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0CAN051901

May 13, 2019

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

SUBJECT: Annual Radiological Environmental Operating Report for 2018

Arkansas Nuclear One – Units 1 and 2
NRC Docket Nos. 50-313 and 50-368
Renewed Facility Operating License Nos. DPR-51 and NPF-6

Dear Sir or Madam:

In accordance with Arkansas Nuclear One (ANO), Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2, the submittal of an annual radiological environmental operating report for the previous year is required by May 15 of each year. The subject ANO report for the calendar year 2018 is enclosed.

This report fulfills the reporting requirements of the TSs referenced above.

The radionuclides detected by the radiological environmental monitoring program during 2018 were significantly below the regulatory limits. The operation of the ANO station during 2018 had no harmful radiological effects nor resulted in any irreversible damage to the local environment.

Based on ANO's review, no environmental samples from the monitoring program equaled or exceeded the reporting levels for radioactivity concentration due to ANO effluents when averaged over any calendar quarter. A map of all sampling locations and a corresponding table providing the respective distances and directions from the reactor building is included in the Offsite Dose Calculation Manual submitted as part of the referenced Annual Radioactive Effluent Release Report.

This letter contains no new commitments.

If you have any questions or require additional information, please contact me.

Sincerely,

ORIGINAL SIGNED BY TIMOTHY L. ARNOLD

TLA/rwc

Enclosure: Annual Radiological Environmental Operating Report for 2018

Plant: Arkansas Nuclear One	Page 1 of 53
	YEAR: 2018
Document Number: 0CAN051901	
Annual Radiological Environmental Operating Report	

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

1.1 Radiological Environmental Monitoring Program

The Annual Radiological Environmental Operating Report presents data obtained through analyses of environmental samples collected for Arkansas Nuclear One (ANO) Radiological Environmental Monitoring Program (REMP) for the period January 1 through December 31, 2018. This report fulfills the requirements of ANO, Unit 1 (ANO-1) Technical Specification (TS) 5.6.2 and ANO, Unit 2 (ANO-2) TS 6.6.2.

All required lower limit of detection (LLD) capabilities were achieved in all sample analyses during 2018, as required by the ANO's Offsite Dose Calculation Manual (ODCM). No measurable levels of radiation above baseline levels attributable to ANO operation were detected in the vicinity of ANO. The 2018 Radiological Environmental Monitoring Program thus substantiated the adequacy of source control and effluent monitoring at ANO with no observed impact of plant operations on the environment.

ANO established the REMP prior to the station's becoming operational (1974) to provide data on background radiation and radioactivity normally present in the area. ANO has continued to monitor the environment by sampling air, water, sediment, fish and food products, as well as measuring direct radiation. ANO also samples milk if milk-producing animals used for human consumption are present within five miles (8 km) of the plant.

The REMP includes sampling indicator and control locations within an approximate 20-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 the presence of only naturally occurring radioactivity. ANO personnel compare indicator results with control and preoperational results to assess any impact ANO operation might have had on the surrounding environment.

In 2018, environmental samples were collected for radiological analysis. The results of indicator locations were compared with control locations and previous studies. It was concluded that no significant relationship exists between ANO operation and effect on the area around the plant. The review of 2018 data concluded that radioactivity levels in the environment were undetectable in many locations and near background levels in significant pathways.

1.2 Reporting Levels

No samples equaled or exceeded reporting levels.

1.3 Comparison to State and/or Federal Program

ANO personnel compared REMP data to state monitoring programs as results became available. Historically, the programs used for comparison have included the U.S. Nuclear Regulatory Commission (NRC) Thermoluminescent Dosimeter (TLD) Direct Radiation Monitoring Network and the Arkansas Department of Health.

The NRC TLD Network Program was discontinued in 1998. Historically these results have compared to those from the ANO REMP. ANO TLD results continue to remain similar to the historical average and continue to verify that plant operation is not affecting the ambient radiation levels in the environment.

The Arkansas Department of Health and the ANO REMP entail similar radiological environmental monitoring program requirements. These programs include collecting air samples and splitting or sharing sample media such as water, sediment and fish. Both programs have obtained similar results over previous years.

1.4 Sample Deviations

During 2018, environmental sampling was performed for eight (8) media types addressed in the ODCM and for direct radiation. A total of 278 samples of the 279 scheduled were obtained. Of the scheduled samples, 100% were collected and analyzed in accordance with the requirements specified in the ODCM. Attachment 1 contains the listing of sample deviations and actions taken.

1.5 Program Modifications

Changes made to ANO Site Procedure OP-1608.005:

- In January 2018 the procedure was revised to make some sections clearer and easier to perform.

- In December 2018, OP-1608.005 was deleted and replaced by a fleet procedure EN-CY-130-01.

These changes had no impact to the stations ODCM, Technical Requirements Manual (TRM), Radioactive Effluents Control Program, or data trending. All changes made were enhancements.

2.0 INTRODUCTION

2.1 Radiological Environmental Monitoring Program

ANO established the REMP to ensure that plant operating controls properly function to minimize any associated radiation endangerment to human health or the environment. The REMP is designed for:

- Analyzing applicable pathways for anticipated types and quantities of radionuclides released into the environment.

- Considering the possibility of a buildup of long-lived radionuclides in the environment and identifying physical and biological accumulations that may contribute to human exposures.

- Considering the potential radiation exposure to plant and animal life in the environment surrounding ANO.

- Correlating levels of radiation and radioactivity in the environment with radioactive releases from station operation.

2.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by ANO ODCM. A description of the REMP utilized to monitor the exposure pathways is described in the attached tables and figures.

Section 4.0 of this report provides a discussion of 2018 sampling results with Section 5.0 providing a summary of results for the monitored exposure pathways.

2.3 Land Use Census

ANO conducts a land use census biennially, as required by Section B 2.5.2 of the ODCM. The purpose of this census is to identify changes in uses of land within five miles of ANO that would require modifications to the REMP and the ODCM. The most important criteria during this census are to determine the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 ft^2 producing fresh leafy vegetables in each of the 16 meteorological sectors within a 5-mile distance from one reactor (containment).

3.0 RADIOLOGICAL ENVIRONMENTAL SAMPLING PROGRAM REQUIREMENTS

Table 1 – Exposure Pathway – Airborne			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency of Analyses**
RADIOIODINE AND PARTICULATES 3 samples close to the Site Boundary, in (or near) different sectors with the highest calculated annual average ground level D/Q.	**Station 2 (243° - 0.5 miles)** - South of the sewage treatment plant. **Station 56 (264° - 0.4 miles)** – West end of the sewage treatment plant. **Station 1 (88° - 0.5 miles)** - Near the meteorology tower.	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.
RADIOIODINE AND PARTICULATES 1 sample from the vicinity of a community having the highest calculated annual average ground level D/Q.	**Station 6 (111° - 6.8 miles)** – Local Entergy office, 305 South Knoxville Avenue, Russellville	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.
RADIOIODINE AND PARTICULATES 1 sample from a control location, as for example 15 - 30 km distance and in the least prevalent wind direction.	**Station 7 (210° - 19.0 miles)** – Entergy Supply Yard on Highway 10 in Danville. (Control)	Continuous sampler operation with sample collection every two weeks, or more frequently if required by dust loading.	• Radioiodine Canisters – I-131 analysis every two weeks. • Air Particulate – Gross beta radioactivity analysis following filter change.

Table 2 – Exposure Pathway – Direct Radiation			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency of Analyses**
TLDS 16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the site boundary.	**Station 1 (88° - 0.5 miles)** - On a pole near the meteorology tower. **Station 2 (243° - 0.5 miles)** - South of the sewage treatment plant. **Station 3 (5° - 0.7 miles)** – West of ANO Gate #2 on Highway 333 (approximately 0.35 miles) **Station 4 (181° - 0.5 miles)** – West of May Cemetery entrance on south side of the road. **Station 56 (264° - 0.4 miles)** - West end of the sewage treatment plant. **Station 108 (306° - 0.9 miles)** - South on Flatwood Road on a utility pole. **Station 109 (291° - 0.6 miles)** - Utility pole across from the junction of Flatwood Road and Round Mountain Road. **Station 110 (138° - 0.8 miles)** - Bunker Hill Lane on the first utility pole on the left. **Station 145 (28° - 0.6 miles)** - Near west entrance to the RERTC on a utility pole. **Station 146 (45° - 0.6 miles)** - South end of east parking lot at RERTC on a utility pole. **Station 147 (61° - 0.6 miles)** - West side of Bunker Hill Road, approximately 100 yards from intersection with State Highway 333. **Station 148 (122° - 0.6 miles)** - Intersection of Bunker Hill Road with Scott Lane on county road sign post. **Station 149 (156° - 0.5 miles)** – On a utility pole on the south side of May Road. **Station 150 (205° - 0.6 miles)** – North side of May Road on a utility pole past the McCurley Place turn. **Station 151 (225° - 0.4 miles)** – West side of sewage treatment plant near the lake on a metal post. **Station 152 (338° - 0.8 miles)** – South side of State Highway 333 on a road sign post.	Once per 92 days.	mR exposure quarterly.

Table 2 – Exposure Pathway – Direct Radiation			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency of Analyses**
TLDS 8 stations with two or more dosimeters in special interest areas such as population centers, nearby residences, schools, and in 1 - 2 areas to serve as control locations.	**Station 6 (111° - 6.8 miles)** - Entergy local office in Russellville (305 South Knoxville Avenue). **Station 7 (210° - 19.0 miles)** – Entergy Supply Yard on Highway 10 in Danville. **Station 111 (120° - 2.0 miles)** – Marina Road on a utility pole on the left just prior to curve. **Station 116 (318° - 1.8 miles)** - Highway 333 and Highway 64 in London on a utility pole north of the railroad tracks. **Station 125 (46° - 8.7 miles)** - College Street on a utility pole at the southeast corner of the red brick school building. **Station 127 (100° - 5.2 miles)** - Arkansas Tech Campus on a utility pole across from Paine Hall. **Station 137 (151° - 8.2 miles)** – On a speed limit sign on the right in front of the Morris R. Moore Arkansas National Guard Armory. **Station 153 (304° - 9.2 miles)** - Knoxville Elementary School near the school entrance gate on a utility pole.	Once per 92 days.	mR exposure quarterly.

