Entergy

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

James Nadeau
Manager, Regulatory Assurance
Grand Gulf Nuclear Station
Tel. (601) 437-2103

GNRO-2017/00029

April 27, 2017

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

SUBJECT: Grand Gulf Nuclear Station Annual Radiological Environmental Operating 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 (GGNS) Unit 1 Technical Specification 5.6.2, attached is the Annual Radiological Environmental Operating Report (AREOR) for the time period of January 1, 2016 through December 31, 2016.

There are no new commitments contained in this submittal. If you have any questions or require any additional information, please contact Richard Sumrall at 601-437-2115.

Sincerely,

JJN/sas

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

cc: (see next page)

cc: U.S. Nuclear Regulatory Commission
ATTN: Mr. Siva Lingham
Mail Stop OWFN 8 B1
Rockville, MD 20852-2738

U.S. Nuclear Regulatory Commission
ATTN: Mr. Kriss M. Kennedy (w/2)
Regional Administrator, Region IV
1600 East Lamar Boulevard
Arlington, TX 76011-4511

Mr. B. J. Smith (w/2)
Director, Division of Radiological Health
Mississippi State Department of Health
Division of Radiological Health
3150 Lawson Street
Jackson, MS 39213

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

Attachment to GNRO-2017/00029

Grand Gulf Nuclear Station 2016 Annual Radiological Environmental Operating Report (AREOR)

ENTERGY OPERATIONS, INC.
GRAND GULF NUCLEAR STATION

ANNUAL
RADIOLOGICAL ENVIRONMENTAL
OPERATING REPORT

January 1, 2016 - December 31, 2016

Tom Ashley, 04/17/17

Prepared By

Trey Reeves 4/20/17

Reviewed By

Richard Sumrall 4-26-17

Approved By

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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, 2016, through December 31, 2016. 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 2016, 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 2016 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 2016, 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 2016 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 2016, 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 2016 were within the limits for all samples with the following exception:

Sample Type Location / Analysis Date	**Nuclides**
Air Particulate AS-3 VA / I-131 & Gross Beta 05/10/16 – 05/17/17	Iodine-131 Gross Beta

  Cause was attributed to unavoidable small sample size due to failure of the sampling equipment. All remaining LLDs were achieved and no plant related nuclides were detected in the 2Q16 samples. As described in ODCM Specification Table 6.12.1-3, footnote (b), LLDs may be unachievable due to unavoidable small sample size and other legitimate reasons.

  Air particulate samples are collected weekly at indicator [AS-1 PG, AS-7 UH] and control [AS-3 VA] locations. In addition, a quarterly composite sample for each location is analyzed for gamma isotopic. For all remaining 2016 air particulate samples, LLDs were achieved and no plant related nuclides were detected.

- **Thermoluminescent Dosimeters**

  TLD M-36 (Sector P, Radius 5.0 Miles), was unavailable during 2nd quarter, 2016, due to the TLD was missing during sample collection. 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.

- **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 2016

Sample Location	Date In	Date Out	Run Time (Hours)	Out-of-Service (Hours)	Comments
AS-7 UH	03/08/2016	03/15/2016	165.02	3.69	Power outage
AS-7 UH	03/29/2016	04/05/2016	158.75	9.16	Power outage
AS-7 UH	04/12/2016	04/19/2016	165.90	1.86	Power outage
AS-7 UH	04/19/2016	04/26/2016	167.98	0.82	Power outage
AS-3 61VA	05/10/2016	05/17/2016	16.30	157.41	Equipment Failure
AS-20 GR	07/12/2016	07/19/2016	159.70	7.83	Power outage
AS-7 UH	08/09/2016	08/16/2016	163.18	5.03	Power outage
AS-20 GR	08/09/2016	08/16/2016	162.37	5.84	Power outage
AS-20 GR	09/13/2016	09/20/2016	90.42	77.68	Equipment Failure
AS-7 UH	09/20/2016	09/27/2016	162.67	4.91	Power outage
AS-20 GR	09/20/2016	09/27/2016	167.17	0.49	Power outage
AS-20 GR	10/11/2016	10/18/2016	128.72	36.41	Equipment Failure
AS-7 UH	10/18/2016	10/25/2016	166.95	3.03	Power outage
AS-20 GR	10/18/2016	10/25/2016	166.55	3.10	Power outage
AS-20 GR	11/08/2016	11/15/2016	167.21	0.74	Power outage
AS-7 UH	11/15/2016	11/22/2016	165.72	1.66	Power outage
AS-20 GR	11/15/2016	11/22/2016	165.72	1.64	Power outage
AS-7 UH	11/22/2016	11/29/2016	160.38	7.92	Power outage
AS-20 GR	11/22/2016	11/29/2016	166.46	1.87	Power outage
AS-7 UH	11/29/2016	12/06/2016	168.62	0.63	Power outage
AS-20 GR	11/29/2016	12/06/2016	168.99	0.24	Power outage
AS-20 GR	12/06/2016	12/13/2016	160.86	7.79	Power outage
AS-7 UH	12/27/2016	01/03/2017	162.00	5.61	Power outage

Sample location AS-20 GR was placed in service on 06/14/16. Based on the sample collection period reductions, air samples were collected the following percentages of the available time:

AS-1 PG	100.0%
AS-3 61VA	98.2%
AS-7 UH	99.5%
AS-20 GR	97.0%

- **Missed Samples**

  All required samples were collected in accordance with REMP requirements. There were no missed samples.

- **Unavailable Results**

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

Program Modifications

During 2016, one additional air monitoring station was installed in the vicinity of the nearest community located within Sector L. Meteorological data indicates that Sector L has the highest calculated X/Q at the site boundary. The new air sampling location was placed in service on 06/14/16. The additional monitoring location will enhance the site's radiological environmental monitoring program, and will demonstrate robust compliance with the Offsite Dose Calculation Manual requirements. Laboratory analytical data indicates I-131 and Gross Beta activity levels are similar for samples collected from AS-20 and the existing control location AS-3.

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.

GGNS personnel conduct the land use census by:

- Conducting field surveys
- Identifying locations on maps and aerial photographs and measuring distances to GGNS
- Comparing current land use census results to results from the previous census
- Contacting the Claiborne County Agent for verification of nearest dairy animals

No significant changes were identified between the biennial land use census performed in 2014 and the most recent census performed in 2016 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-20 GR (Sector L, Radius 0.9 Miles)** – Southwest of GGNS on Bald Hill Road, at the Former Glodjo Residence.		
	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.		
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. **OUTFALL 007 (Sector N, Radius 0.2 Miles)** – Storm Drain System	366 days 31 days	Gamma isotopic and tritium analyses; 366 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.	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

