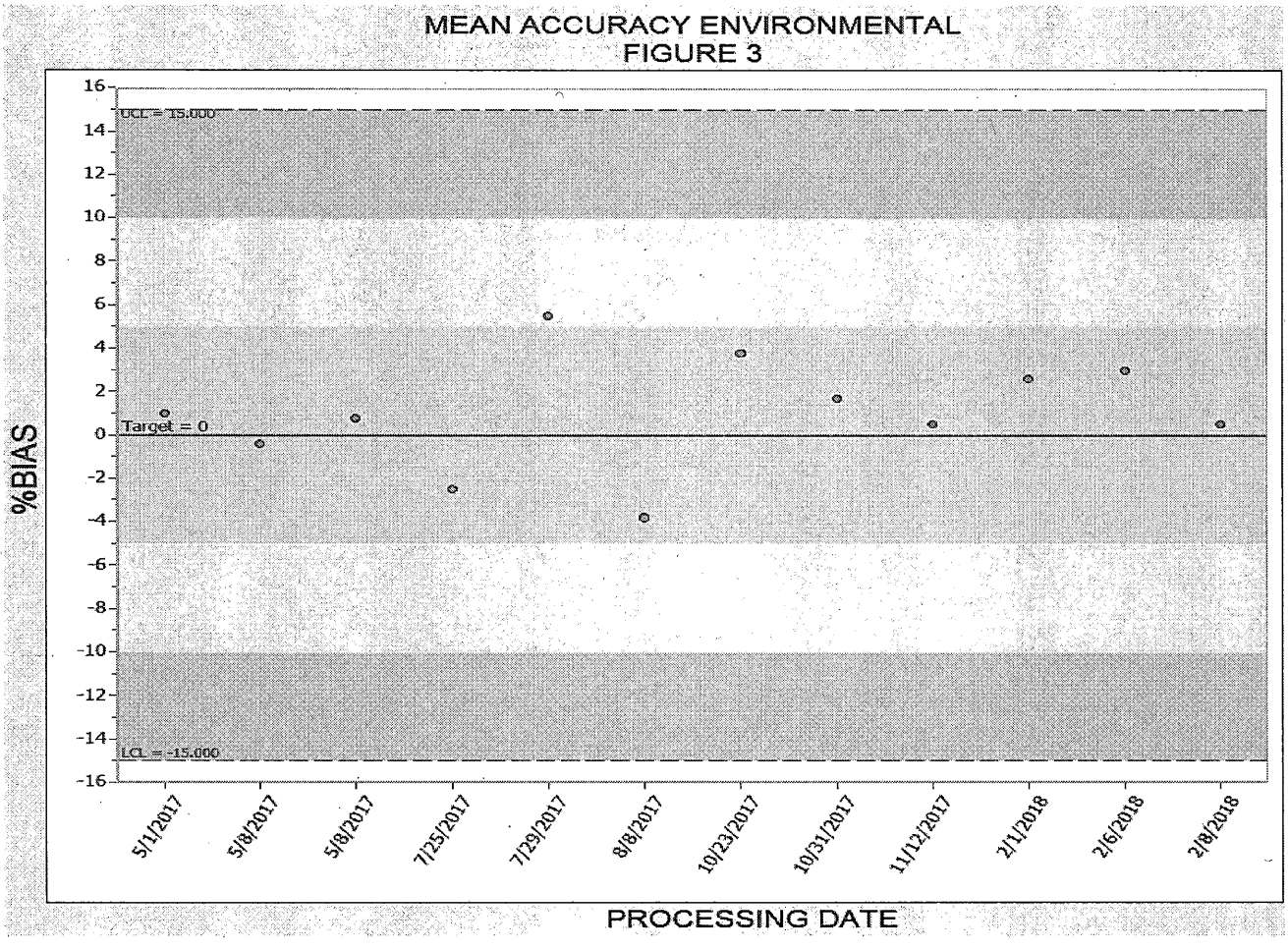
INDIVIDUAL ACCURACY ENVIRONMENTAL
FIGURE 1