Table 3 – Exposure Pathway – Waterborne			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency of Analyses**
SURFACE WATER 1 indicator location (influenced by plant discharge) 1 control location (uninfluenced by plant discharge)	**Station 8 (166° - 0.2 miles)** - Plant discharge canal. **Station 10 (95° - 0.5 miles)** – Plant intake canal.	Grab samples every 92 days.	Gamma isotopic analysis and tritium analysis quarterly.
Drinking Water 1 indicator location (influenced by plant discharge) 1 control location (uninfluenced by plant discharge)	**Station 14 (70° - 5.1 miles)** - Russellville city water system from the Illinois Bayou. **Station 57 (208° - 19.5 miles)** - Danville public water supply treatment on Fifth Street.	Once per 92 days.	I-131, gross beta, gamma isotopic and tritium analyses once per 92 days.
GROUNDWATER a control location up gradient from the protected area 2 sample locations of Groundwater from indicator locations down gradient from the protected area.	**Station 58 (GWM-1, 22° - 0.3 miles)** – North of Protected Area in Owner Control Area (OCA). West of Security North Check Point, east side of access road. **Station 62 (GWM-101, 34° - 0.5 miles)** – North of Protected Area in OCA. East of outside receiving building. **Station 63 (GWM-103, 206° - 0.1 miles)** – South of Protected area in OCA. North- east of Stator Rewind Bldg. near wood line. **Station 64 (GWM-13, 112° - 0.1 miles)** – South of Oily Water Separator facility, northwest corner of U-2 Intake Structure. Inside Protected area.	Grab samples every 92 days.	Gamma isotopic, gross beta, and tritium analysis quarterly.
SEDIMENT FROM SHORELINE 1 indicator location (influenced by plant discharge) 1 control location (uninfluenced by plant discharge)	**Station 8 (243° - 0.9 miles)** - Plant discharge canal. **Station 16 (287° - 5.5 miles)** - Panther Bay on south side of Arkansas River across from mouth of Piney Creek.	Once per 365 days.	Gamma isotopic analysis annually.

Table 4 – Exposure Pathway – Ingestion			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency of Analyses**
MILK • If commercially available, 1 sample from milking animals within 8 km distant where doses are calculated to be greater than 1 mrem per year. • 1 sample from milking animals at a control location 15 – 30 km distant when an indicator location exists.	Currently, no available milking animals within 5 miles of ANO.	Gamma isotopic and I-131 analyses once per 92 days.	Gamma isotopic and I-131 analyses once per 92 days.
FISH AND INVERTEBRATES • 1 sample of a commercially and/or recreationally important species in vicinity of plant discharge area. • 1 sample of similar species in area not influenced by plant discharge.	**Station 8 (212° - 0.5 miles)** – Plant discharge canal. **Station 16 (287° - 5.5 miles)** - Panther Bay on south side of Arkansas River across from mouth of Piney Creek.	Once per 365 days.	Gamma isotopic analysis on edible portions annually
FOOD PRODUCTS • 1 sample of one type of broadleaf vegetation grown near the SITE BOUNDARY location of highest predicted annual average ground level D/Q if milk sampling is not performed. • 1 sample of similar broadleaf vegetation grown 15 – 30 km distant, if milk sampling is not performed.	**Station 13 (273° - 0.5 miles)** - West from ANO toward Gate 4 onto Flatwood Road. **Station 55 (217° - 13.1 miles)** – Ozark National Forest north of Danville	Three per 365 days.	Gamma. isotopic and I-131 analyses three times per 365 days