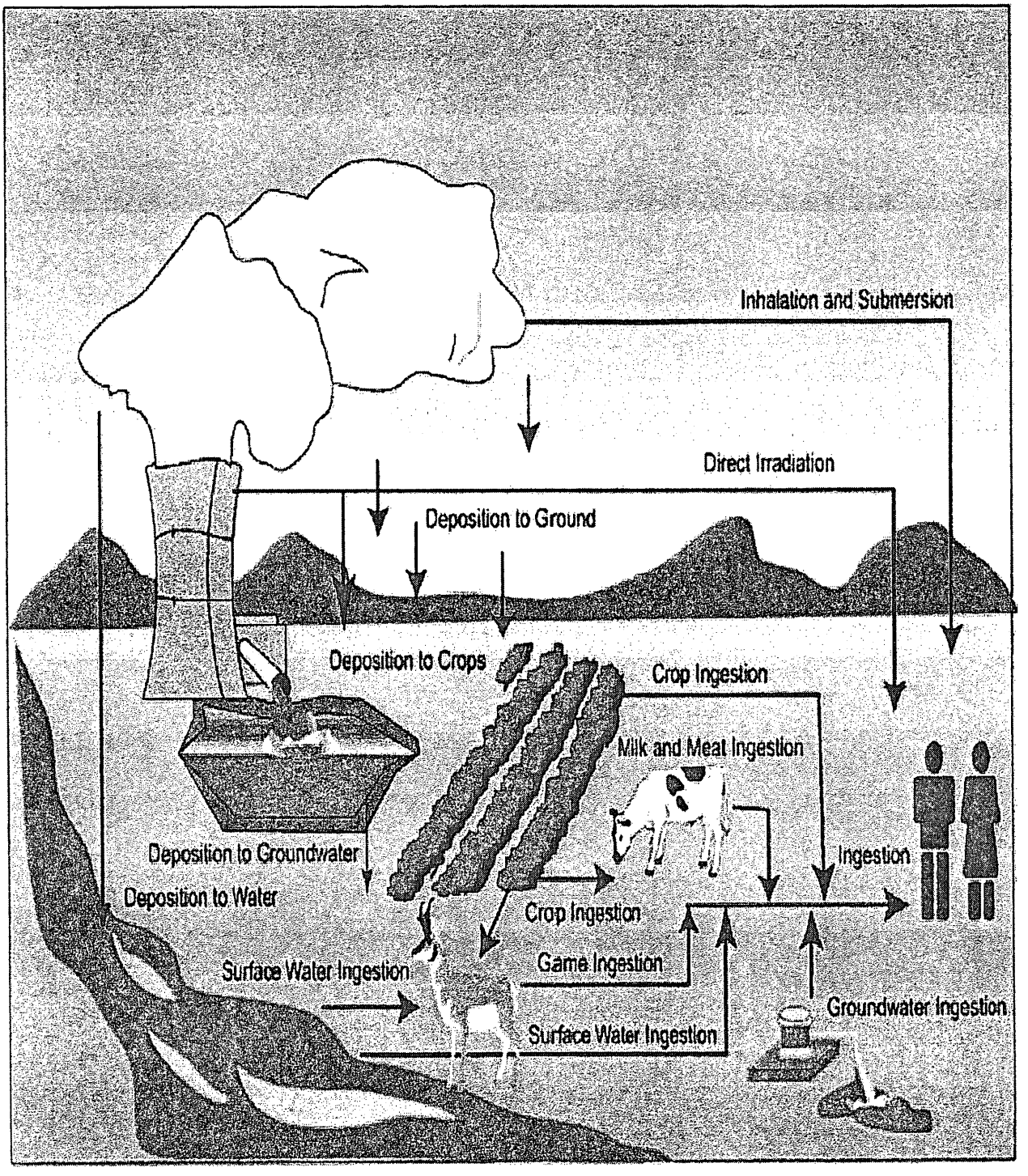


FIGURE 1-2
SAMPLE COLLECTION SITES – NEAR FIELD

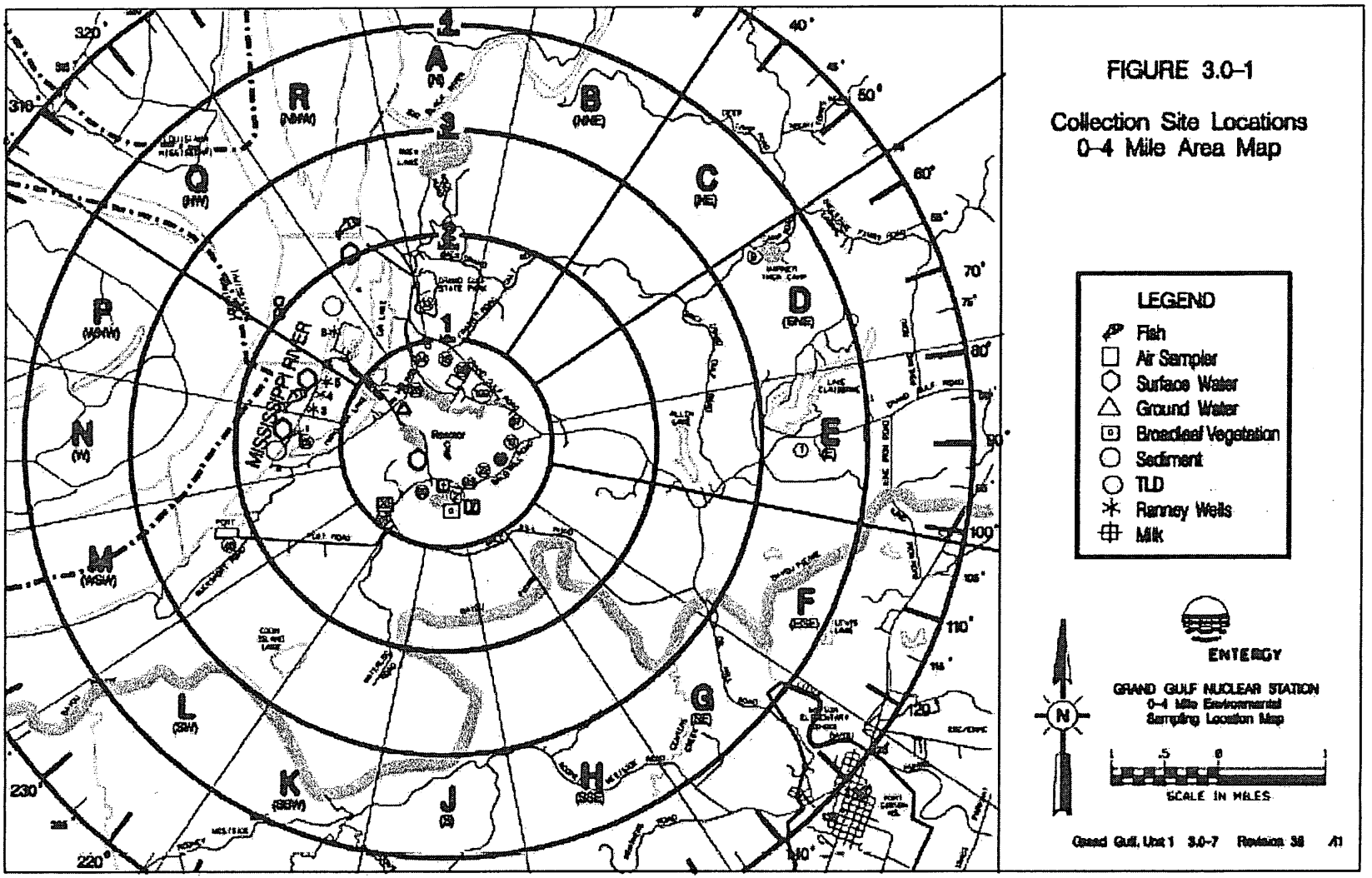
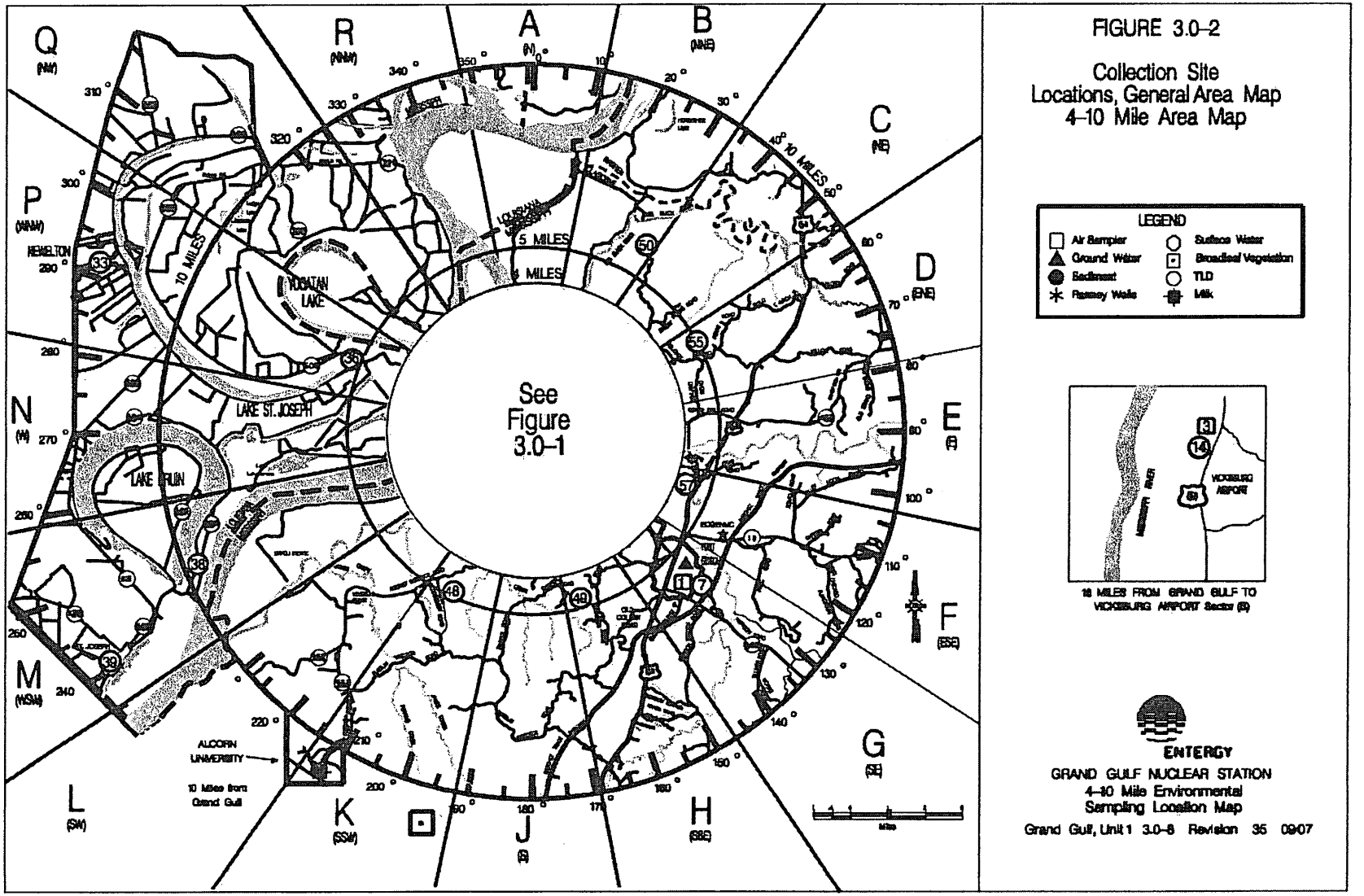


FIGURE 1-3
SAMPLE COLLECTION SITES – FAR FIELD



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 2016.

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.

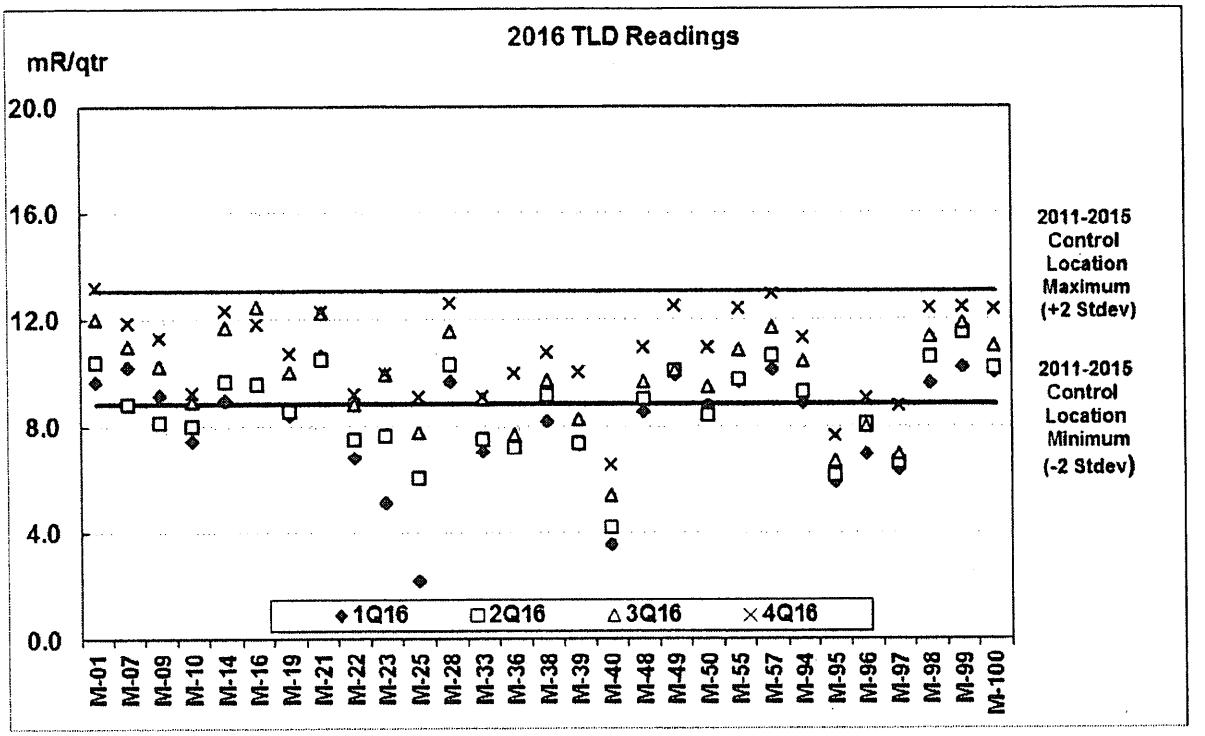
2.2 Thermoluminescent Dosimetry Sample Results

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 January (2100 ± 537 pCi/L) and August (698 ± 195 pCi/L) at the Outfall 007 (indicator) location. Tritium was not observed in the remaining Outfall 007 samples collected during 2016.