INDIVIDUAL PRECISION ENVIRONMENTAL
FIGURE 2



MEAN ACCURACY ENVIRONMENTAL
FIGURE 3



SEABROOK CO-LOCATE ACCURACY
FIGURE 4

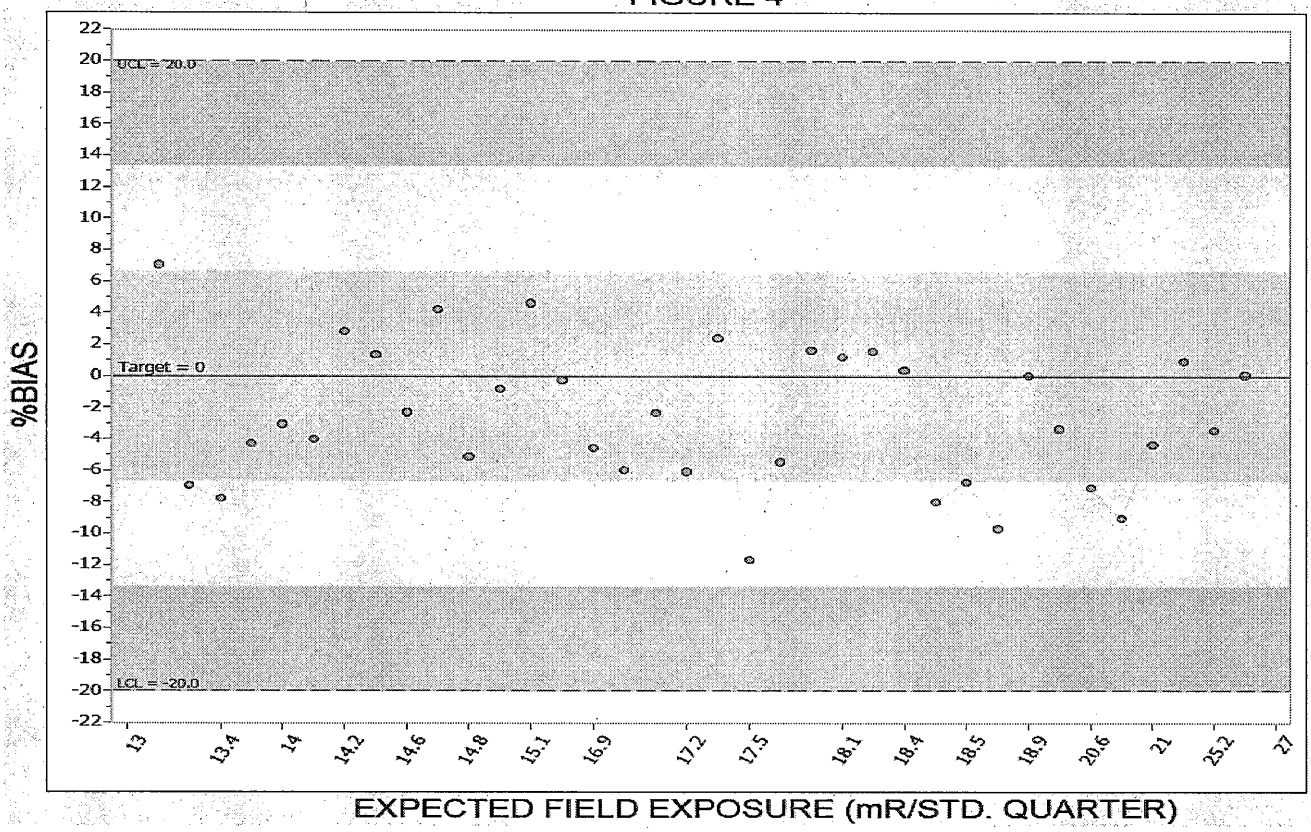


Table A.9.2
Sample Type: Quality Assurance Report
Matrix: Milk, Soil, Liquid, Vegetation, Air Charcoal, Air Particulate, Water

TELEDYNE BROWN ENGINEERING

Summary of Results – Inter-laboratory Comparison Program (ICP)

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate, air iodine, milk, soil, vegetation, and water matrices for various analytes. The PE samples supplied by Analytics Inc., Environmental Resource Associates (ERA) and Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP), were evaluated against the following pre-set acceptance criteria:

A. Analytics Evaluation Criteria

Analytics' evaluation report provides a ratio of TBE's result and Analytics' known value. Since flag values are not assigned by Analytics, TBE evaluates the reported ratios based on internal QC requirements based on the DOE MAPEP criteria.