Figure 1 – Exposure Pathway

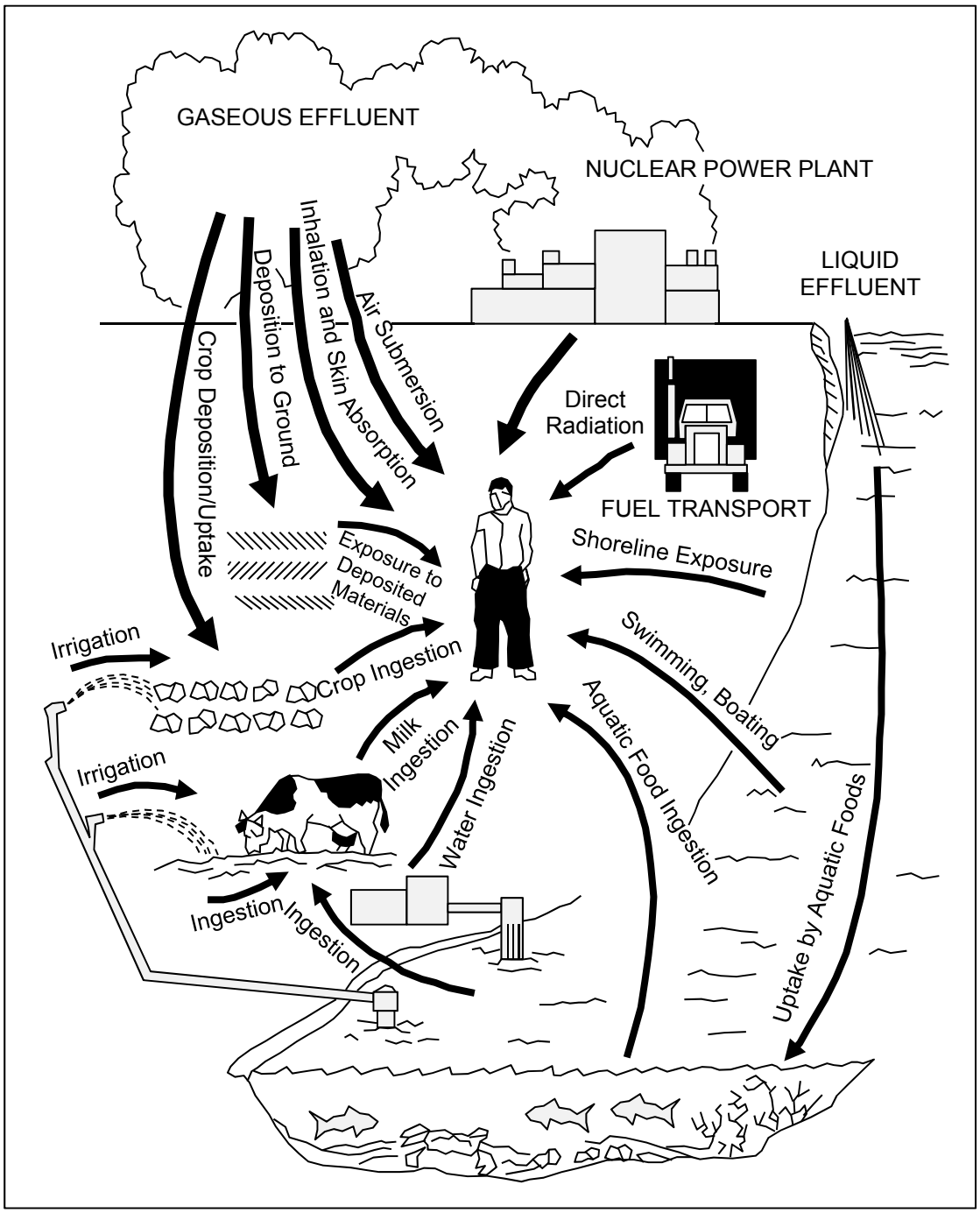


Figure 2 – Sample Collection Sites – Near Field

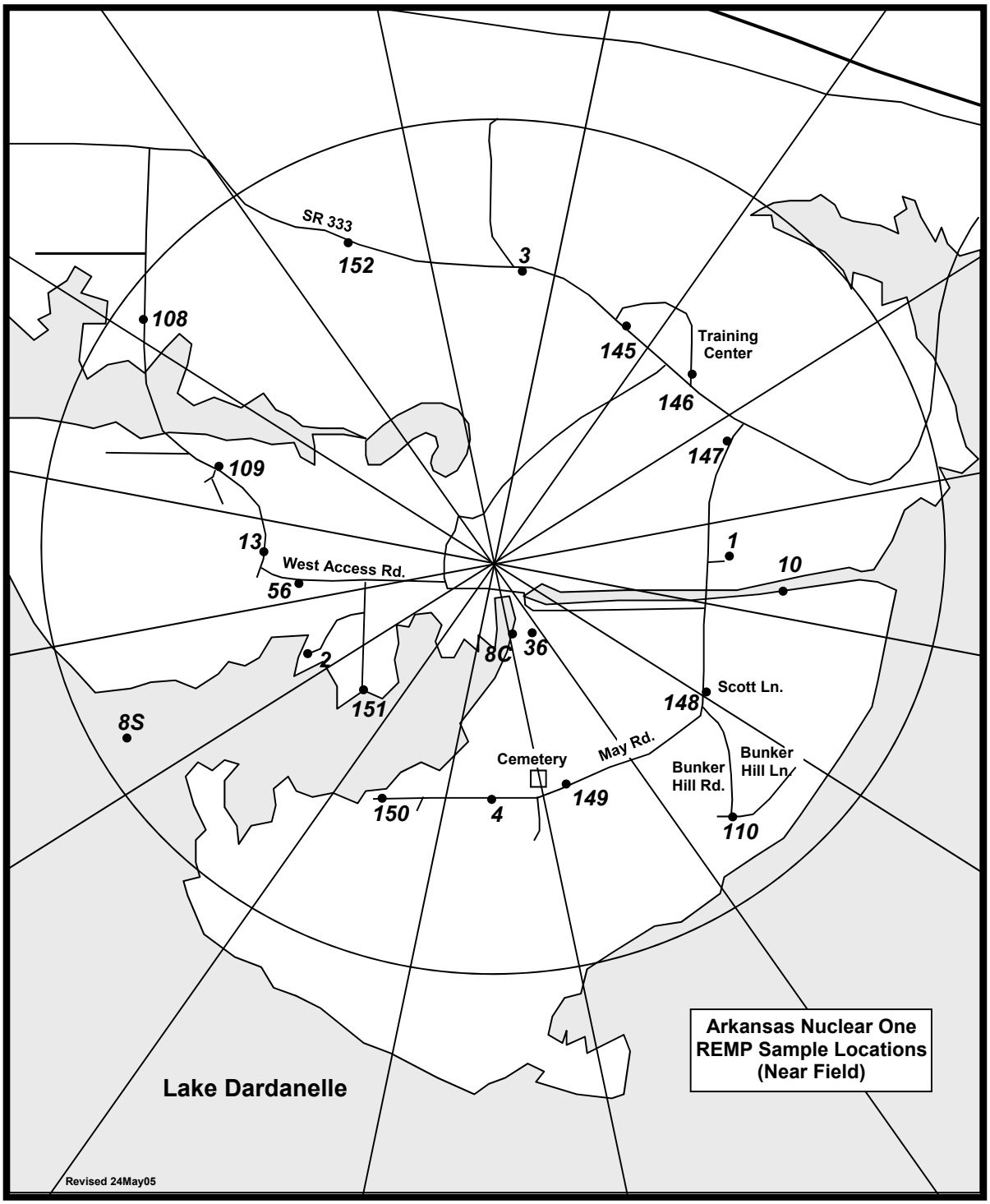


Figure3 – Sample Collection Sites – Far Field

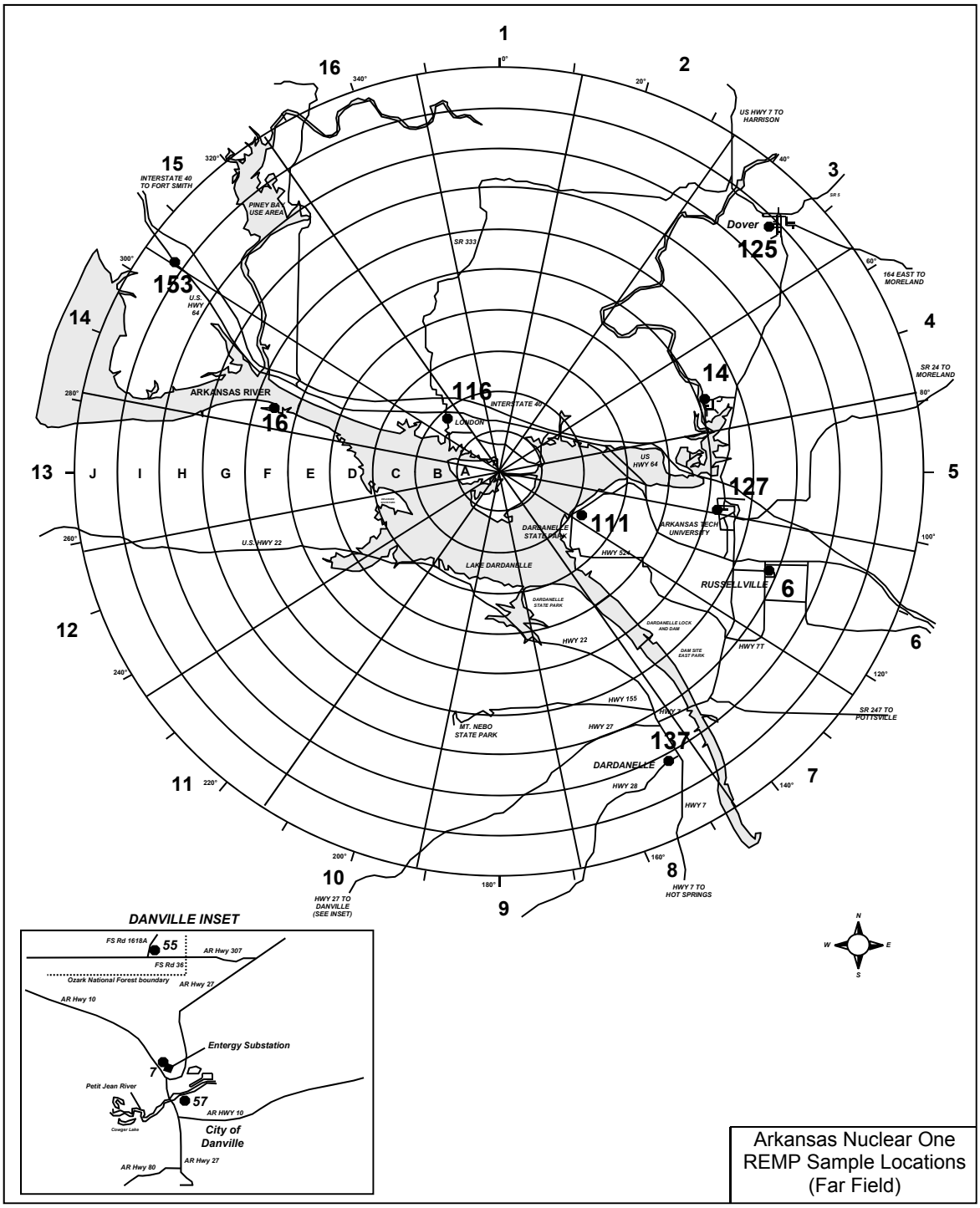
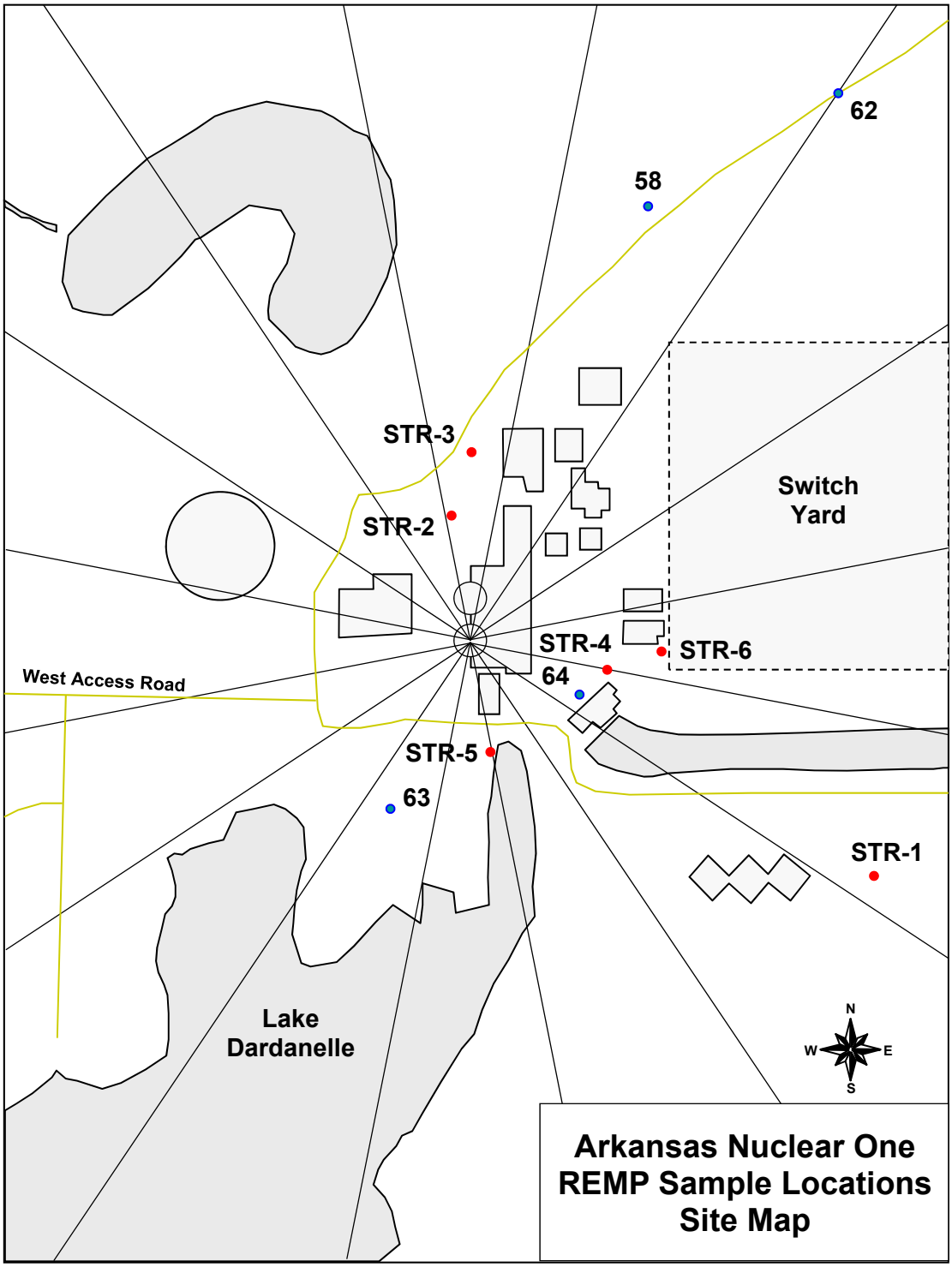


Figure 4 – Sample Collection Sites



4.0 INTERPRETATION AND TRENDS OF RESULTS

4.1 Air Particulate and Radioiodine Sample Results – Example

The REMP has detected radioactivity in the airborne pathway attributable to other sources. These include the 25th Chinese nuclear test explosion in 1980, the radioactive plume release due to reactor core degradation at Chernobyl Nuclear Power Plant in 1986, and the Fukushima Daiichi Nuclear Power Plant accident (March 11, 2011).

In 2018 there were no samples above the LLD for I-131. Indicator gross beta air particulate results for 2018 were comparable to results obtained from 2008-2017 of the operational REMP, but less than 2013 when the annual average was 0.043. Also, the 2018 gross beta annual average was less than the average for preoperational levels. Results are reported as annual average picocuries per cubic meter (pCi/m^3).

Monitoring Period	Result
2008 – 2017 (Minimum Value)	0.018
2018 Average Value	0.019
2008 – 2017 (Maximum Value)	0.043
Preoperational	0.050

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. Table 9, "Air Particulate Data Summary," includes gross beta concentrations and provides a comparison of the indicator and control means and ranges emphasizing the consistent trends seen in this pathway to support the presence of naturally occurring activity. Therefore, it can be concluded that the airborne pathway continues to be unaffected by ANO operations.