In addition to the tritium samples required by the REMP, four 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 the ODCM were determined to be 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.

GEL Laboratories 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 2016

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 184	0.01	0.01742 (132/132) [0.00505 - 0.03690]	AS-20 GR (Sector L, 0.9 mi)	0.01839 (28/28) [0.00674-0.03580]	0.01850 (52/52) [0.00818-0.03530]	0
	GS 15						
	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-131 156	0.07	<LLD	N/A	N/A	<LLD	0
Inner Ring TLDs (mR/Qtr)	Gamma 56	f	9.3 (56/56) [2.2 – 12.6]	M-99 (Sector J, 0.4 mi.)	11.5 (4/4) [10.2 – 12.5]	N/A	0
Outer Ring TLDs (mR/Qtr)	Gamma 27	f	9.3 (27/27) [3.5 – 13.0]	M-57 (Sector F, 4.5 mi.)	11.4 (4/4) [9.9 – 12.5]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma 28	f	9.4 (28/28) [7.1 – 13.2]	M-01 (Sector E, 3.5 mi.)	11.3 (4/4) [9.6 – 13.2]	N/A	0
Control TLDs (mR/Qtr)	Gamma 4	f	N/A	N/A	N/A	10.7 (4/4) [9.0 – 12.3]	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 2016

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 32	3000	1399 (2/26) [698 - 2100]	Outfall 007 (Sector N, Radius 0.2 mi.)	1399 (2/26) [698 - 2100]	<LLD	0
	GS 14						
	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 2016

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 2016

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 2						
	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 2016

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 2						
	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)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L66432-1/4	12/29/15	01/05/16	<0.04632	0.02550	±0.00396
L66463-1/4	01/05/16	01/12/16	<0.04171	0.01340	±0.00307
L66587-1/4	01/12/16	01/19/16	<0.05486	0.03120	±0.00440
L66635-1/4	01/19/16	01/26/16	<0.03432	0.01510	±0.00326
L66726-1/4	01/26/16	02/02/16	<0.04757	0.02080	±0.00364
L66829-1/4	02/02/16	02/09/16	<0.04666	0.01240	±0.00317
L66915-1/4	02/09/16	02/16/16	<0.04686	0.01720	±0.00335
L66990-1/4	02/16/16	02/23/16	<0.02744	0.01290	±0.00315
L67081-1/4	02/23/16	03/01/16	<0.06706	0.01420	±0.00322
L67163-1/4	03/01/16	03/08/16	<0.04461	0.01700	±0.00336
L67243-1/4	03/08/16	03/15/16	<0.03015	0.00639	±0.00248
L67320-1/4	03/15/16	03/22/16	<0.05916	0.01140	±0.00313
L67366-1/4	03/22/16	03/29/16	<0.05953	0.01290	±0.00314
L67480-1/4	03/29/16	04/05/16	<0.05518	0.01790	±0.00348
L67589-1/4	04/05/16	04/12/16	<0.06881	0.01370	±0.00305
L67683-1/4	04/12/16	04/19/16	<0.04587	0.00975	±0.00277
L67804-1/4	04/19/16	04/26/16	<0.04239	0.01200	±0.00310
L67933-1/4	04/26/16	05/03/16	<0.03376	0.01430	±0.00330
L68039-1/4	05/03/16	05/10/16	<0.05523	0.01460	±0.00322
L68137-1/4	05/10/16	05/17/16	<0.01381	0.01820	±0.00325
L68240-1/4	05/17/16	05/24/16	<0.05851	0.02030	±0.00360
L68307-1/4	05/24/16	05/31/16	<0.06813	0.01500	±0.00324
L68396-1/4	05/31/16	06/07/16	<0.06309	0.01170	±0.00312
L68496-1/5	06/07/16	06/14/16	<0.04911	0.01270	±0.00313
L68572-1/5	06/14/16	06/21/16	<0.03603	0.01800	±0.00331
L68711-1/5	06/21/16	06/28/16	<0.04312	0.01610	±0.00339
L68749-1/5	06/28/16	07/05/16	<0.06806	0.01770	±0.00352
L68844-1/5	07/05/16	07/12/16	<0.05053	0.01200	±0.00285
L68942-1/5	07/12/16	07/19/16	<0.05381	0.01460	±0.00317
L69076-1/5	07/19/16	07/26/16	<0.05179	0.01280	±0.00307
L69194-1/5	07/26/16	08/02/16	<0.04554	0.01030	±0.00292
L69272-1/5	08/02/16	08/09/16	<0.04339	0.01420	±0.00319
L69363-1/5	08/09/16	08/16/16	<0.04136	0.00826	±0.00276
L69443-1/5	08/16/16	08/23/16	<0.04012	0.00902	±0.00268
L69544-1/5	08/23/16	08/30/16	<0.06753	0.01610	±0.00333

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)			0.07	0.01	
LAB ID	START DATE	END DATE	I-131	GROSS BETA	
L69615-1/5	08/30/16	09/06/16	<0.01821	0.02030	±0.00364
L69726-1/5	09/06/16	09/13/16	<0.05677	0.01080	±0.00285
L69883-1/5	09/13/16	09/20/16	<0.03610	0.00793	±0.00268
L69934-1/5	09/20/16	09/27/16	<0.04949	0.02190	±0.00387
L70048-1/5	09/27/16	10/04/16	<0.03904	0.02180	±0.00360
L70178-1/5	10/04/16	10/11/16	<0.04483	0.02030	±0.00348
L70282-1/5	10/11/16	10/18/16	<0.03147	0.02000	±0.00369
L70393-1/5	10/18/16	10/25/16	<0.06442	0.01380	±0.00319
L70536-1/5	10/25/16	11/01/16	<0.05197	0.03690	±0.00456
L70560-1/5	11/01/16	11/08/16	<0.03599	0.02740	±0.00403
L70676-1/5	11/08/16	11/15/16	<0.05512	0.03570	±0.00467
L70742-1/5	11/15/16	11/22/16	<0.02909	0.03500	±0.00464
L70806-1/5	11/22/16	11/29/16	<0.05501	0.02810	±0.00403
L70869-1/6	11/29/16	12/06/16	<0.03559	0.01950	±0.00370
L70951-1/5	12/06/16	12/13/16	<0.02608	0.02160	±0.00355
L71048-1/5	12/13/16	12/20/16	<0.06460	0.02210	±0.00358
L71091-1/5	12/20/16	12/27/16	<0.05707	0.01810	±0.00348
Average:				0.01732	
Maximum:				0.03690	
Minimum:				0.00639	

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	
L66432-2/5	12/29/15	01/05/16	<0.04636	0.02960	±0.00420
L66463-2/5	01/05/16	01/12/16	<0.04176	0.01450	±0.00316
L66587-2/5	01/12/16	01/19/16	<0.05500	0.03110	±0.00439
L66635-2/5	01/19/16	01/26/16	<0.01334	0.01800	±0.00346
L66726-2/5	01/26/16	02/02/16	<0.04763	0.01970	±0.00357
L66829-2/5	02/02/16	02/09/16	<0.04679	0.01330	±0.00324
L66915-2/5	02/09/16	02/16/16	<0.04699	0.01660	±0.00330
L66990-2/5	02/16/16	02/23/16	<0.03123	0.01480	±0.00330
L67081-2/5	02/23/16	03/01/16	<0.06796	0.01630	±0.00339
L67163-2/5	03/01/16	03/08/16	<0.04460	0.01550	±0.00324
L67243-2/5	03/08/16	03/15/16	<0.03079	0.01050	±0.00287
L67320-2/5	03/15/16	03/22/16	<0.02468	0.01480	±0.00336
L67366-2/5	03/22/16	03/29/16	<0.05954	0.01310	±0.00315
L67480-2/5	03/29/16	04/05/16	<0.05523	0.01760	±0.00346
L67589-2/5	04/05/16	04/12/16	<0.06889	0.01580	±0.00322
L67683-2/5	04/12/16	04/19/16	<0.04597	0.00987	±0.00278
L67804-2/5	04/19/16	04/26/16	<0.04244	0.01760	±0.00350
L67933-2/5	04/26/16	05/03/16	<0.03383	0.01530	±0.00337
L68039-2/5	05/03/16	05/10/16	<0.05534	0.01840	±0.00350
L68137-2/5	05/10/16	05/17/16	<0.146*	0.04820*	±0.02170
L68240-2/5	05/17/16	05/24/16	<0.05899	0.02140	±0.00369
L68307-2/5	05/24/16	05/31/16	<0.06829	0.01950	±0.00355
L68396-2/5	05/31/16	06/07/16	<0.06313	0.01460	±0.00335
L68496-2/5	06/07/16	06/14/16	<0.05114	0.01160	±0.00312
L68572-2/6	06/14/16	06/21/16	<0.03546	0.01720	±0.00320
L68711-2/6	06/21/16	06/28/16	<0.01809	0.01760	±0.00349
L68749-2/6	06/28/16	07/05/16	<0.06456	0.02050	±0.00361
L68844-2/6	07/05/16	07/12/16	<0.05222	0.01680	±0.00331
L68942-2/6	07/12/16	07/19/16	<0.05391	0.01470	±0.00318
L69076-2/6	07/19/16	07/26/16	<0.05191	0.01180	±0.00300
L69194-2/6	07/26/16	08/02/16	<0.04559	0.01020	±0.00290
L69272-2/6	08/02/16	08/09/16	<0.01822	0.01590	±0.00332
L69363-2/6	08/09/16	08/16/16	<0.04151	0.00922	±0.00284
L69443-2/6	08/16/16	08/23/16	<0.04014	0.00818	±0.00261

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	
L69544-2/6	08/23/16	08/30/16	<0.06764	0.01250	±0.00305
L69615-2/6	08/30/16	09/06/16	<0.04350	0.02000	±0.00362
L69726-2/6	09/06/16	09/13/16	<0.05686	0.00879	±0.00267
L69883-2/6	09/13/16	09/20/16	<0.03618	0.00913	±0.00278
L69934-2/6	09/20/16	09/27/16	<0.02078	0.02540	±0.00408
L70048-2/6	09/27/16	10/04/16	<0.03910	0.03030	±0.00412
L70178-2/6	10/04/16	10/11/16	<0.04661	0.02280	±0.00371
L70282-2/6	10/11/16	10/18/16	<0.03089	0.01790	±0.00347
L70393-2/6	10/18/16	10/25/16	<0.06474	0.01660	±0.00341
L70536-2/6	10/25/16	11/01/16	<0.05198	0.03390	±0.00440
L70560-2/6	11/01/16	11/08/16	<0.03641	0.02810	±0.00409
L70676-2/6	11/08/16	11/15/16	<0.05490	0.03530	±0.00463
L70742-2/6	11/15/16	11/22/16	<0.06568	0.03130	±0.00444
L70806-2/6	11/22/16	11/29/16	<0.05510	0.03020	±0.00416
L70869-2/6	11/29/16	12/06/16	<0.03564	0.02180	±0.00385
L70951-2/7	12/06/16	12/13/16	<0.02613	0.01890	±0.00335
L71048-2/6	12/13/16	12/20/16	<0.06470	0.02790	±0.00395
L71091-2/6	12/20/16	12/27/16	<0.05720	0.02110	±0.00368
Average:				0.01850	
Maximum:				0.03530	
Minimum:				0.00818	

* LLD not met due to small sample size. Data not included in avg/max/min calculations.