B. ERA Evaluation Criteria

ERA's evaluation report provides an acceptance range for control and warning limits with associated flag values. ERA's acceptance limits are established per the USEPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

C. DOE Evaluation Criteria

MAPEP's evaluation report provides an acceptance range with associated flag values. MAPEP defines three levels of performance:

- Acceptable (flag = "A") - result within ± 20% of the reference value
- Acceptable with Warning (flag = "W") - result falls in the ± 20% to ± 30% of the reference value
- Not Acceptable (flag = "N") – bias is greater than 30% of the reference value

Note: The Department of Energy (DOE) Mixed Analyte Performance Evaluation Program (MAPEP) samples are created to mimic conditions found at DOE sites which do not resemble typical environmental samples obtained at commercial nuclear power facilities.

For the TBE laboratory, 168 out of 173 analyses performed met the specified acceptance criteria. Five analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

1. The ERA April 2017 two nuclides in water were evaluated as *Not Acceptable*. (NCR 17-09)

   a. The Zn-65 result of 39.3 pCi/L, exceeded the lower acceptance limit of 47.2. The known value was unusually low for this study. The sample was run in duplicate on two different detectors. The results of each were 39.3 ± 18.2 pCi/L (46% error and lower efficiency) and 59.3 ± 8.23 pCi/L (13.9% error and higher efficiency). The result from the 2nd detector would have been well within the acceptable range (47.2 – 65.9) and 110.2% of the known value of 53.8 pCi/L.

   b. The Sr-89 result of 40.7 pCi/L exceeded the lower acceptance limit of 53.8. All associated QC and recoveries were reviewed and no apparent cause could be determined for the failure. The prior three cross-check results were from 99 – 115% of the known values and the one that followed this sample (November, 2017) was 114% of the known value.

2. The DOE MAPEP August 2017 air particulate U-238 result of 0.115 ± 0.025 Bq/sample was higher than the known value of 0.087 ± 0.002 with a ratio of 1.32, therefore the upper ratio of 1.30 (acceptable with warning) was exceeded. TBE's result with error easily overlaps with the acceptable range. MAPEP does not evaluate results with any associated error. Also, the spike level for this sample was very low (2.35 pCi) compared to TBE's normal LCS of 6 pCi. TBE considers this result as passing. (NCR 17-15)

3. The Analytics September 2017 soil Cr-51 result was evaluated as *Not Acceptable* (Ratio of TBE to known result at 0.65). The reported value was 0.230 ± 0.144 pCi/g and the known value was 0.355 ± 0.00592 pCi/g. The sample was counted overnight for 14 hours, however the Cr-51 was spiked at a very low level and had a counting error of 65%. Cr-51 has a 27-day half-life, making low-level quantification even more difficult. The error does not appear to have been taken into consideration for this result. If it had been evaluated with the error, the highest result would have been 105% of the reference value, which is acceptable. Also, the known value is significantly lower than TBE's typical MDC for this nuclide in a soil matrix and would typically not be reported to clients (unless specified). The results of all of the previous cross-checks have been in the acceptable (80 – 120%) range. TBE will evaluate further upon completion of the next ICP sample. (NCR 17-16)

4. The ERA November 2017 water Sr-90 sample was evaluated as *Not Acceptable*. TBE's result of 27.1 pCi/L exceeded the lower acceptance range (30.8 – 48.0 pCi/L). After reviewing the associated QC data for this sample, it was determined that although the spike recovery for Sr-90 was within our laboratory guidelines (70% -130%), both the spike result and our ERA result were biased low. The original cross-check sample was completely consumed and we were unable to reanalyze before

submitting the result. We have modified our preparation process to avoid this situation for future cross-check samples. We also have enhanced LIMS programming to force a LCSD when a workgroup includes cross-check samples (as opposed to running a DUP). (NCR 17-19)

The Inter-Laboratory Comparison Program provides evidence of "in control" counting systems and methods, and that the laboratories are producing accurate and reliable data.