4.2 Thermoluminescent Dosimetry (TLD) Sample Results – Example

ANO reports measured dose as net exposure (field reading less transit reading) normalized to 92 days and relies on comparison of the indicator locations to the control as a measure of plant impact. ANO's comparison of the inner ring and special interest area TLD results to the control, as seen in Table 5, "Direct Radiation Annual Summary," identified no noticeable trend that would indicate that the ambient radiation levels are being affected by plant operations. In addition, the inner ring value of 7.7 millirem (mrem) shown in Table 5 for 2018 is within the historical bounds of 2008 – 2017 annual average results, which have ranged from 7.5 to 8.5 mrem. Overall, ANO concluded that the ambient radiation levels are not being affected by plant operations.

Table 5 – Direct Radiation Annual Summary			
Year	**Inner Ring (mR/Qtr)**	**Special Interest (mR/Qtr)**	**Control Location (mR/Qtr)**
2008	7.5	7.1	7.3
2009	8.3	7.2	6.5
2010	8.3	7.4	6.9
2011	8.5	7.6	6.9
2012	8.0	7.2	7.0
2013	8.3	7.6	6.8
2014	7.8	6.9	6.1
2015	7.6	6.9	6.1
2016	8.0	6.7	6.5
2017	8.2	7.2	6.7
2018	7.7	6.4	5.7

4.3 Waterborne Sample Results – Example

Analytical results for 2018 drinking water and ground water samples were similar to those reported in previous years. Gamma radionuclides analytical results for 2018 surface water samples were similar to those reported in previous years. Tritium in ANO surface water indicator samples continues to be detected, but at levels below those experienced in 2013 and below the ODCM-required LLD. These results are further explained below.

4.3.1 Surface Water

Samples were collected and analyzed for gamma radionuclides and tritium. Gamma radionuclides were below detectable limits which is consistent with results seen in previous operational years. Tritium continues to be detected at the indicator location (Station 8) where previously monitored liquid radioactive effluent from the plant is periodically discharged in accordance with the regulatory criteria established in the ODCM and, for 2018, at levels considerably lower than the ODCM-required LLD of 3000 pCi/l. Furthermore, unlike the elevated tritium levels observed in 2013 attributable to particular plant events, no elevated levels attributable to particular events were observed in 2018. Results are reported as annual average pCi/l.

Monitoring Period	Result
2008 – 2017 (Minimum Value)	427.0
2018 Value	814.5
2008 – 2017 (Maximum Value)	2940*
Preoperational	200.0

* Indicates value from 2013

ANO personnel have noted no definable increasing trends associated with the tritium levels at the discharge location. Levels detected during 2018 and previous operational years have been well below regulatory reporting limits. Therefore, the operation of ANO had no definable impact on this waterborne pathway during 2018 and levels of radionuclides remain similar to those obtained in previous operational years.

4.3.2 Drinking Water

Samples were collected from two locations (indicator and control). Although ANO personnel utilize Station 14 (City of Russellville) as an indicator location due to the potential for the drinking water pathway to exist, the City of Russellville has not withdrawn water from Lake Dardanelle in the past several years.

Drinking water samples were analyzed for gross beta radionuclides, I-131, gamma radionuclides and tritium. Gamma radionuclides, gross beta radionuclides, I-131, and tritium concentrations were below the LLD limits at the indicator and control locations, which is consistent with the preoperational and operational years as shown below. Results from 2018 are summarized in table below. Results are reported as annual average pCi/L. The control location has historically shown gross beta above MDC but less than LLD, while the indicator location is below MDC and LLD.

Radionuclide	2018	2017	2008 – 2016***	Preoperational
Gross Beta	3.59*	2.76**	2.85	2.0
Iodine-131	< LLD	< LLD	< LLD	< LLD
Gamma	< LLD	< LLD	< LLD	< LLD
Tritium	< LLD	< LLD	< LLD	200.0

* Average for the control sample during 2018, gross beta was 3.59 pCi/L which is > MDC, but < LLD.

** Value represents 4th quarter sampling results from 2017.

*** Average of the results from the years 2008-2017.

ANO personnel have noted no definable trends associated with drinking water results at the indicator location. Therefore, the operation of ANO had no definable impact on this waterborne pathway during 2018 and levels of radionuclides remain similar to those obtained in previous operational years.

4.3.3 Groundwater

Samples were collected from four REMP locations (2 control, and 2 indicator locations). During 2011, ANO incorporated sixteen additional groundwater monitoring wells into the Groundwater Protection Initiative (GPI) site program. Sample data are compiled, organized and reviewed annually to:

- Analyze for increasing or decreasing trends at individual sample points, wells or groups of wells.
- Review the radionuclides detected to determine whether changes should be made to the analysis sites or sampling frequencies for each sampling location.

- Evaluate the locations of radionuclides in ground water to determine if changes should be made to the sampling locations.
- Review current investigation levels and determine if changes should be made.
- Determine if any change to the ODCM is required.
- Determine if a corrective action/remediation is required.

Groundwater samples from the four REMP locations were analyzed for tritium and gamma radionuclides. Tritium, gamma, and gross beta concentrations were below the LLD limits at all four locations. Listed below is a comparison of 2018 indicator results to past operational years. Results are reported as annual average pCi/l. REMP Groundwater data are captured in the table below. ANO operations had no significant impact on the environment or public by this waterborne pathway.

Radionuclide	2018	2008 – 2017
Iodine-131	< LLD	< LLD
Gamma	< LLD	< LLD
Tritium	< LLD	< LLD
Gross Beta	4.5*	< LLD**

* Average for Indicator wells for 2018.

** Only 2014-2017 gross beta data available for review as historical data.

4.4 Soil Sample Results – Example

Sediment samples were collected from two locations in 2018 and analyzed for gamma radionuclides. Listed below is a comparison of 2018 indicator results to the 2008 – 2017 operational years. ANO operations had no significant impact on the environment or public by this waterborne pathway. Results are reported as pCi/kg.

Monitoring Period	Result
2008 – 2017 (Minimum Value)	41.79
2018 Value	< LLD
2008 – 2017 (Maximum Value)	661.0

Sediment samples were collected from two locations in 2018 and analyzed for gamma radionuclides. Although Cesium-137 has been detected in years prior to 2018, all gamma radionuclides from 2018 samples were below detectable limits. These results are consistent with 2017 results where all gamma radionuclides were also below detectable limits. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway.

4.5 Ingestion Sample Results – Example

4.5.1 Milk Sample Results

Milk samples were not collected during 2018 due to the unavailability of indicator locations within five miles of ANO.

4.5.2 Fish Sample Results

Fish samples were collected from two locations and analyzed for gamma radionuclides. In 2018, gamma radionuclides were below detectable limits which are consistent with the preoperational monitoring period and operational results since 1997. Therefore, based on these measurements, ANO operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.5.3 Food Product Sample Results

The REMP has detected radionuclides prior to 1990 that are attributable to other sources. These include the radioactive plume release due to reactor core degradation at Chernobyl Nuclear Power Plant in 1986 and atmospheric weapons testing.

In 2018, food product samples were collected when available from two locations and analyzed for Iodine-131 and gamma radionuclides. The 2018 levels remained undetectable, as has been the case in previous years. Therefore, based on these measurements, ANO operations had no significant radiological impact upon the environment or public by this ingestion pathway.

4.6 Land Use Census Results – Example

The latest land use census (performed in 2017) did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated Table 6, "Land Use Census – [2017] Nearest Residence Within Five Miles."

Also, the land use census identified no milk-producing animals within a five-mile radius of the plant site. ANO personnel chose not to perform a garden census in 2017, but instead to sample broadleaf vegetation, which is allowed by ODCM Section L 2.5.2. As allowed by NRC Regulatory Guide 1.21, Revision 2, Section 3.2, broadleaf vegetation sampling in the meteorological sector (Sector 13) with a D/Q value within 10% of the sector with the highest D/Q (Sector 12) was performed.

Table 6 – Land Use Census – [2017] Nearest Residence Within Five Miles

Sector	Direction	Nearest Residence	Range (Miles)	Nearest Milk Animal	Range (Unit)	Comment
1	N	1	0.9	N/A	N/A	None
2	NNE	2	1.3	N/A	N/A	None
3	NE	3	0.9	N/A	N/A	None
4	ENE	4	0.8	N/A	N/A	None
5	E	5	0.8	N/A	N/A	None

Table 6 – Land Use Census – [2017] Nearest Residence Within Five Miles						
Sector	**Direction**	**Nearest Residence**	**Range (Miles)**	**Nearest Milk Animal**	**Range (Unit)**	**Comment**
6	ESE	6	0.8	N/A	N/A	None
7	SE	7	0.8	N/A	N/A	None
8	SSE	8	0.8	N/A	N/A	None
9	S	9	0.8	N/A	N/A	None
10	SSW	10	0.7	N/A	N/A	None
11	SW	11	2.8	N/A	N/A	None
12	WSW	12	0.7	N/A	N/A	None
13	W	13	0.8	N/A	N/A	None
14	WNW	14	0.8	N/A	N/A	None
15	NW	15	1.0	N/A	N/A	None
16	NNW	16	0.9	N/A	N/A	None

A land use census was not conducted for the year 2018. The next land use census is scheduled to be conducted in 2019.

4.7 Interlaboratory Comparison Results

Attachment 3 and Attachment 4 contain result summaries for Interlaboratory Comparison Program for Teledyne Brown Engineering and Environmental Dosimetry Group.

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Table 7, "Radiological Environmental Monitoring Program Summary," summarizes data for the 2018 REMP program.