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	
L66432-3/6	12/29/15	01/05/16	<0.04628	0.02830	±0.00412
L66463-3/6	01/05/16	01/12/16	<0.04169	0.00966	±0.00276
L66587-3/6	01/12/16	01/19/16	<0.05480	0.02880	±0.00426
L66635-3/6	01/19/16	01/26/16	<0.03429	0.01430	±0.00319
L66726-3/6	01/26/16	02/02/16	<0.04753	0.01990	±0.00359
L66829-3/6	02/02/16	02/09/16	<0.04661	0.01040	±0.00301
L66915-3/6	02/09/16	02/16/16	<0.02074	0.01560	±0.00323
L66990-3/6	02/16/16	02/23/16	<0.03110	0.01320	±0.00318
L67081-3/6	02/23/16	03/01/16	<0.06688	0.01540	±0.00331
L67163-3/6	03/01/16	03/08/16	<0.04462	0.01710	±0.00337
L67243-3/6	03/08/16	03/15/16	<0.03080	0.00724	±0.00260
L67320-3/6	03/15/16	03/22/16	<0.05944	0.01260	±0.00323
L67366-3/6	03/22/16	03/29/16	<0.02490	0.01150	±0.00303
L67480-3/6	03/29/16	04/05/16	<0.05832	0.01860	±0.00366
L67589-3/6	04/05/16	04/12/16	<0.06874	0.01340	±0.00303
L67683-3/6	04/12/16	04/19/16	<0.04635	0.01220	±0.00300
L67804-3/6	04/19/16	04/26/16	<0.04255	0.01570	±0.00339
L67933-3/6	04/26/16	05/03/16	<0.01414	0.01570	±0.00340
L68039-3/6	05/03/16	05/10/16	<0.05517	0.01650	±0.00337
L68137-3/6	05/10/16	05/17/16	<0.01381	0.01470	±0.00299
L68240-3/6	05/17/16	05/24/16	<0.05847	0.01870	±0.00348
L68307-3/6	05/24/16	05/31/16	<0.06811	0.01580	±0.00330
L68396-3/6	05/31/16	06/07/16	<0.06303	0.01230	±0.00317
L68496-3/6	06/07/16	06/14/16	<0.05111	0.01430	±0.00332
L68572-3/7	06/14/16	06/21/16	<0.03444	0.01750	±0.00318
L68711-3/7	06/21/16	06/28/16	<0.04354	0.01530	±0.00337
L68749-3/7	06/28/16	07/05/16	<0.06804	0.01990	±0.00366
L68844-3/7	07/05/16	07/12/16	<0.05047	0.01350	±0.00297
L68942-3/7	07/12/16	07/19/16	<0.05373	0.00956	±0.00275
L69076-3/7	07/19/16	07/26/16	<0.05165	0.01360	±0.00313
L69194-3/7	07/26/16	08/02/16	<0.04548	0.01090	±0.00297
L69272-3/7	08/02/16	08/09/16	<0.04336	0.01480	±0.00324
L69363-3/7	08/09/16	08/16/16	<0.04259	0.00899	±0.00288
L69443-3/7	08/16/16	08/23/16	<0.04007	0.01010	±0.00278
L69544-3/7	08/23/16	08/30/16	<0.06745	0.01330	±0.00311

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	
L69615-3/7	08/30/16	09/06/16	<0.04037	0.01800	±0.00349
L69726-3/7	09/06/16	09/13/16	<0.05669	0.00770	±0.00257
L69883-3/7	09/13/16	09/20/16	<0.03599	0.00505	±0.00240
L69934-3/7	09/20/16	09/27/16	<0.05093	0.02460	±0.00411
L70048-3/7	09/27/16	10/04/16	<0.03902	0.01990	±0.00347
L70178-3/7	10/04/16	10/11/16	<0.04542	0.02100	±0.00355
L70282-3/7	10/11/16	10/18/16	<0.03120	0.01900	±0.00359
L70393-3/7	10/18/16	10/25/16	<0.06550	0.01550	±0.00336
L70536-3/7	10/25/16	11/01/16	<0.05187	0.03280	±0.00434
L70560-3/7	11/01/16	11/08/16	<0.03594	0.02440	±0.00384
L70676-3/7	11/08/16	11/15/16	<0.05508	0.03600	±0.00468
L70742-3/7	11/15/16	11/22/16	<0.06611	0.03000	±0.00439
L70806-3/7	11/22/16	11/29/16	<0.05734	0.02730	±0.00409
L70869-3/7	11/29/16	12/06/16	<0.03580	0.02160	±0.00386
L70951-3/8	12/06/16	12/13/16	<0.02603	0.02050	±0.00346
L71048-3/7	12/13/16	12/20/16	<0.06454	0.02280	±0.00362
L71091-3/7	12/20/16	12/27/16	<0.05685	0.01790	±0.00346
Average:				0.01699	
Maximum:				0.03600	
Minimum:				0.00505	

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	
L68572-4/8	06/14/16	06/21/16	<0.03546	0.01710	±0.00321
L68711-4/8	06/21/16	06/28/16	<0.04307	0.01460	±0.00329
L68749-4/8	06/28/16	07/05/16	<0.06790	0.01900	±0.00361
L68844-4/8	07/05/16	07/12/16	<0.05047	0.01370	±0.00299
L68942-4/8	07/12/16	07/19/16	<0.05639	0.01430	±0.00325
L69076-4/8	07/19/16	07/26/16	<0.05167	0.01250	±0.00305
L69194-4/8	07/26/16	08/02/16	<0.04547	0.01010	±0.00290
L69272-4/8	08/02/16	08/09/16	<0.04337	0.01240	±0.00305
L69363-4/8	08/09/16	08/16/16	<0.04281	0.00904	±0.00290
L69443-4/8	08/16/16	08/23/16	<0.04009	0.00830	±0.00262
L69544-4/8	08/23/16	08/30/16	<0.06747	0.01430	±0.00319
L69615-4/8	08/30/16	09/06/16	<0.01568	0.02040	±0.00364
L69726-4/8	09/06/16	09/13/16	<0.05670	0.00674	±0.00248
L69883-4/8	09/13/16	09/20/16	<0.06700	0.01180	±0.00471
L69934-4/8	09/20/16	09/27/16	<0.05096	0.02960	±0.00441
L70048-4/8	09/27/16	10/04/16	<0.03903	0.01970	±0.00346
L70178-4/8	10/04/16	10/11/16	<0.04530	0.01870	±0.00339
L70282-4/8	10/11/16	10/18/16	<0.03117	0.01420	±0.00324
L70393-4/8	10/18/16	10/25/16	<0.06563	0.01780	±0.00353
L70536-4/8	10/25/16	11/01/16	<0.05190	0.03580	±0.00450
L70560-4/8	11/01/16	11/08/16	<0.03595	0.02820	±0.00408
L70676-4/8	11/08/16	11/15/16	<0.05509	0.03050	±0.00438
L70742-4/8	11/15/16	11/22/16	<0.06613	0.03180	±0.00449
L70806-4/8	11/22/16	11/29/16	<0.05526	0.02310	±0.00373
L70869-4/8	11/29/16	12/06/16	<0.03574	0.01590	±0.00346
L70951-5/10	12/06/16	12/13/16	<0.02915	0.02210	±0.00391
L71048-4/8	12/13/16	12/20/16	<0.06454	0.02350	±0.00367
L71091-4/8	12/20/16	12/27/16	<0.05685	0.01970	±0.00358
Average:				0.01839	
Maximum:				0.03580	
Minimum:				0.00674	

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
L67692-1	AS-1 PG	02/12/16	<0.001861	<0.002114
L67692-2	AS-3 61VA	02/12/16	<0.002451	<0.001763
L67692-3	AS-7 UH	02/12/16	<0.003138	<0.002981
L68987-1	AS-1 PG	05/13/16	<0.001597	<0.00161
L68987-2	AS-3 61VA	05/13/16	<0.001931	<0.001599
L68987-3	AS-7 UH	05/13/16	<0.001755	<0.001427
L68987-4	AS-20 GR	06/21/16	<0.01107*	<0.008607*
L70077-1	AS-1 PG	08/16/16	<0.001622	<0.001359
L70077-2	AS-3 61VA	08/16/16	<0.002109	<0.001509
L70077-3	AS-7 UH	08/16/16	<0.001899	<0.001399
L70077-4	AS-20 GR	08/16/16	<0.002201	<0.001654
L71344-1	AS-1 PG	11/18/16	<0.001483	<0.001579
L71344-2	AS-3 61VA	11/18/16	<0.001711	<0.001805
L71344-3	AS-7 UH	11/18/16	<0.002363	<0.001571
L71344-4	AS-20 GR	11/18/16	<0.002707	<0.002552

* New monitoring location AS-20 was activated on 06/14/16 with only two weeks left in the quarterly monitoring period. Due to the activation date, only two weekly samples were included in the quarterly composite analysis (06/21/16) for AS-20, as compared to 13 samples for each of the remaining (05/13/16) monitoring locations. The difference in activity between the (06/21/16) AS-20 sample and the remaining locations is attributed to the non-comparable sample volumes and sampling intervals. Weekly gross beta and I-131 activity, as well as the remaining 2016 quarterly composite gamma analyses were comparable for all monitoring locations.