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Ratio of TBE to Analytics Result	Evaluation [b]
March 2017	E11811	Milk	Sr-89	pCi/L	87	97.7	0.89	A
			Sr-90	pCi/L	12.4	16.2	0.77	A
	E11812	Milk	Ce-141	pCi/L	135	145	0.93	A
			Co-58	pCi/L	153	150	1.02	A
			Co-60	pCi/L	182	183	1.00	A
			Cr-51	pCi/L	258	290	0.89	A
			Cs-134	pCi/L	104	120	0.87	A
			Cs-137	pCi/L	142	140	1.02	A
			Fe-59	pCi/L	135	129	1.05	A
			I-131	pCi/L	92.6	97.9	0.95	A
			Mn-54	pCi/L	173	164	1.05	A
			Zn-65	pCi/L	208	199	1.04	A
	E11813	Charcoal	I-131	pCi	92	93.9	0.98	A
	E11814	AP	Ce-141	pCi	99.9	101	0.99	A
			Co-58	pCi	95.4	104	0.92	A
			Co-60	pCi	140	127	1.10	A
			Cr-51	pCi	211	201	1.05	A
			Cs-134	pCi	82.1	83.2	0.99	A
			Cs-137	pCi	92.8	97.0	0.96	A
			Fe-59	pCi	107	89.3	1.20	A
			Mn-54	pCi	106	114	0.93	A
			Zn-65	pCi	137	138	0.99	A
	E11816	Soil	Ce-141	pCi/g	0.258	0.250	1.03	A
			Co-58	pCi/g	0.241	0.258	0.93	A
			Co-60	pCi/g	0.312	0.315	0.99	A
			Cr-51	pCi/g	0.439	0.500	0.88	A
			Cs-134	pCi/g	0.176	0.207	0.85	A
			Cs-137	pCi/g	0.304	0.317	0.96	A
			Fe-59	pCi/g	0.210	0.222	0.95	A
			Mn-54	pCi/g	0.292	0.283	1.03	A
			Zn-65	pCi/g	0.353	0.344	1.03	A
	E11815	Water	Fe-55	pCi/L	1600	1890	0.85	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Ratio of TBE to Analytics Result	Evaluation [b]
June 2017	E11844	Milk	Sr-89	pCi/L	81.3	92.6	0.88	A
			Sr-90	pCi/L	12.1	13.5	0.90	A
	E11846	Milk	Ce-141	pCi/L	142	151	0.94	A
			Co-58	pCi/L	147	155	0.95	A
			Co-60	pCi/L	185	191	0.97	A
			Cr-51	pCi/L	321	315	1.02	A
			Cs-134	pCi/L	168	188	0.89	A
			Cs-137	pCi/L	148	150	0.99	A
			Fe-59	pCi/L	116	115	1.01	A
			I-131	pCi/L	102	93.6	1.09	A
			Mn-54	pCi/L	168	172	0.98	A
			Zn-65	pCi/L	195	204	0.96	A
	E11847	Charcoal	I-131	pCi	87.9	84.8	1.04	A
	E11845	AP	Sr-89	pCi	70.8	79.1	0.90	A
			Sr-90	pCi	9.10	11.5	0.79	W
	E11848	AP	Ce-141	pCi	112	116	0.96	A
			Co-58	pCi	119	119	1.00	A
			Co-60	pCi	171	146	1.17	A
			Cr-51	pCi	270	241	1.12	A
			Cs-134	pCi	152	144	1.05	A
			Cs-137	pCi	114	115	0.99	A
			Fe-59	pCi	94.1	88.3	1.07	A
			Mn-54	pCi	139	132	1.06	A
			Zn-65	pCi	141	156	0.90	A
	E11849	Water	Fe-55	pCi/L	1840	1890	0.97	A
July 2017	E11901	AP	GR-A	pCi	50.1	44.2	1.13	A
			GR-B	pCi	218	233	0.93	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

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W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Ratio of TBE to Analytics Result	Evaluation [b]
September 2017	E11914	Milk	Sr-89	pCi/L	84.3	82.7	1.02	A
			Sr-90	pCi/L	12.6	12.1	1.04	A
	E11915	Milk	Ce-141	pCi/L	93.9	87.0	1.08	A
			Co-58	pCi/L	115	117	0.98	A
			Co-60	pCi/L	265	262	1.01	A
			Cr-51	pCi/L	273	217	1.26	W
			Cs-134	pCi/L	186	201	0.93	A
			Cs-137	pCi/L	175	172	1.02	A
			Fe-59	pCi/L	137	125	1.09	A
			I-131	pCi/L	78.0	71.0	1.10	A
			Mn-54	pCi/L	128	123	1.04	A
			Zn-65	pCi/L	206	184	1.12	A
	E11916	Charcoal	I-131	pCi	71.9	64.4	1.12	A
	E11917	AP	Ce-141	pCi	80.1	86.3	0.93	A
			Co-58	pCi	110	116	0.95	A
			Co-60	pCi	277	260	1.07	A
			Cr-51	pCi	275	215	1.28	W
			Cs-134	pCi	192	199	0.96	A
			Cs-137	pCi	165	170	0.97	A
			Fe-59	pCi	122	124	0.98	A
			Mn-54	pCi	120	122	0.99	A
			Zn-65	pCi	175	183	0.96	A
	E11918	Water	Fe-55	pCi/L	1630	1630	1.00	A
	E11919	Soil	Ce-141	pCi/g	0.136	0.142	0.96	A
			Co-58	pCi/g	0.179	0.191	0.94	A
			Co-60	pCi/g	0.405	0.429	0.94	A
			Cr-51	pCi/g	0.230	0.355	0.65	N [1]
			Cs-134	pCi/g	0.272	0.328	0.83	A
			Cs-137	pCi/g	0.336	0.356	0.94	A
			Fe-59	pCi/g	0.210	0.205	1.02	A
			Mn-54	pCi/g	0.210	0.201	1.05	A
			Zn-65	pCi/g	0.301	0.301	1.00	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) See NCR 17-16