Table 7 – Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F) [Note 3] [Range]	Location [Note 4] [Highest Annual Mean]		Control Locations Mean (F) [Note 3] [Range]	Number of Non-Routine Results [Note 5]
				Location	Mean (F) [Note 3] [Range]		
Air Particulates (pCi/m^3)	GB / 135	0.01	0.0192 (81 / 81) [0.0095 – 0.036]	Station 1 (88°, 0.5 mi)	0.021 (27 / 27) [0.0095 - 0.036]	0.0193 (54 / 54) [0.009 - 0.034]	2
Airborne Iodine (pCi/ m^3)	I-131 / 135	0.07	< LLD	N/A	N/A	< LLD	2
Inner Ring TLDs (mR/Qtr)	Gamma / 64	[Note 6]	7.73 (64 / 64) [5.0 – 10.6]	Station 56 (264°, 0.4 mi)	10.6 (4 / 4) [7.7 – 15.5]	N/A	2
Special Interest TLDs (mR/Qtr)	Gamma / 28	[Note 6]	6.37 (27 / 28) [4.7 – 8.5]	Station 116 (318° - 1.8 mi)	8.5 (4 / 4) [8.2 - 8.9]	N/A	0
Control TLD (mR/Qtr)	Gamma / 4	[Note 6]	N/A	N/A	N/A	5.7 (4 / 4) [4.3 - 6.6]	0

Table 7 – Radiological Environmental Monitoring Program Summary							
Sample Type (Units)	**Type / Number of Analyses** [Note 1]	**LLD** [Note 2]	**Indicator Locations Mean (F)** [Note 3] **[Range]**	**Location** [Note 4] **[Highest Annual Mean]**		**Control Locations Mean (F)** [Note 3] **[Range]**	**Number of Non-Routine Results** [Note 5]
				Location	**Mean (F)** [Note 3] **[Range]**		
Surface Water (pCi/l)	H-3 / 8	3000	814.5 (4 / 4) [793 – 836]	Station 8 (166°, 0.2 mi)	814.5 (4 / 4) [793 – 836]	< LLD	0
	GS / 24						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< 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
	Zr-95	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	15	< 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 7 – Radiological Environmental Monitoring Program Summary

Sample Type (Units)	Type / Number of Analyses [Note 1]	LLD [Note 2]	Indicator Locations Mean (F) [Note 3] [Range]	Location [Note 4] [Highest Annual Mean]		Control Locations Mean (F) [Note 3] [Range]	Number of Non-Routine Results [Note 5]
				Location	Mean (F) [Note 3] [Range]		
Drinking Water (pCi/1)	GB / 8	4	1.655 (4 / 4) [1.64 – 1.67]	Station 57 (208°, 19.5 mi)	3.59 (4 / 4) [3.51 – 3.66]	3.59 (4 / 4) [3.51 – 3.66]	0
	I-131 / 8	1	< LLD	N/A	N/A	< LLD	0
	H-3 / 8	2000	< LLD	N/A	N/A	< LLD	0
	GS / 8						
	Mn-54	15	< LLD	N/A	N/A	< LLD	0
	Fe-59	30	< LLD	N/A	N/A	< LLD	0
	Co-58	15	< 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
	Zr-95	30	< LLD	N/A	N/A	< LLD	0
	Nb-95	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 7 – Radiological Environmental Monitoring Program Summary							
Sample Type (Units)	**Type / Number of Analyses [Note 1]**	**LLD [Note 2]**	**Indicator Locations Mean (F) [Note 3] [Range]**	**Location [Note 4] [Highest Annual Mean]**		**Control Locations Mean (F) [Note 3] [Range]**	**Number of Non-Routine Results [Note 5]**
				Location	**Mean (F) [Note 3] [Range]**		
Fish (pCi/kg)	GS / 2						
	Mn-54	130	< LLD	N/A	N/A	< LLD	0
	Fe-59	260	< LLD	N/A	N/A	< LLD	0
	Co-58	130	< 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 (pCi/kg)	I-131 / 6	60	< LLD	N/A	N/A	N/A	0
	GS / 6						
	Cs-134	60	< LLD	N/A	N/A	N/A	0
	Cs-137	80	< LLD	N/A	N/A	N/A	0

LEGEND:

[Note 1] - GB = Gross beta; I-131 = Iodine-131; H-3 = Tritium; GS = Gamma scan.

[Note 2] - LLD = Required lower limit of detection based on ANO-1 and ANO-2 ODCM Table 2.5-1.

[Note 3] - Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified locations is indicated in parenthesis (F).

[Note 4] - Locations are specified (1) by name and (2) degrees relative to reactor site.

[Note 5] - 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.

[Note 6] - LLD is not defined in ANO-1 and ANO-2 ODCM Table 2.5-1.

Attachment 1

Sample Deviations

Table 8 – Sample Deviations					
Comment No.	**Sample Media Affected**	**Sample Location**	**Date**	**Problem**	**Evaluation / Actions**
1	Air Sample	Air Station 1	03/13/2018	Power Loss	Due to suspected power loss, the hour meter had advanced approximately 5 hours less than expected. Checked on hour meter later that day to ensure hour meter was advancing appropriately. CR-ANO-C-2018-1068.
2	TLD	TLD Station 56	06/12/2018	TLD Missing	The TLD was found approximately 15 feet away from the cage with the protective housing of the TLD in pieces. It appears that recent mowing activities knocked loose the end caps which caused the TLD to fall out. It was then run over by the mowing machine. The TLD itself was intact, but not in its beta shield. The TLD was placed back in the cage along with both end caps. The TLD was sent off to the lab during the next quarterly collection per the schedule. Results were higher than normal as expected. CR-ANO-C-2018-4141.
3	Air Sample	Air Station 6	01/02/2019	Power Loss	Due to power loss, the hour meter had advanced approximately 4 hours less than expected. This is due to the loss of power that affected the east side of Russellville on 12/31/18. CR-ANO-C-2019-0006.
4	TLD	TLD Station 127	10/23/2018	TLD Missing	TLD had been removed from the cage attached to a post. Cage was intact with no TLD inside. CR-ANO-C-2018-4646.

Attachment 2

Monitoring Results Tables

Table 9 – Air Particulate Data Summary						
Analysis: Gross Beta				Units: pCi/m^3		
Start Date	End Date	Station 1[Note 1] (Indicator)	Station 2 (Indicator)	Station 56 (Indicator)	Station 6 (Control)	Station 7 (Control)
REQUIRED LLD ➔		0.01	0.01	0.01	0.01	0.01
12/19/2017	01/2/2018	2.47E-02	2.40E-02	2.17E-02	2.45E-02	2.55E-02
01/2/2018	1/16/2018	2.64E-02	2.46E-02	1.98E-02	2.43E-02	1.96E-02
1/16/2018	1/30/2018	2.26E-02	1.85E-02	1.60E-02	2.16E-02	1.83E-02
1/30/2018	2/13/2018	2.69E-02	2.29E-02	2.18E-02	2.26E-02	2.02E-02
2/13/2018	2/27/2018	1.38E-02	1.45E-02	1.16E-02	1.61E-02	1.39E-02
2/27/2018	3/13/2018	1.99E-02[Note 2]	2.01E-02	1.42E-02	1.71E-02	1.64E-02
3/13/2018	3/27/2018	1.84E-02	1.78E-02	1.38E-02	1.90E-02	1.65E-02
3/27/2018	4/10/2018	1.56E-02	1.43E-02	1.63E-02	1.52E-02	1.53E-02
4/10/2018	4/24/2018	1.64E-02	1.45E-02	1.07E-02	1.60E-02	1.70E-02
4/24/2018	5/8/2018	1.95E-02	1.68E-02	1.46E-02	1.92E-02	1.73E-02
5/8/2018	5/22/2018	2.16E-02	2.11E-02	1.69E-02	2.23E-02	2.05E-02
5/22/2018	6/5/2018	1.87E-02	1.60E-02	1.62E-02	1.63E-02	1.81E-02
6/5/2018	6/19/2018	1.91E-02	1.92E-02	1.52E-02	2.14E-02	1.85E-02
6/19/2018	7/3/2018	1.75E-02	1.50E-02	1.25E-02	1.54E-02	1.59E-02
7/3/2018	7/17/2018	1.96E-02	1.77E-02	1.47E-02	1.87E-02	1.68E-02
7/17/2018	7/31/2018	2.36E-02	1.91E-02	1.79E-02	2.14E-02	2.17E-02
7/31/2018	8/14/2018	2.05E-02	1.80E-02	1.33E-02	2.00E-02	1.81E-02
8/14/2018	8/28/2018	2.64E-02	1.96E-02	1.92E-02	2.09E-02	2.31E-02
8/28/2018	9/11/2018	9.54E-03	8.82E-03	8.68E-03	9.02E-03	1.16E-02
9/11/2018	9/25/2018	2.01E-02	1.89E-02	1.71E-02	1.98E-02	2.10E-02
9/25/2018	10/9/2018	3.36E-02	3.62E-02	2.32E-02	3.25E-02	3.40E-02
10/9/2018	10/23/2018	1.47E-02	1.41E-02	1.18E-02	1.13E-02	1.34E-02
10/23/2018	11/6/2018	2.31E-02	1.87E-02	1.18E-02	1.81E-02	1.87E-02
11/6/2018	11/20/2018	2.47E-02	2.64E-02	2.05E-02	2.32E-02	2.24E-02
11/20/2018	12/4/2018	2.51E-02	2.61E-02	1.73E-02	2.59E-02	2.17E-02
12/4/2018	12/18/2018	2.39E-02	2.54E-02	2.01E-02	2.22E-02	1.83E-02
12/18/2018	1/1/2019	1.83E-02	1.69E-02	1.53E-02	1.69E-02[Note 2]	1.54E-02

[Note 1] – Station with highest annual mean.

[Note 2] – Reference Attachment 1, Table 8, "Sample Deviations," Comment # 1 and #3.