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	9.6	9.6	12.5	11.8	10.8
M-19	8.4	8.6	10.0	10.7	9.4
M-21	10.6	10.5	12.2	12.3	11.4
M-22	6.8	7.5	8.8	9.2	8.1
M-23	5.1	7.6	9.9	10.0	8.2
M-25	2.2	6.0	7.8	9.1	6.3
M-28	9.7	10.3	11.6	12.6	11.0
M-94	8.9	9.3	10.4	11.3	10.0
M-95	5.9	6.1	6.7	7.7	6.6
M-96	7.0	8.1	8.0	9.1	8.0
M-97	6.4	6.6	7.0	8.8	7.2
M-98	9.6	10.6	11.4	12.4	11.0
M-99*	10.2	11.5	11.8	12.5	11.5
M-100	10.0	10.2	11.0	12.4	10.9

*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	Not Available	7.2	7.7	10.0	8.3
M-40	3.5	4.2	5.4	6.5	4.9
M-48	8.6	9.0	9.7	10.9	9.5
M-49	9.9	10.1	10.1	12.5	10.6
M-50	8.8	8.4	9.5	10.9	9.4
M-55	9.7	9.7	10.8	12.4	10.7
M-57*	10.1	10.6	11.7	13.0	11.4

*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*	9.6	10.4	12.0	13.2	11.3
M-07	10.2	8.8	11.0	11.9	10.5
M-09	9.1	8.1	10.3	11.3	9.7
M-10	7.5	8.0	8.9	9.3	8.4
M-33	7.1	7.5	9.0	9.1	8.2
M-38	8.2	9.2	9.7	10.8	9.5
M-39	7.3	7.4	8.3	10.0	8.2

*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	9.0	9.6	11.7	12.3	10.7

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
L66700-1	MRDOWN	01/28/16	<4.04	<4.181	<9.821	<4.665	<9.369	<5.258	<10.36	<8.202	<3.522	<4.709	<22.22	<6.429
L66700-2	MRDOWN GG	01/28/16	<5.028	<5.203	<13.54	<5.518	<11.54	<4.863	<10.71	<9.498	<5.244	<6.982	<31.15	<9.123
L66700-5	MRUP	01/28/16	<5.812	<5.276	<12.77	<5.717	<14.56	<5.293	<9.876	<7.603	<5.776	<6.815	<27	<7.967
L66700-6	MRUPGG	01/28/16	<7.004	<8.457	<12.73	<6.747	<13.78	<6.367	<16.48	<13.58	<8.282	<8.363	<38.64	<7.868
L67955-1	MRDOWN	05/04/16	<4.725	<4.656	<10.64	<9.226	<9.971	<7.216	<10.75	<11.83	<5.182	<6.947	<35.76	<12.04
L67955-3	MRUP	05/04/16	<6.193	<7.182	<16.14	<8.43	<17.72	<7.421	<12.41	<11.62	<6.709	<8.409	<35.51	<8.197
L69273-1	MRDOWN	08/04/16	<8.043	<7.064	<11.06	<8.658	<10.11	<6.514	<13.48	<13.33	<7.706	<7.855	<40.98	<9.544
L69273-3	MRUP	08/04/16	<8	<7.778	<15.71	<6.538	<16.7	<5.643	<15.17	<14.8	<7.029	<5.497	<41.63	<13.12
L70558-1R1	MRDOWN	11/03/16	<2.074	<2.542	<5.822	<2.381	<4.726	<2.712	<4.557	<11.64	<2.035	<2.381	<22.41	<7.768
L70558-3R1	MRUP	11/03/16	<2.171	<2.082	<5.373	<2.172	<4.639	<2.638	<4.308	<9.784	<1.831	<2.168	<19.05	<6.132
L70558-5R1	MRDOWN GG	11/03/16	<2.316	<2.563	<5.503	<2.514	<4.816	<2.834	<4.436	<11.17	<2.256	<2.378	<20.72	<6.749
L70558-7R1	MRUP GG	11/03/16	<2.661	<3.077	<7.257	<2.595	<5.853	<3.247	<5.26	<12.32	<2.554	<2.878	<25.13	<7.458
L70609-1R1	MRDOWN*	11/09/16	<1.772	<1.795	<4.152	<1.698	<3.693	<2.094	<3.463	<4.957	<1.705	<2.051	<12.17	<3.548
L70609-3R1	MRDOWN GG*	11/09/16	<2.351	<2.527	<5.134	<2.186	<4.74	<2.591	<4.77	<7.842	<2.819	<2.581	<16.44	<4.402

"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	
L66597-1	OUTFALL 007	01/20/16	2020	±399
L66597-1C1	OUTFALL 007	01/20/16	2100	±537
L66597-1R1	OUTFALL 007	01/20/16	2050	±539
L66700-3	MRDOWN	01/28/16	<589	
L66700-4	MRDOWN GG	01/28/16	<590	
L66700-7	MRUP	01/28/16	<592	
L66700-8	MRUP GG	01/28/16	<594	
L66916-1C1	OUTFALL 007	02/17/16	<533	
L66916-2C1	OUTFALL 007 GG	02/17/16	<528	
L67281-1	OUTFALL 007	03/17/16	<441	
L67637-1	OUTFALL 007	04/14/16	<542	
L67955-2	MRDOWN	05/04/16	<443	
L67955-4	MRUP	05/04/16	<449	
L68136-1C1	OUTFALL 007	05/18/16	<572	
L68136-2	OUTFALL 007 GG	05/18/16	<496	
L68475-1	OUTFALL 007	06/08/16	<500	
L68982-1	OUTFALL 007	07/20/16	<502	
L69273-2	MRDOWN	08/04/16	<491	
L69273-4	MRUP	08/04/16	<482	
L69405-1	OUTFALL 007	08/17/16	698	±195
L69663-1C1	OUTFALL 007	09/07/16	<458	
L69663-2C1	OUTFALL 007 GG	09/07/16	<468	
L70179-1	OUTFALL 007	10/12/16	<370	
L70558-2	MRDOWN	11/03/16	<597	
L70558-4	MRUP	11/03/16	<588	
L70558-6	MRDOWN GG	11/03/16	<597	
L70558-8	MRUP GG	11/03/16	<599	
L70609-2	MRDOWN*	11/09/16	<525	
L70609-4	MRDOWN GG*	11/09/16	<515	
L70677-1	OUTFALL 007	11/15/16	<577	
L70956-1	OUTFALL 007	12/14/16	<509	
L70956-2	OUTFALL 007 GG	12/14/16	<497	

* 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) 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 CS-134	18 CS-137	60 BA-140	15 LA-140
L70675-1	PGWELL	11/16/16	<7.819	<8.921	<15.99	<8.332	<17.72	<11.9	<15.54	<11.51	<9.43	<36.87	<7.972
L70675-5	CONSTWELL 3	11/16/16	<10.96	<10.11	<18.33	<8.68	<20.51	<8.684	<15.54	<9.291	<9.564	<31.52	<11.8
L70675-9	CONSTWELL 4	11/16/16	<8.531	<8.158	<13.67	<7.554	<15.32	<9.443	<12.09	<9.681	<8.422	<30.48	<10.31

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
L70675-3	PGWELL	11/16/16	<564
L70675-4	PGWELL GG	11/16/16	<571
L70675-7	CONSTWELL 3	11/16/16	<575
L70675-8	CONSTWELL 3 GG	11/16/16	<572
L70675-11	CONSTWELL 4	11/16/16	<574
L70675-12	CONSTWELL 4 GG	11/16/16	<575

"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
L70675-2	PGWELL	11/16/16	<0.654
L70675-6	CONSTWELL 3	11/16/16	<0.874
L70675-10	CONSTWELL 4	11/16/16	<0.978

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
L69790-1	SEDHAM	09/15/16	<47.07	<44.08
L69790-2	SEDCONT	09/15/16	<55.30	<44.28
L69790-3	SEDHAM GG	09/15/16	<42.23	<43.63
L69790-4	SEDCONT GG	09/15/16	<65.25	<44.80

"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
L69764-1	FISHUP	09/12/16	<50.47	<50.98	<90.56	<50.57	<112.5	<57.99	<46.59
L69764-2	FISHDOWN	09/12/16	<48.35	<48.92	<91.05	<40.76	<100.7	<56.13	<51.91

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
L66964-1	VEG-CONT	02/18/16	<28.74	<13.43	<17.25
L66964-2	VEG-J	02/18/16	<45.11	<29.37	<29.45
L68361-1	VEG-CONT	06/02/16	<48.2	<20.7	<22.69
L68361-2	VEG-J	06/02/16	<46.85	<17.81	<18.17
L69404-1	VEG-CONT	08/18/16	<54.45	<21.9	<26.98
L69404-2	VEG-J	08/18/16	<45.23	<29.69	<35.95
L70740-1	VEG-CONT	11/18/16	<58.7	<20.66	<18.66
L70740-2	VEG-J	11/18/16	<59.61	<20.33	<23.33

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
L67282-1	OUTFALL 007	03/17/16	<3.783	<3.87	<8.073	<3.557	<8.171	<3.945	<6.315	<6.05	<3.859	<3.866	<18.8	<5.547
L68475-1	OUTFALL 007	06/08/16	<4.924	<5.452	<12.45	<6.23	<12.96	<6.685	<10.34	<14.64	<5.737	<7.146	<38.73	<14.44
L69765-1	OUTFALL 007	09/14/16	<8.508	<7.587	<15.47	<7.912	<15.95	<7.996	<10.39	<12.12	<6.151	<6.289	<30.35	<13.53
L69765-2	OUTFALL 007 GG	09/14/16	<5.875	<6.712	<12.02	<6.12	<11.76	<6.045	<9.541	<9.667	<6.041	<5.803	<28.09	<8.569
L71173-1	OUTFALL 007	12/20/16	<2.237	<2.315	<5.641	<2.236	<5.15	<2.611	<4.158	<11.39	<2.103	<2.129	<22.68	<7.422

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
L70071-1	Meat 1	10/03/16	<31.21	<34.33	<61.04	<25.55	<86.28	<37.86	<43.9
L70071-2	Meat 2	10/03/16	<41.5	<43.19	<88.9	<31.8	<55.13	<46.3	<47.66

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

STANFORD DOSIMETRY

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2016

Prepared By: _____ Date: 3/8/17

Approved By: _____ Date: 3/8/17

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 period, 100% (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 was performed in 2016. There were no findings.

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 2016

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 period, 100% (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 Bias + 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

A. Internal

EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2016. There were no findings identified.

B. External

None.

VI. PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2016

Several procedures 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, 2016.