Analytics Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Ratio of TBE to Analytics Result	Evaluation [b]
December 2017	E12054	Milk	Sr-89	pCi/L	92.1	92.3	1.00	A
			Sr-90	pCi/L	18.3	16.9	1.09	A
	E12055	Milk	Ce-141	pCi/L	97.8	98.3	0.99	A
			Co-58	pCi/L	92.3	89.9	1.03	A
			Co-60	pCi/L	176	173	1.02	A
			Cr-51	pCi/L	226	242	0.93	A
			Cs-134	pCi/L	118	125	0.95	A
			Cs-137	pCi/L	148	141	1.05	A
			Fe-59	pCi/L	123	113	1.08	A
			I-131	pCi/L	66.0	57.8	1.14	A
			Mn-54	pCi/L	173	161	1.08	A
			Zn-65	pCi/L	233	211	1.10	A
	E12056	Charcoal	I-131	pCi	48.1	47.5	1.01	A
	E12057A	AP	Ce-141	pCi	108	111	0.97	A
			Co-58	pCi	89.5	102	0.88	A
			Co-60	pCi	223	196	1.14	A
			Cr-51	pCi	311	274	1.13	A
			Cs-134	pCi	141	142	1.00	A
			Cs-137	pCi	162	160	1.01	A
			Fe-59	pCi	121	129	0.94	A
			Mn-54	pCi	177	182	0.97	A
			Zn-65	pCi	203	239	0.85	A
	E12058	Water	Fe-55	pCi/L	1970	1740	1.13	A
	E12059	AP	Sr-89	pCi	71.2	87.4	0.81	A
			Sr-90	pCi	12.9	16.0	0.81	A

(a) The Analytics known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) Analytics evaluation based on TBE internal QC limits:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

DOE's Mixed Analyte Performance Evaluation Program (MAPEP)
Teledyne Brown Engineering Environmental Services

Month/Year	Identification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Acceptance Range	Evaluation [b]
February 2017	17-MaS36	Soil	Ni-63	Bq/kg	-5.512		*(1)*	A
			Sr-90	Bq/kg	571	624	437 - 811	A
	17-MaW36	Water	Am-241	Bq/L	0.693	0.846	0.592 - 1.100	A
			Ni-63	Bq/L	13.4	12.2	8.5 - 15.9	A
			Pu-238	Bq/L	0.7217	0.703	0.492 - 0.914	A
			Pu-239/240	Bq/L	0.9277	0.934	0.654 - 1.214	A
	17-RdF36	AP	U-234/233	Bq/sample	0.0911	0.104	0.073 - 0.135	A
			U-238	Bq/sample	0.0967	0.107	0.075 - 0.139	A
	17-RdV36	Vegetation	Cs-134	Bq/sample	6.44	6.95	4.87 - 9.04	A
			Cs-137	Bq/sample	4.61	4.60	3.22 - 5.98	A
			Co-57	Bq/sample	-0.0229		*(1)*	A
			Co-60	Bq/sample	8.52	8.75	6.13 - 11.38	A
			Mn-54	Bq/sample	3.30	3.28	2.30 - 4.26	A
			Sr-90	Bq/sample	1.30	1.75	1.23 - 2.28	W
			Zn-65	Bq/sample	5.45	5.39	3.77 - 7.01	A
August 2017	17-MaS37	Soil	Ni-63	Bq/kg	1130	1220	854 - 1586	A
			Sr-90	Bq/kg	296	289	202 - 376	A
	17-MaW37	Water	Am-241	Bq/L	0.838	0.892	0.624 - 1.160	A
			Ni-63	Bq/L	-0.096		*(1)*	A
			Pu-238	Bq/L	0.572	0.603	0.422 - 0.784	A
			Pu-239/240	Bq/L	0.863	0.781	0.547 - 1.015	A
	17-RdF37	AP	U-234/233	Bq/sample	0.103	0.084	0.059 - 0.109	W
			U-238	Bq/sample	0.115	0.087	0.061 - 0.113	N [2]
	17-RdV37	Vegetation	Cs-134	Bq/sample	2.34	2.32	1.62 - 3.02	A
			Cs-137	Bq/sample	0.05		*(1)*	A
			Co-57	Bq/sample	3.32	2.8	2.0 - 3.6	A
			Co-60	Bq/sample	2.09	2.07	1.45 - 2.69	A
			Mn-54	Bq/sample	2.90	2.62	1.83 - 3.41	A
			Sr-90	Bq/sample	1.17	1.23	0.86 - 1.60	A
			Zn-65	Bq/sample	6.07	5.37	3.76 - 6.98	A