Monitoring Results Tables

Table 10 – Radioiodine Cartridge Data Table Summary						
Analysis: I-131				Units: pCi/m3		
Start Date	End Date	Station 1 (Indicator)	Station 2 (Indicator)	Station 56 (Indicator)	Station 6 (Control)	Station 7 (Control)
12/19/2017	01/2/2018	< 1.05E-02	< 2.97E-02	< 2.97E-02	< 2.96E-02	< 2.96E-02
01/2/2018	1/16/2018	< 2.30E-02	< 4.47E-02	< 4.47E-02	< 4.42E-02	< 4.40E-02
1/16/2018	1/30/2018	< 2.85E-02	< 2.83E-02	< 1.19E-02	< 2.88E-02	< 2.88E-02
1/30/2018	2/13/2018	< 1.85E-02	< 3.43E-02	< 3.44E-02	< 3.40E-02	< 3.39E-02
2/13/2018	2/27/2018	< 2.03E-02	< 2.42E-02	< 2.42E-02	< 2.41E-02	< 2.41E-02
2/27/2018	3/13/2018	< 3.47E-02[Note 1]	< 3.43E-02	< 3.43E-02	< 3.41E-02	< 3.41E-02
3/13/2018	3/27/2018	< 2.24E-02	< 2.69E-02	< 2.80E-02	< 2.67E-02	< 2.66E-02
3/27/2018	4/10/2018	< 6.22E-03	< 1.48E-02	< 1.48E-02	< 1.46E-02	< 1.45E-02
4/10/2018	4/24/2018	< 1.58E-02	< 1.88E-02	< 1.89E-02	< 1.88E-02	< 1.88E-02
4/24/2018	5/8/2018	< 1.88E-02	< 2.25E-02	< 2.25E-02	< 2.24E-02	< 2.23E-02
5/8/2018	5/22/2018	< 4.06E-02	< 1.71E-02	< 4.07E-02	< 4.06E-02	< 4.05E-02
5/22/2018	6/5/2018	< 1.86E-02	< 1.86E-02	< 2.56E-02	< 1.85E-02	< 2.53E-02
6/5/2018	6/19/2018	< 1.31E-02	< 3.13E-02	< 3.13E-02	< 3.12E-02	< 3.12E-02
6/19/2018	7/3/2018	< 1.94E-02	< 4.63E-02	< 4.63E-02	< 4.61E-02	< 4.60E-02
7/3/2018	7/17/2018	< 2.04E-02	< 2.44E-02	< 2.45E-02	< 2.44E-02	< 2.44E-02
7/17/2018	7/31/2018	< 1.68E-02	< 3.06E-02	< 3.06E-02	< 3.14E-02	< 3.04E-02
7/31/2018	8/14/2018	< 2.31E-02	< 2.76E-02	< 2.76E-02	< 2.75E-02	< 2.74E-02
8/14/2018	8/28/2018	< 3.03E-02	< 3.03E-02	< 1.27E-02	< 3.02E-02	< 3.01E-02
8/28/2018	9/11/2018	< 1.20E-02	< 2.86E-02	< 2.86E-02	< 2.88E-02	< 2.90E-02
9/11/2018	9/25/2018	< 1.39E-02	< 1.66E-02	< 1.66E-02	< 1.65E-02	< 1.64E-02
9/25/2018	10/9/2018	< 1.39E-02	< 2.57E-02	< 2.57E-02	< 2.56E-02	< 2.55E-02
10/9/2018	10/23/2018	< 1.93E-02	< 2.31E-02	< 2.31E-02	< 2.27E-02	< 2.28E-02
10/23/2018	11/6/2018	< 2.39E-02	< 2.00E-02	< 2.39E-02	< 2.39E-02	< 2.37E-02
11/6/2018	11/20/2018	< 2.63E-02	< 5.93E-02	< 5.93E-02	< 5.91E-02	< 5.89E-02
11/20/2018	12/4/2018	< 1.44E-02	< 3.45E-02	< 3.45E-02	< 3.42E-02	< 3.43E-02
12/4/2018	12/18/2018	< 2.11E-02	< 2.51E-02	< 2.51E-02	< 2.52E-02	< 2.49E-02
12/18/2018	1/1/2019	< 1.03E-02	< 2.46E-02	< 2.46E-02	< 2.47E-02[Note 1]	< 2.45E-02

[Note 1] – Reference Attachment 1, Table 8, "Sample Deviations," Comment # 1 and #3.

Attachment 2

Monitoring Results Tables

Table 11 – Thermoluminescent Dosimeters – Inner Ring					
Analysis: Gamma Dose				Units: mrem	
Station	**1st Qtr [2018]**	**2nd Qtr [2018]**	**3rd Qtr [2018]**	**4th Qtr [2018]**	**Annual Mean [2018]**
1	8.4	7.4	7.9	6.7	**7.6**
2	7.9	7.9	8.3	4.8	**7.2**
3	5.3	4.7	5.9	4.2	**5.0**
4	8.2	7.1	8.7	5.9	**7.5**
56[Note 1]	**9.4**	**15.5[Note 2]**	**9.6**	**7.7**	**10.6**
108	9.0	7.8	8.5	6.5	**8.0**
109	8.3	8.5	8.3	6.9	**8.0**
110	8.2	7.7	8.8	6.2	**7.7**
145	7.3	7.6	7.5	6.2	**7.2**
146	7.8	7.7	7.9	5.7	**7.3**
147	6.8	7.2	6.9	5.5	**6.6**
148	10.6	7.6	8.0	6.3	**8.1**
149	10.7	7.8	8.8	5.8	**8.3**
150	9.0	9.4	8.9	8.1	**8.9**
151	8.9	9.4	8.7	7.3	**8.6**
152	5.8	7.1	6.9	5.3	**6.3**

[Note 1] – Station with highest annual mean.

[Note 2] – Reference Attachment 1, Table 8, "Sample Deviations," Comment # 1 and #3.

Monitoring Results Tables

Table 12 – Thermoluminescent Dosimeters – Special Interest Areas					
Analysis: Gamma Dose			**Units: mrem**		
Station	**1st Qtr [2018]**	**2nd Qtr [2018]**	**3rd Qtr [2018]**	**4th Qtr [2018]**	**Annual Mean [2018]**
6	7.6	5.9	6.8	5.9	**6.6**
111	5.1	5.9	5.3	3.3	**4.9**
116[Note 1]	**8.5**	**8.9**	**8.2**	**8.5**	**8.5**
125	4.4	5.1	5.5	3.8	**4.7**
127	6.5	6.8	Lost[Note 2]	5.5	**6.3**
137	7.8	8.5	8.0	6.6	**7.7**
153	8.0	7.5	7.5	6.8	**7.5**

[Note 1] – Station with highest annual mean.

[Note 2] – Reference Attachment 1, Table 8, "Sample Deviations," Comment # 1 and #3.

Table 13 – Thermoluminescent Dosimeters – Control					
Analysis: Gamma Dose			**Units: mrem**		
Station	**1st Qtr [2018]**	**2nd Qtr [2018]**	**3rd Qtr [2018]**	**4th Qtr [2018]**	**Annual Mean [2018]**
7	6.6	5.2	6.5	4.3	5.7

Attachment 2

Monitoring Results Tables

Table 14 – Surface Water – Gamma

Analysis: Gamma Isotopic | **Units: pCi/L**

Location	Start Date	End 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
REQUIRED LLD →			15	15	30	15	30	15	30	15	15	18	60	15
Station 8 (Indicator)	12/31/2017	01/31/2018	< 2.04	< 2.44	< 6.39	< 2.37	< 4.48	< 2.76	< 4.83	< 12.9	< 2.54	< 2.32	< 22.6	< 7.61
Station 10 (Control)	12/31/2017	01/31/2018	< 6.91	< 7.74	< 13.7	< 7.24	< 14.1	< 8.42	< 12.4	< 12.8	< 8.16	< 7.57	< 31.8	< 9.80
Station 8 (Indicator)	01/31/2018	02/28/2018	< 2.05	< 2.63	< 5.61	< 2.10	< 4.27	< 2.49	< 4.12	< 11.7	< 2.38	< 2.16	< 21.0	< 6.01
Station 10 (Control)	01/31/2018	02/28/2018	< 6.91	< 7.63	< 13.2	< 8.73	< 15.8	< 7.30	< 11.4	< 10.1	< 5.86	< 8.50	< 40.1	< 9.32
Station 8 (Indicator)	02/28/2018	03/31/2018	< 2.29	< 2.65	< 5.45	< 2.86	< 4.38	< 2.57	< 4.51	< 12.2	< 2.68	< 2.50	< 21.4	< 6.22
Station 10 (Control)	02/28/2018	03/31/2018	< 8.62	< 7.54	< 16.9	< 7.75	< 15.3	< 7.91	< 11.3	< 9.76	< 8.94	< 9.97	< 35.8	< 10.01
Station 8 (Indicator)	03/31/2018	04/30/2018	< 1.58	< 1.96	< 4.27	< 1.82	< 3.37	< 2.07	< 3.39	< 11.6	< 1.76	< 1.73	< 19.3	< 6.25
Station 10 (Control)	03/31/2018	04/30/2018	< 4.92	< 4.71	< 12.7	< 5.94	< 8.59	< 4.32	< 7.25	< 8.68	< 5.39	< 6.28	< 25.61	< 8.47
Station 8 (Indicator)	04/30/2018	05/31/2018	< 2.33	< 2.53	< 6.13	< 2.59	< 4.89	< 2.78	< 4.76	< 13.2	< 2.40	< 2.28	< 22.7	< 9.26
Station 10 (Control)	04/30/2018	05/31/2018	< 5.31	< 5.54	< 11.7	< 8.16	< 10.9	< 6.94	< 9.42	< 10.1	< 6.47	< 4.76	< 24.6	< 7.92
Station 8 (Indicator)	05/31/2018	06/30/2018	< 1.75	< 1.96	< 4.17	< 1.86	< 3.53	< 2.10	< 3.61	< 10.6	< 1.93	< 1.92	< 18.7	< 5.40
Station 10 (Control)	05/31/2018	06/30/2018	< 6.63	< 7.43	< 12.8	< 7.91	< 12.6	< 6.24	< 10.5	< 9.62	< 7.04	< 7.03	< 32.1	< 9.92