2. EDC Manual 1, Quality System Manual, Rev. 3, August 1, 2012.

TABLE 1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2016[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 2016[1], [2]

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/- 15%
4/22/2016	40	3.5	0.7	Pass
4/29/2016	80	1.8	0.7	Pass
5/10/2016	70	1.8	1.8	Pass
7/25/2016	33	2.4	1.5	Pass
8/2/2016	56	2.4	1.6	Pass
8/2/2016	123	0.7	1.4	Pass
10/25/2016	28	2.9	1.0	Pass
10/29/2016	93	3.2	1.8	Pass
11/6/2016	61	0.0	1.6	Pass
1/30/2017	39	1.4	2.5	Pass
1/31/2017	76	2.2	1.3	Pass
1/31/2017	101	-1.7	1.5	Pass

[1]This table summarizes results of tests conducted by EDC for TLDs issued in 2016.
[2]Environmental dosimeter results are free in air.

TABLE 3
SUMMARY OF INDEPENDENT DOSIMETER TESTING JANUARY – DECEMBER 2016[1], [2]

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2016	Millstone	-0.2	1.0	Pass
2nd Qtr.2016	Millstone	-3.4	3.0	Pass
2nd Qtr.2016	Seabrook	1.8	0.8	Pass
3rd Qtr. 2016	Millstone	3.0	2.4	Pass
4th Qtr.2016	Millstone	.0.9	3.9	Pass
4th Qtr.2016	Seabrook	-0.2	0.7	Pass