(a) The MAPEP known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation

(b) DOE/MAPEP evaluation:

A = Acceptable - reported result falls within ratio limits of 0.80-1.20

W = Acceptable with warning - reported result falls within 0.70-0.80 or 1.20-1.30

N = Not Acceptable - reported result falls outside the ratio limits of < 0.70 and > 1.30

(1) False positive test

(2) See NCR 17-15

ERA Environmental Radioactivity Cross Check Program
Teledyne Brown Engineering Environmental Services

Month/Year	Identrification Number	Matrix	Nuclide	Units	TBE Reported Value	Known Value [a]	Acceptance Limits	Evaluation [b]
March 2017	MRAD-26	AP	GR-A	pCi/sample	76.3	85.5	28.6 - 133	A
April 2017	RAD-109	Water	Ba-133	pCi/L	49.2	49.7	40.8 - 55.1	A
			Cs-134	pCi/L	83.2	90.1	74.0 - 99.1	A
			Cs-137	pCi/L	202	206	185 - 228	A
			Co-60	pCi/L	51.2	54.7	49.2 - 62.7	A
			Zn-65	pCi/L	39.3	53.8	47.2 - 65.9	N [1]
			GR-A	pCi/L	53.6	75.0	39.5 - 92.3	A
			GR-B	pCi/L	42.7	38.5	25.5 - 46.0	A
			U-Nat	pCi/L	50.1	55.6	45.2 - 61.7	A
			H-3	pCi/L	7080	6850	5920 - 7540	A
			Sr-89	pCi/L	40.7	66.2	53.8 - 74.3	N [1]
			Sr-90	pCi/L	26.9	26.7	19.3 - 31.1	A
			I-131	pCi/L	26.7	29.9	24.9 - 34.9	A
September 2017	MRAD-27	AP	GR-A	pCi/sample	40.9	50.1	16.8 - 77.8	A
		AP	GR-B	pCi/sample	58.0	61.8	39.1 - 90.1	A
October 2017	RAD-111	Water	Ba-133	pCi/L	71.3	73.7	61.7 - 81.1	A
			Cs-134	pCi/L	43.0	53.0	42.8 - 58.3	A
			Cs-137	pCi/L	48.2	52.9	47.6 - 61.1	A
			Co-60	pCi/L	69.0	69.5	62.6 - 78.9	A
			Zn-65	pCi/L	335	348	313 - 406	A
			GR-A	pCi/L	32.5	35.6	18.3 - 45.8	A
			GR-B	pCi/L	24.3	25.6	16.0 - 33.6	A
			U-Nat	pCi/L	36.6	37.0	30.0 - 40.9	A
			H-3	pCi/L	6270	6250	5390 - 6880	A
			I-131	pCi/L	26.4	24.2	20.1 - 28.7	A
November 2017	111317O	Water	Sr-89	pCi/L	57.1	50.0	39.4 - 57.5	A
			Sr-90	pCi/L	27.1	41.8	30.8 - 48.0	N [2]

(a) The ERA known value is equal to 100% of the parameter present in the standard as determined by gravimetric and/or volumetric measurements made during standard preparation.

(b) ERA evaluation:
A = Acceptable - Reported value falls within the Acceptance Limits
N = Not Acceptable - Reported value falls outside of the Acceptance Limits

(1) See NCR 17-09
(2) See NCR 17-19