Attachment 2

Monitoring Results Tables

Table 14 – Surface Water – Gamma

Analysis: Gamma Isotopic | **Units: pCi/L**

Location	Start Date	End 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
REQUIRED LLD ➔			**15**	**15**	**30**	**15**	**30**	**15**	**30**	**15**	**15**	**18**	**60**	**15**
Station 8 (Indicator)	06/30/2018	07/31/2018	< 1.77	< 1.99	< 4.54	< 1.74	< 3.41	< 2.12	< 3.61	< 12.3	< 1.91	< 1.89	< 20.7	< 5.79
Station 10 (Control)	06/30/2018	07/31/2018	< 6.75	< 8.54	< 15.0	< 8.08	< 14.8	< 6.85	< 13.3	< 14.0	< 8.90	< 7.15	< 44.7	< 12.8
Station 8 (Indicator)	07/31/2018	08/31/2018	< 1.25	< 1.57	< 3.40	< 1.27	< 2.56	< 1.59	< 2.69	< 8.03	< 1.41	< 1.40	< 14.4	< 4.72
Station 10 (Control)	07/31/2018	08/31/2018	< 6.09	< 5.03	< 13.7	< 6.50	< 13.5	< 6.66	< 12.2	< 10.7	< 7.62	< 8.00	< 25.3	< 12.2
Station 8 (Indicator)	08/31/2018	09/30/2018	< 1.66	< 1.92	< 4.25	< 1.86	< 3.60	< 1.89	< 3.45	< 7.57	< 1.81	< 1.64	< 15.5	< 4.56
Station 10 (Control)	08/31/2018	09/30/2018	< 7.53	< 7.95	< 18.8	< 9.45	< 12.3	< 6.73	< 11.0	< 12.2	< 9.61	< 6.93	< 33.0	< 13.2
Station 8 (Indicator)	09/30/2018	10/31/2018	< 1.39	< 1.52	< 3.88	< 1.30	< 2.51	< 1.66	< 2.89	< 14.2	< 1.52	< 1.35	< 20.2	< 6.69
Station 10 (Control)	09/30/2018	10/31/2018	< 3.04	< 3.33	< 7.50	< 4.22	< 6.06	< 3.87	< 6.56	< 8.69	< 3.41	< 3.01	< 19.1	< 8.14
Station 8 (Indicator)	10/31/2018	11/30/2018	< 2.00	< 2.32	< 5.06	< 1.93	< 4.17	< 2.64	< 4.27	< 14.9	< 2.24	< 2.16	< 24.8	< 6.58
Station 10 (Control)	10/31/2018	11/30/2018	< 7.90	< 6.70	< 11.7	< 9.10	< 17.1	< 7.62	< 14.7	< 10.6	< 8.60	< 8.37	< 29.0	< 13.4
Station 8 (Indicator)	11/30/2018	12/31/2018	< 2.16	< 2.45	< 4.87	< 2.05	< 4.51	< 2.63	< 4.33	< 11.8	< 2.36	< 2.29	< 21.4	< 6.37
Station 10 (Control)	11/30/2018	12/31/2018	< 4.50	< 5.04	< 11.1	< 6.27	< 9.07	< 6.24	< 9.14	< 7.34	< 6.97	< 5.35	< 20.4	< 3.60

Attachment 2

Monitoring Results Tables

Table 15 – Surface Water – Tritium			
Analysis: H-3		Units: pCi/L	
Location	**Start Date**	**End Date**	**H-3**
REQUIRED LLD ➔			**3000**
Station 8 (Indicator)	12/31/2017	3/31/2018	<396
Station 10 (Control)	12/31/2017	3/31/2018	< 385
Station 8 (Indicator)	3/31/2018	6/30/2018	<388
Station 10 (Control)	3/31/2018	6/30/2018	< 381
Station 8 (Indicator)	6/30/2018	9/30/2018	793
Station 10 (Control)	6/30/2018	9/30/2018	< 364
Station 8 (Indicator)	9/30/2018	12/31/2018	836
Station 10 (Control)	9/30/2018	12/31/2018	< 386

Attachment 2

Monitoring Results Tables

Table 16 – Drinking Water –Gamma, GB, I-131														
Analysis: Gamma Isotopic, Gross Beta, I-131										Units: pCi/L				
Location	**Collection Date**	**Gross Beta**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Nb-95**	**Zr-95**	**I-131**	**Cs-134**	**Cs-137**	**Ba-140**	**La-140**
REQUIRED LLD ➔		**4.0**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**1.0**	**15**	**18**	**60**	**15**
Station 14 (Indicator)	01/02/2018	1.64	< 4.71	< 5.68	< 10.3	< 10.8	< 18.2	< 8.12	< 10.3	< .761	< 7.29	< 6.36	< 25.8	< 8.82
Station 57 (Control)	01/02/2018	3.66	< 7.03	< 5.21	< 14.1	< 8.94	< 21.4	< 8.23	< 16.4	< .925	< 9.06	< 6.65	< 30.8	< 12.5
Station 14 (Indicator)	03/27/2018	< 1.91	< 6.78	< 6.67	< 11.6	< 5.51	< 9.10	< 7.38	< 13.4	< .547	< 8.98	< 6.05	< 27.6	< 8.08
Station 57 (Control)	03/27/2018	< 1.99	< 4.14	< 4.93	< 7.32	< 3.17	< 13.7	< 5.31	< 7.61	< .266	< 5.39	< 6.49	< 22.71	< 8.56
Station 14 (Indicator)	07/03/2018	< 1.64	< 7.28	< 7.68	< 14.9	< 5.59	< 12.8	< 6.95	< 11.0	< .693	< 8.43	< 7.36	< 33.5	< 12.8
Station 57 (Control)	07/03/2018	< 1.82	< 6.55	< 7.84	< 13.9	< 8.15	< 15.5	< 6.56	< 11.1	< .714	< 6.99	< 7.97	< 37.5	< 12.1
Station 14 (Indicator)	10/02/2018	1.67	< 6.76	< 5.34	< 14.1	< 6.15	< 16.1	< 6.71	< 12.2	< .422	< 7.73	< 6.76	< 31.7	< 13.51
Station 57 (Control)	10/02/2018	3.51	< 5.28	< 5.41	< 12.01	< 4.93	< 13.0	< 5.40	< 12.0	< .352	< 7.02	< 5.66	< 26.6	< 6.99

Attachment 2

Monitoring Results Tables

Table 17 – Drinking Water – Tritium		
Analysis: H-3	**Units: pCi/L**	
Location	**Collection Date**	**H-3**
	REQUIRED LLD ➔	**2000**
Station 14 (Indicator)	01/02/2018	< 282
Station 57 (Control)	01/02/2018	<335
Station 14 (Indicator)	03/27/2018	< 295
Station 57 (Control)	03/27/2018	< 297
Station 14 (Indicator)	07/03/2018	< 332
Station 57 (Control)	07/03/2018	< 337
Station 14 (Indicator)	10/02/2018	< 339
Station 57 (Control)	10/02/2018	< 345

Table 18 – Sediment			
Analysis: Gamma Isotopic		**Units: pCi/kg**	
Location	**Collection Date**	**Cs-134**	**Cs-137**
	REQUIRED LLD ➔	**150**	**180**
Station 8 (Indicator)	10/02/2018	< 130	< 122
Station 16 (Control)	10/02/2018	< 81.3	< 64.2

Table 19 – Fish								
Analysis: Gamma Isotopic				**Units: pCi/kg**				
Location	**Collection Date**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Cs-134**	**Cs-137**
	REQUIRED LLD ➔	**130**	**130**	**260**	**130**	**260**	**130**	**150**
Station 8 (Indicator)	10/02/2018	< 75.20	< 89.70	< 195.0	< 106.0	< 189.0	< 94.30	< 91.40
Station 16 (Control)	10/02/2018	< 44.80	< 73.40	< 158.0	< 40.80	< 122.0	< 57.10	< 67.0

Monitoring Results Tables

Table 20 – Food Products				
Analysis: I-131, Gamma Isotopic		**Units: pCi/kg**		
Location	**Collection Date**	**I-131**	**Cs-134**	**Cs-137**
	REQUIRED LLD ➔	**60**	**60**	**80**
Station 13 (Indicator)	06/05/2018	< 26.30	< 26.70	< 24.50
Station 55 (Control)	06/05/2018	< 38.90	< 31.10	< 27.90
Station 13 (Indicator)	07/18/2018	< 59.40	< 35.80	< 35.10
Station 55 (Control)	07/18/2018	< 56.70	< 37.90	< 38.20
Station 13 (Indicator)	08/14/2018	< 57.40	< 26.70	< 29.90
Station 55 (Control)	08/14/2018	< 21.80	< 14.90	< 13.80

Attachment 2

Monitoring Results Tables

Table 21 – Groundwater - Gamma and Iodine

Analysis: Gross Beta, I-131, Gamma Isotopic | **Units: pCi/L**

Location	Collection Date	Gr-B	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	I-131	Cs-134	Cs-137	Ba-140	La-140
REQUIRED LLD →		**N/A[Note 1]**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**15**	**15**	**18**	**60**	**15**
Station 58 (Control)	3/14/2018	< 2.04	< 3.91	< 4.22	< 8.71	< 4.08	< 7.73	< 4.64	< 7.43	< 10.31	< 4.59	< 4.58	< 23.8	< 6.78
Station 62 (Control)	3/14/2018	< 3.15	< 3.85	< 4.19	< 8.18	< 4.29	< 8.95	< 4.61	< 6.10	< 7.49	< 4.47	< 4.29	< 20.6	< 6.56
Station 63 (Indicator)	3/14/2018	4.40	< 2.97	< 3.70	< 7.96	< 3.27	< 6.75	< 4.02	< 6.56	< 7.76	< 3.46	< 3.57	< 20.1	< 6.24
Station 64 (Indicator)	3/15/2018	< 2.92	< 3.95	< 3.67	< 8.32	< 4.33	< 8.89	< 4.95	< 7.13	< 7.20	< 4.32	< 3.97	< 21.0	< 6.76
Station 58 (Control)	06/12/2018	< 2.26	< 5.89	< 7.11	< 12.4	< 5.35	< 10.1	< 7.57	< 9.34	< 12.0	< 7.02	< 6.02	< 39.31	< 9.09
Station 62 (Control)	06/12/2018	< 3.15	< 7.11	< 6.72	< 14.61	< 6.02	< 16.8	< 9.01	< 11.5	< 14.7	< 7.60	< 6.58	< 40.0	< 11.1
Station 63 (Indicator)	06/12/2018	7.03	< 5.73	< 6.52	< 14.3	< 9.14	< 12.5	< 5.84	< 9.50	< 11.3	< 6.93	< 6.43	< 29.0	< 7.65
Station 64 (Indicator)	06/13/2018	< 2.73	< 6.73	< 6.52	< 10.2	< 7.36	< 16.6	< 7.75	< 10.5	< 14.2	< 6.97	< 7.42	< 29.4	< 13.21
Station 58 (Control)	09/11/2018	< 1.95	< 3.68	< 3.63	< 7.88	< 3.46	< 8.19	< 4.80	< 6.88	< 9.23	< 4.55	< 3.95	< 20.8	< 6.77
Station 62 (Control)	09/11/2018	< 2.92	< 3.14	< 3.90	< 9.98	< 4.15	< 8.35	< 4.33	< 7.35	< 9.85	< 4.33	< 4.37	< 23.6	< 7.96