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

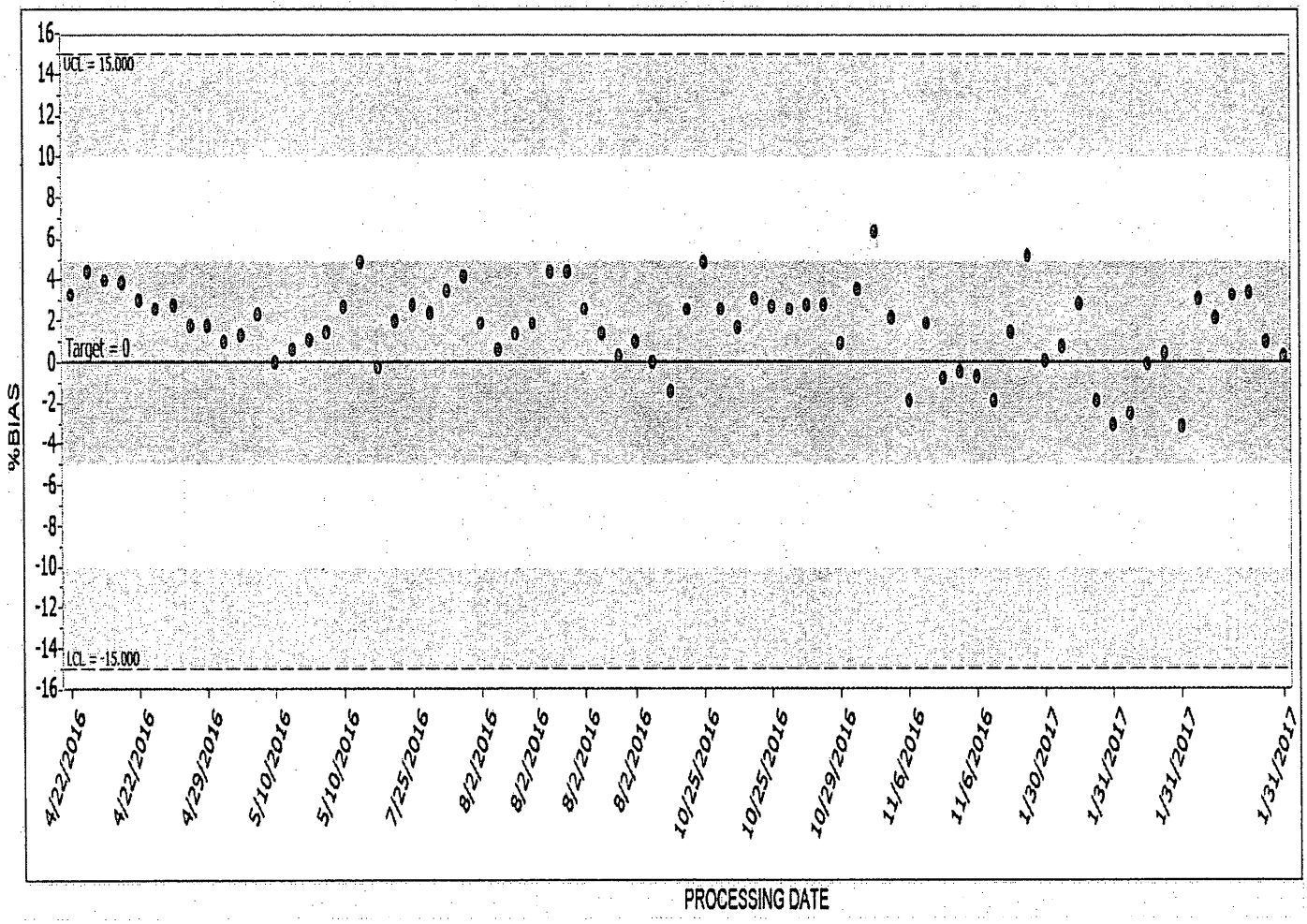
APPENDIX A

DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

ISSUE PERIOD JANAURY - DECEMBER 2016

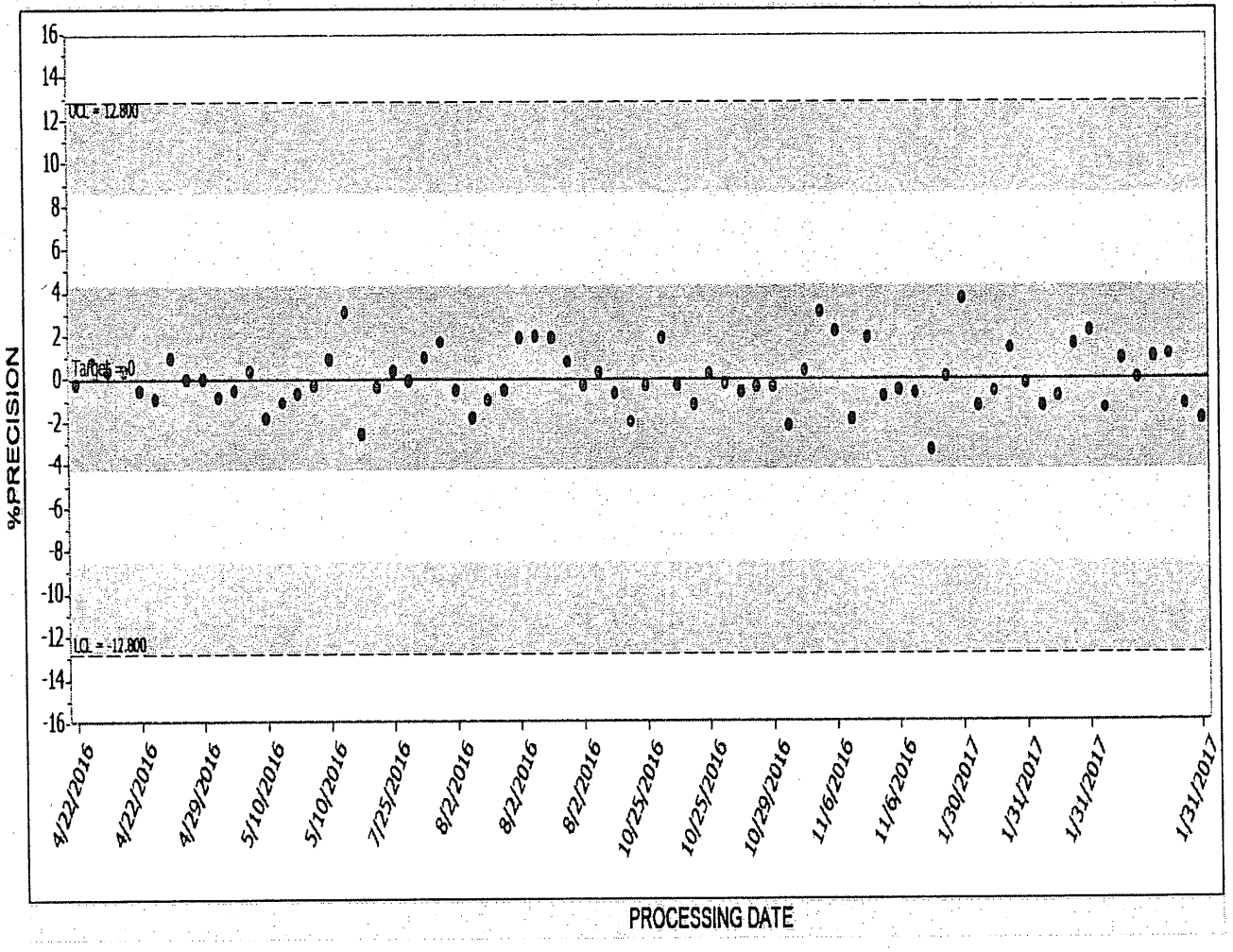
INDIVIDUAL ACCURACY ENVIRONMENTAL

FIGURE 1



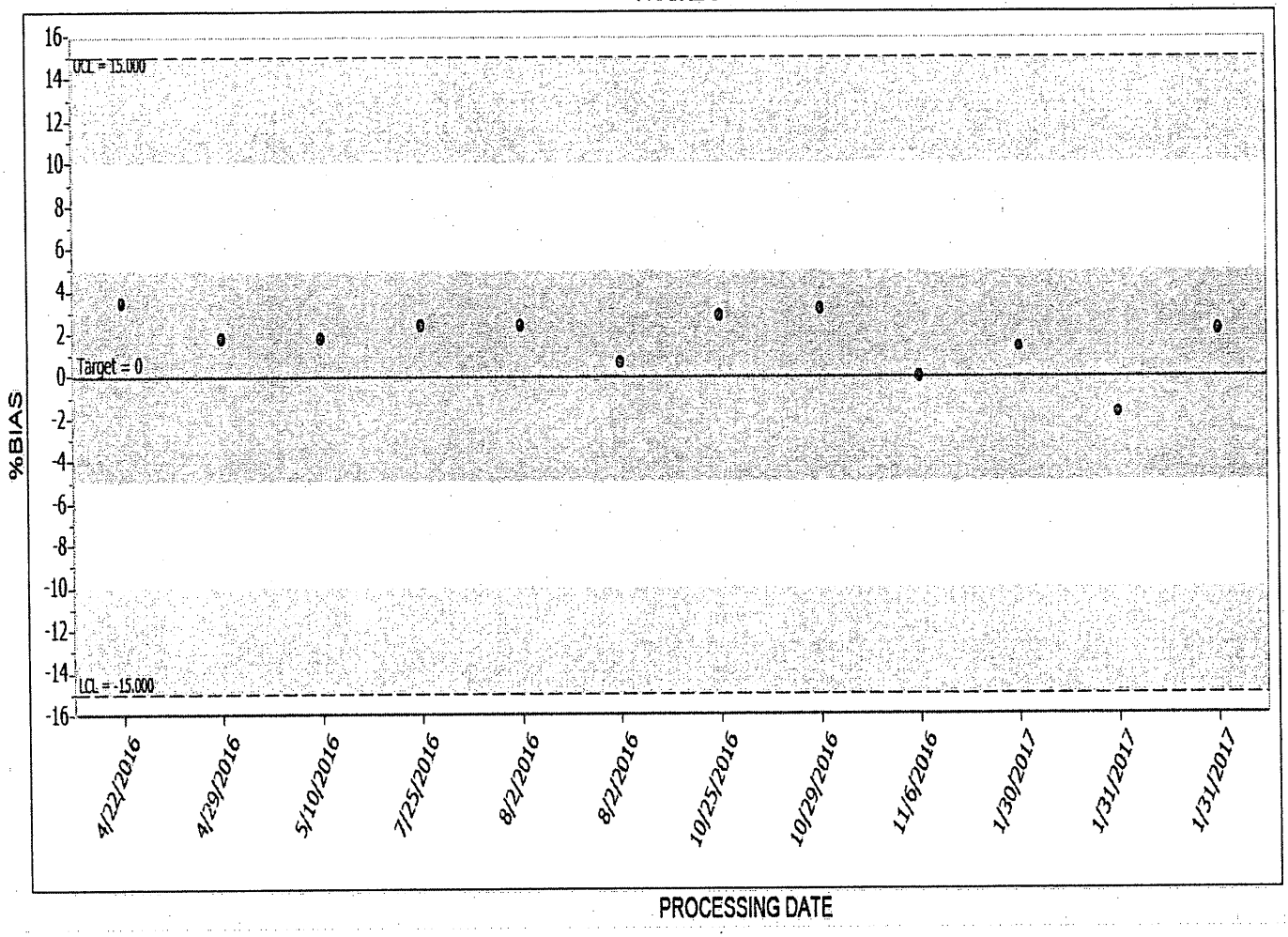
INDIVIDUAL PRECISION ENVIRONMENTAL

FIGURE 2



MEAN ACCURACY ENVIRONMENTAL

FIGURE 3



SEABROOK CO-LOCATE ACCURACY
FIGURE 4

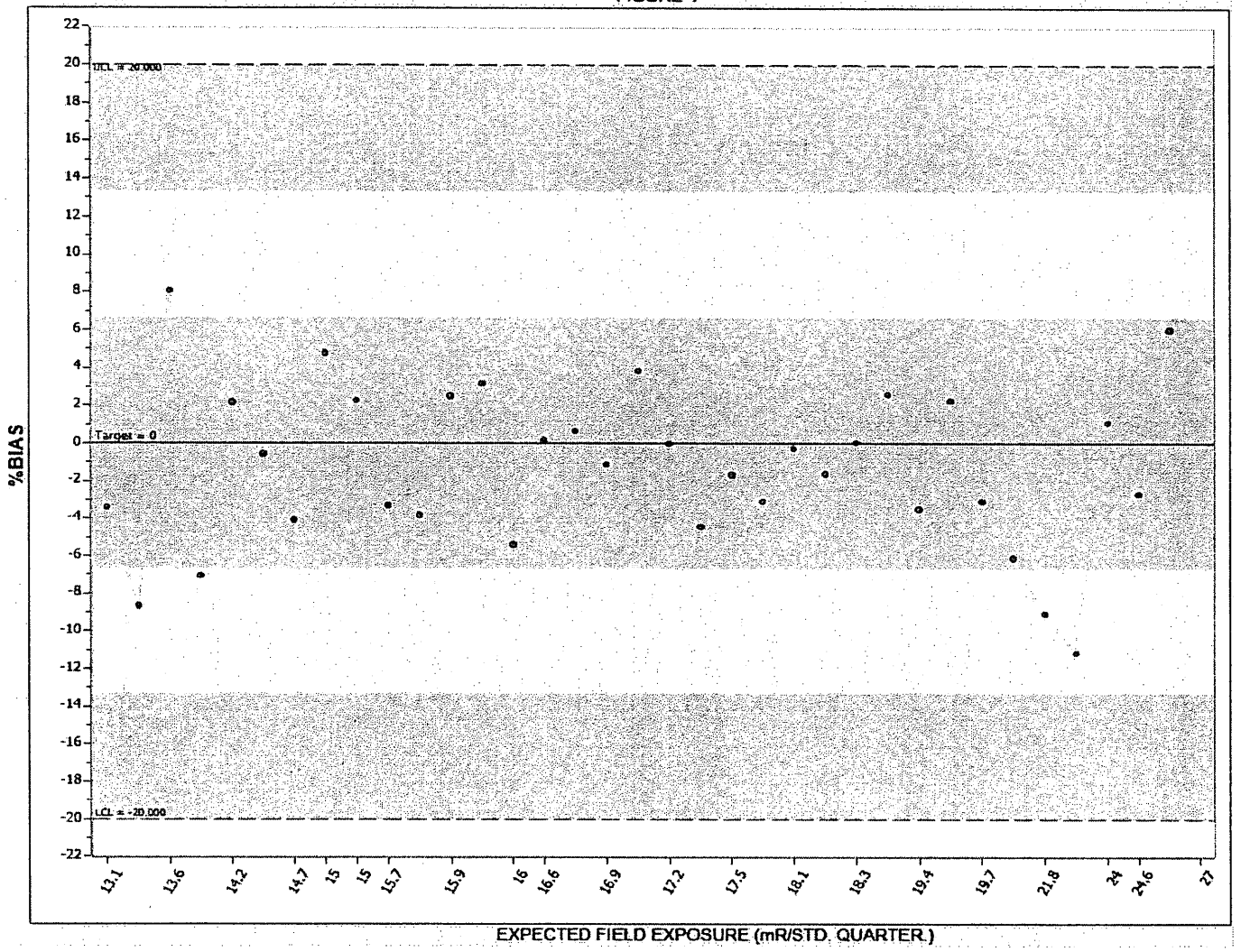


Table A.9.2
Sample Type: Quality Assurance Report
Matrix: Milk, Soil, Liquid, Vegetation, Air Charcoal, Air Particulate, Water

TELEDYNE BROWN ENGINEERING

For the TBE laboratory, 156 out of 160 analyses performed met the specified acceptance criteria. Four analyses (Milk - Sr-90, Vegetation - Sr-90, and Water - H-3 samples) did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

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.

1. Teledyne Brown Engineering's MAPEP March 2016 air particulate cross check sample is now being provided to TBE by Analytics. MAPEP's policy is to evaluate as failed non-reported nuclides that were reported in the previous study. NCR 16-14

1a. Since the Sr-90 was reported in the previous MAPEP study but not in this study MAPEP evaluated the Sr-90 for Soil as failed. NCR 16-14

1b. The MAPEP March 2016 Sr-90 in vegetation was evaluated as failing a false positive test. In reviewing the data that was reported vs the data in LIMS, it was found that the error was incorrectly reported as 0.023 rather than the correct value of 0.230. If the value had been reported with the activity and correct uncertainty of 0.301 ± 0.230, MAPEP would have evaluated the result as acceptable. NCR 16-14

2. Teledyne Brown Engineering's Analytics' March 2016 milk Sr-90 result of 15 ± .125 pCi/L was higher than the known value of 11.4 pCi/L with a ratio of 1.32. The upper ratio of 1.30 (acceptable with warning) was exceeded. After an extensive review of the data it is believed the technician did not rinse the filtering apparatus properly and some cross contamination from one of the internal laboratory spike samples may have been transferred to the analytics sample. We feel the issue is specific to the March 2016 Analytics sample. NCR 16-26

3. Teledyne Brown Engineering's ERA November 2016 sample for H-3 in water was evaluated as failing. A result of 918 pCi/L was reported incorrectly due to a data entry issue. If the correct value of 9180 had been reported, ERA would have evaluated the result as acceptable. NCR 16-34

4. Teledyne Brown Engineering's Analytics' December 2016 milk Sr-90 sample result of 14.7 ± .26 pCi/L was higher than the known value of 10 pCi/L with a ratio of 1.47. The upper ratio of 1.30 (acceptable with warning) was exceeded. The technician entered the wrong aliquot into the LIMS system. To achieve a lower error term TBE uses a larger aliquot of 1.2L (Normally we use .6L for client samples). If the technician had entered an aliquot of 1.2L into the LIMS system, the result would have been 12.2 pCi/L, which would have been considered acceptable. NCR 16-35

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
March 2016	E11476	Milk	Sr-89	pCi/L	97	86.7	1.12	A
			Sr-90	pCi/L	15	11.4	1.32	N(2)
	E11477	Milk	I-131	pCi/L	85.9	82.2	1.05	A
			Ce-141	pCi/L	106	98.4	1.08	A
			Cr-51	pCi/L	255	243	1.05	A
			Cs-134	pCi/L	134	130	1.03	A
			Cs-137	pCi/L	174	161	1.08	A
			Co-58	pCi/L	123	117	1.05	A
			Mn-54	pCi/L	141	117	1.21	W
			Fe-59	pCi/L	152	131	1.16	A
			Zn-65	pCi/L	193	179	1.08	A
			Co-60	pCi/L	259	244	1.06	A
	E11479	AP	Ce-141	pCi	69	81.1	0.85	A
			Cr-51	pCi	242	201	1.20	W
			Cs-134	pCi	98.1	107.0	0.92	A
			Cs-137	pCi	136	133	1.02	A
			Co-58	pCi	91.9	97	0.95	A
			Mn-54	pCi	98.6	96.2	1.02	A
			Fe-59	pCi	98.8	108	0.91	A
			Zn-65	pCi	131	147	0.89	A
			Co-60	pCi	209	201	1.04	A
	E11478	Charcoal	I-131	pCi	85.3	88.3	0.97	A
	E11480	Water	Fe-55	pCi/L	1800	1666	1.08	A
June 2016	E11537	Milk	Sr-89	pCi/L	94.4	94.4	1.00	A
			Sr-90	pCi/L	13.4	15.4	0.87	A
	E11538	Milk	I-131	pCi/L	96.8	94.5	1.02	A
			Ce-141	pCi/L	129	139	0.93	A
			Cr-51	pCi/L	240	276	0.87	A
			Cs-134	pCi/L	157	174	0.90	A
			Cs-137	pCi/L	117	120	0.98	A
			Co-58	pCi/L	131	142	0.92	A
			Mn-54	pCi/L	128	125	1.02	A
			Fe-59	pCi/L	132	122	1.08	A
			Zn-65	pCi/L	235	235	1.00	A
			Co-60	pCi/L	169	173	0.98	A

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) 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.

(2) NCR 16-26 was initiated

ANALYTICS ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Matrix	Nuclide	Units	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
June 2016	E11539	Charcoal	I-131	pCi	86.1	89.4	0.96	A
	E11540	AP	Ce-141	pCi	105	99.8	1.05	A
			Cr-51	pCi	216	198.0	1.09	A
			Cs-134	pCi	113	125	0.90	A
			Cs-137	pCi	94.5	86.6	1.09	A
			Co-58	pCi	101	102	0.99	A
			Mn-54	pCi	88.8	90.2	0.98	A
			Fe-59	pCi	82	87.5	0.94	A
			Zn-65	pCi	174	169	1.03	A
			Co-60	pCi	143	124	1.15	A
	E11541	Water	Fe-55	pCi/L	164	186	0.88	A
September 2016	E11609	Milk	Sr-89	pCi/L	90	90.9	0.99	A
			Sr-90	pCi/L	13.3	13.7	0.97	A
	E11610	Milk	I-131	pCi/L	80.4	71.9	1.12	A
			Ce-141	pCi/L	81.3	93	0.87	A
			Cr-51	pCi/L	198	236	0.84	A
			Cs-134	pCi/L	122	136	0.90	A
			Cs-137	pCi/L	119	119	1.00	A
			Co-58	pCi/L	92.2	97.4	0.95	A
			Mn-54	pCi/L	156	152	1.03	A
			Fe-59	pCi/L	97.5	90.6	1.08	A
			Zn-65	pCi/L	189	179	1.06	A
			Co-60	pCi/L	131	135	0.97	A
	E11611	Charcoal	I-131	pCi	52.4	59.9	0.87	A
	E11612	AP	Ce-141	pCi	67.5	63.6	1.06	A
			Cr-51	pCi	192	161.0	1.19	A
			Cs-134	pCi	91.4	92.6	0.99	A
			Cs-137	pCi	93.9	80.8	1.16	A
			Co-58	pCi	66	66.4	0.99	A
			Mn-54	pCi	104	104	1.00	A
			Fe-59	pCi	60.5	61.8	0.98	A
			Zn-65	pCi	140	122	1.15	A
			Co-60	pCi	119	91.9	1.29	W

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) 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	Reported Value (a)	Known Value (b)	Ratio (c) TBE/Analytics	Evaluation (d)
September 2016	E11613	Water	Fe-55	pCi/L	1990	1670	1.19	A
	E11614	Soil	Ce-141	pCi/g	0.153	0.175	0.87	A
			Cr-51	pCi/g	0.482	0.441	1.09	A
			Cs-134	pCi/g	0.270	0.254	1.06	A
			Cs-137	pCi/g	0.313	0.299	1.05	A
			Co-58	pCi/g	0.177	0.182	0.97	A
			Mn-54	pCi/g	0.340	0.285	1.19	A
			Fe-59	pCi/g	0.206	0.17	1.21	W
			Zn-65	pCi/g	0.388	0.335	1.16	A
			Co-60	pCi/g	0.284	0.252	1.13	A
December 2016	E11699	Milk	Sr-89	pCi/L	95	74.2	1.28	W
			Sr-90	pCi/L	14.7	10	1.47	N(3)
	E11700	Milk	I-131	pCi/L	97.5	97.4	1.00	A
			Ce-141	pCi/L	136	143	0.95	A
			Cr-51	pCi/L	247	280	0.88	A
			Cs-134	pCi/L	164	178	0.92	A
			Cs-137	pCi/L	120	126	0.95	A
			Co-58	pCi/L	139	146	0.95	A
			Mn-54	pCi/L	126	129	0.98	A
			Fe-59	pCi/L	114	125	0.91	A
			Zn-65	pCi/L	237	244	0.97	A
			Co-60	pCi/L	168	178	0.94	A
	E11701	Charcoal	I-131	pCi	95.6	98	0.98	A
	E11702	AP	Ce-141	pCi	91.7	97.7	0.94	A
			Cr-51	pCi	210	192.0	1.09	A
			Cs-134	pCi	122	122	1.00	A
			Cs-137	pCi	93.9	86.4	1.09	A
			Co-58	pCi	92	100	0.92	A
			Mn-54	pCi	93.7	88.5	1.06	A
			Fe-59	pCi	84.9	84.5	1.00	A
			Zn-65	pCi	176	167	1.05	A
			Co-60	pCi	151	122	1.24	W
	E11702	AP	Sr-89	pCi	79.1	92	0.86	A
			Sr-90	pCi	10	12.5	0.80	A
	E11703	Water	Fe-55	pCi/L	2180	1800	1.21	W

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) Ratio of Teledyne Brown Engineering to Analytics results.

(d) 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.

(3) NCR 16-35 was initiated

DOE's MIXED ANALYTE PERFORMANCE EVALUATION PROGRAM (MAPEP)
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Range	Evaluation (c)
March 2016	16-MaW34	Water	Am-241	Bq/L	0.008		(1)	A
			Ni-63	Bq/L	12.4	12.3	8.6-16.0	A
			Pu-238	Bq/L	1.4900	1.2440	0.871-1.617	A
			Pu-239/240	Bq/L	0.729	0.641	0.449-0.833	A
	16-MaS34	Soil	Ni-63	Bq/kg	1140	1250.0	875-1625	A
			Sr-90	Bq/kg	8.15		(1)	A
	16-RdF34	AP	U-234/233	Bq/sample	0.1620	0.1650	0.116-0.215	A
			U-238	Bq/sample	0.163	0.172	0.120-0.224	A
	16-GrF34	AP	Gr-A	Bq/sample	0.608	1.20	0.36-2.04	A
			Gr-B	Bq/sample	0.8060	0.79	0.40-1.19	A
	16-RdV34	Vegetation	Cs-134	Bq/sample	10.10	10.62	7.43-13.81	A
			Cs-137	Bq/sample	6.0	5.62	3.93-7.31	A
			Co-57	Bq/sample	13.3000	11.8	8.3-15.3	A
			Co-60	Bq/sample	0.013		(1)	A
			Mn-54	Bq/sample	0.0150		(1)	A
			Sr-90	Bq/sample	0.301		(1)	N(4)
			Zn-65	Bq/sample	10.500	9.6	6.7-12.5	A
September 2016	16-MaW35	Water	Am-241	Bq/L	0.626	0.814	.570-1058	W
			Ni-63	Bq/L	12.4	17.2	12.0-22.4	A
			Pu-238	Bq/L	1.23	1.13	0.79-1.47	W
			Pu-239/240	Bq/L	0.0318	0.013	(1)	A
	16-MaS35	Soil	Ni-63	Bq/kg	724	990	693-1287	A
			Sr-90	Bq/kg	747	894	626-1162	A
	16-RdF35	AP	U-234/233	Bq/sample	0.160	0.15	0.105-0.195	A
			U-238	Bq/sample	0.157	0.156	0.109-0.203	A
	16-RdV35	Vegetation	Cs-134	Bq/sample	-0.103		(1)	A
			Cs-137	Bq/sample	5.64	5.54	3.88-7.20	A
			Co-57	Bq/sample	7.38	6.81	4.77-8.85	A
			Co-60	Bq/sample	4.81	4.86	3.40-6.32	A
			Mn-54	Bq/sample	7.4	7.27	5.09-9.45	A
			Sr-90	Bq/sample	0.774	0.80	0.56-1.04	A
			Zn-65	Bq/sample	5.46	5.4	3.78-7.02	A

(1) False positive test.

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) DOE/MAPEP evaluation: A=acceptable, W=acceptable with warning, N=not acceptable.

(4)NCR 16-14 was initiated

ERA ENVIRONMENTAL RADIOACTIVITY CROSS CHECK PROGRAM
TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

Month/Year	Identification Number	Media	Nuclide	Units	Reported Value (a)	Known Value (b)	Acceptance Limits	Evaluation (c)
May 2016	RAD-105	Water	Sr-89	pCi/L	48.9	48.2	37.8 - 55.6	A
			Sr-90	pCi/L	25.0	28.5	20.7 - 33.1	A
			Ba-133	pCi/L	53.1	58.8	48.7 - 64.9	A
			Cs-134	pCi/L	40.9	43.3	34.6 - 47.6	A
			Cs-137	pCi/L	84.8	78.4	70.6 - 88.9	A
			Co-60	pCi/L	108	102	91.8 - 114	A
			Zn-65	pCi/L	226	214	193 - 251	A
			Gr-A	pCi/L	38.9	62.7	32.9 - 77.8	A
			Gr-B	pCi/L	41.9	39.2	26.0 - 46.7	A
			I-131	pCi/L	24.1	26.6	22.1 - 31.3	A
			U-Nat	pCi/L	4.68	4.64	3.39 - 5.68	A
			H-3	pCi/L	7720	7840	6790 - 8620	A
November 2016	RAD-107	Water	Sr-89	pCi/L	43.0	43.3	33.4-50.5	A
			Sr-90	pCi/L	30.0	33.6	24.6-38.8	A
			Ba-133	pCi/L	47.8	54.9	45.4-60.7	A
			Cs-134	pCi/L	72.9	81.8	67.0-90.0	A
			Cs-137	pCi/L	189	210	189-233	A
			Co-60	pCi/L	58.4	64.5	58.0-73.4	A
			Zn-65	pCi/L	243	245	220-287	A
			Gr-A	pCi/L	37.2	68.4	35.9-84.5	A
			Gr-B	pCi/L	35.1	33.9	22.1-41.6	A
			I-131	pCi/L	23.5	26.3	21.9-31.0	A
			U-Nat	pCi/L	49.2	51.2	41.6-56.9	A
			H-3	pCi/L	918	9820	8540-10800	N(5)
	MRAD-25	AP	Gr-A	pCi/Filter	56.8	71.2	23.9-111	A

(a) Teledyne Brown Engineering reported result.

(b) 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.

(c) ERA evaluation: A=acceptable. Reported result falls within the Warning Limits. NA=not acceptable. Reported result falls outside of the Control Limits. CE=check for Error. Reported result falls within the Control Limits and outside of the Warning Limit.

(5) NCR 16-34 was initiated