Attachment 2

Monitoring Results Tables

Table 21 – Groundwater - Gamma and Iodine														
Analysis: Gross Beta, I-131, Gamma Isotopic										Units: pCi/L				
Location	**Collection Date**	**Gr-B**	**Mn-54**	**Co-58**	**Fe-59**	**Co-60**	**Zn-65**	**Nb-95**	**Zr-95**	**I-131**	**Cs-134**	**Cs-137**	**Ba-140**	**La-140**
REQUIRED LLD ➔		**N/A[Note 1]**	**15**	**15**	**30**	**15**	**30**	**15**	**30**	**15**	**15**	**18**	**60**	**15**
Station 63 (Indicator)	09/11/2018	4.20	< 3.44	< 3.86	< 8.44	< 3.95	< 7.62	< 4.01	< 6.69	< 9.26	< 4.24	< 3.80	< 23.2	< 6.56
Station 64 (Indicator)	09/12/2018	< 2.65	< 3.85	< 3.99	< 8.16	< 3.91	< 10.2	< 4.63	< 7.74	< 9.99	< 4.37	< 3.65	< 23.5	< 8.80
Station 58 (Control)	12/10/2018	< 2.05	< 4.98	< 7.20	< 15.6	< 8.21	< 12.2	< 7.64	< 13.7	< 13.3	< 7.63	< 7.59	< 36.3	< 11.6
Station 62 (Control)	12/10/2018	< 3.13	< 6.00	< 10.0	< 16.5	< 4.66	< 20.1	< 8.46	< 13.9	< 12.9	< 6.89	< 7.80	< 36.9	< 11.5
Station 63 (Indicator)	12/10/2018	< 3.19	< 4.89	< 7.41	< 14.5	< 6.79	< 11.7	< 6.56	< 10.8	< 13.6	< 5.60	< 7.42	< 37.4	< 7.93
Station 64 (Indicator)	12/11/2018	4.12	< 4.74	< 5.56	< 11.3	< 4.96	< 11.1	< 6.21	< 8.76	< 9.22	< 5.66	< 6.01	< 24.4	< 9.81

[Note 1] – Per ANO's ODCM there is no LLD for groundwater or a reportable detectable concentration.

Monitoring Results Tables

Table 21 – Groundwater – Tritium		
Analysis: H-3	**Units: pCi/L**	
Location	**Collection Date**	**H-3**
REQUIRED LLD ➔		**3000**
Station 58 (Control)	03/14/2018	< 355
Station 62 (Control)	03/14/2018	< 358
Station 63 (Indicator)	03/14/2018	< 362
Station 64 (Indicator)	03/15/2018	< 358
Station 58 (Control)	06/12/2018	< 290
Station 62 (Control)	06/12/2018	< 289
Station 63 (Indicator)	06/12/2018	< 293
Station 64 (Indicator)	06/13/2018	< 295
Station 58 (Control)	09/11/2018	< 357
Station 62 (Control)	09/11/2018	< 356
Station 63 (Indicator)	09/11/2018	< 357
Station 64 (Indicator)	09/12/2018	< 367
Station 58 (Control)	12/10/2018	< 306
Station 62 (Control)	12/10/2018	< 301
Station 63 (Indicator)	12/10/2018	< 293
Station 64 (Indicator)	12/11/2018	< 302

Attachment 3

Interlaboratory Comparison Program Results

1.0 SUMMARY

1.1 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:

1. 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 Quality Control (QC) requirements based on the DOE MAPEP criteria.

2. 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 United States Environmental Protection Agency (US EPA), National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements, or ERA's Standard Operating Procedure (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.

3. 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.

Interlaboratory Comparison Program Results

4. For the TBE laboratory, 164 out of 172 analyses performed met the specified acceptance criteria. Six analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program.

    a. TBE was unable to report the February 2018 DOE MAPEP vegetation Sr-90 result due to QC failure and limited sample amount. (NCR 18-09).

    b. The Analytics September 2018 milk Fe-59 result was evaluated as Not Acceptable (Ratio of TBE to known result at 133%). The reported value was 158 ± 17.6 pCi/L and the known value was 119 ± 19.9 pCi/L. No cause for the failure could be determined. TBE has passed 24 of the previous 27 milk cross-check results since 2012. This sample was run in duplicate on a different detector with comparable results (162 ± 16 pCi/L). NOTE: TBE's 4th Qtr result passed at 105%. (NCR 18-20)

    c. The Analytics September milk I-131 result was evaluated as Not Acceptable (Ratio of TBE to known result at 143%). Due to a personnel change in the gamma prep lab, the sample was not prepped/counted in a timely manner such as to accommodate the I-131 8-day half-life. Analysts have been made aware of the urgency for this analysis and it will be monitored more closely by QA. NOTE: TBE's 4th Qtr result passed at 101%. (NCR 18-24)

    d. The Analytics September soil Cr-51 result was evaluated as Not Acceptable (Ratio of TBE to known result at 131%). As with Item c above, the sample was not prepped/counted in a timely manner such as to accommodate the Cr-51 27-day half-life. The same corrective action applies here as in Item c. (NCR 18-21)

    e. The MAPEP November vegetation Sr-90 result of 0.338 Bq/sample was evaluated as Not Acceptable (Lower acceptable range was 0.554 Bq/sample). It appears that there has been incomplete dissolution of Sr-90 due to the composition of the MAPEP vegetation "matrix". To resolve this issue, the TBE-2018 procedure has been modified to add H_2O_2 to assist in breaking down the organic material that comprises this "matrix". This corrective action will be monitored closely by QA. (NCR 18-25).

    f. The ERA November 2018 water Sr-90 sample was evaluated as Not Acceptable. TBE's initial reported result of 36.8 pCi/L exceeded the upper acceptance range (22.9 – 36.4 pCi/L). After reviewing the data for this sample, it was discovered that there was a typographical error at the time the results were entered at the ERA website. The correct result in the Laboratory Information Management System (LIMS) of 36.2 should have been submitted instead. This result is within ERA's acceptance limits. In addition to the typographical error, ERA's very stringent upper acceptance limit of 116% is not a reflection of TBE's ability to successfully perform this analysis. (NCR 18-23)

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

Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report

ENVIRONMENTAL DOSIMETRY COMPANY

ANNUAL QUALITY ASSURANCE STATUS REPORT

January - December 2018

10 Ashton Lane Sterling, MA 01564

1.0 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 and one external audit were performed in 2018. There were no findings identified.

2.0 INTRODUCTION

The Thermoluminescent Dosimeter (TLD) systems at the 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 (QA) 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:

2.1 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.

2.2 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.

3.0 PERFORMANCE EVALUATION CRITERIA

3.1 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 ith dosimeter (i.e., the reported exposure)

   H_i = the exposure delivered to the ith 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 ith dosimeter (i.e., the reported exposure)

   H_i = the exposure delivered to the ith 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 ith dosimeter is:

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

   Where:

   H'_i = the reported exposure for the ith dosimeter (i.e., the reported exposure)

   H_i = the mean reported exposure; i.e.

   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.

3.2 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.

3.3 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%.

4.0 DATA SUMMARY FOR ISSUANCE PERIOD JANUARY-DECEMBER 2018

4.1 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 and 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.

4.2 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.

5.0 STATUS OF EDC CONDITION REPORTS (CR)

No condition reports were issued during this annual period.

6.0 STATUS OF AUDITS/ASSESSMENTS

1. Internal

   EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2018. There were no findings identified.

2. External

   None.

7.0 PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2018

No procedures or manuals were revised in 2018.

8.0 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.

9.0 REFERENCES

1. EDC Quality Control and Audit Assessment Schedule, 2018.

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 2018[(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.

Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report

TABLE 2

MEAN DOSIMETER ANALYSES (N=6)
JANUARY – DECEMBER 2018[1], [2]

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/-15%
4/30/2018	27	3.5	2.3	Pass
5/02/2018	44	8.0	1.5	Pass
5/03/2018	99	4.6	2.2	Pass
7/27/2018	55	1.0	0.8	Pass
7/30/2018	72	2.5	1.5	Pass
8/2/2018	113	4.0	1.7	Pass
10/29/2018	34	2.6	1.2	Pass
11/03/2018	67	1.7	1.5	Pass
11/17/2018	109	5.0	0.9	Pass
1/23/2019	107	1.3	1.1	Pass
1/26/2019	123	-0.3	2.0	Pass
2/04/2019	39	1.0	1.1	Pass

[1] This table summarizes results of tests conducted by EDC for TLDs issued in 2018.

[2] Environmental dosimeter results are free in air.

Environmental Dosimetry Company Interlaboratory Comparison Program Report

TABLE 3

SUMMARY OF INDEPENDENT DOSIMETER TESTING
JANUARY – DECEMBER 2018[(1), (2)]

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2018	Millstone	2.4	1.9	Pass
2nd Qtr.2018	Millstone	8.2	1.4	Pass
2nd Qtr.2018	Seabrook	2.6	0.9	Pass
2nd Qtr.2018	SONGS	-3.9	1.3	Pass
3rd Qtr. 2018	Millstone	2.6	0.9	Pass
3rd Qtr. 2018	PSEG(PNNL)	-4.8	1.3	Pass
4th Qtr.2018	Millstone	1.0	1.2	Pass
4th Qtr.2018	Seabrook	6.8	1.1	Pass

(1)Performance criteria are +/- 15%.
(2)Blind spike irradiations using Cs-137

APPENDIX A

DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

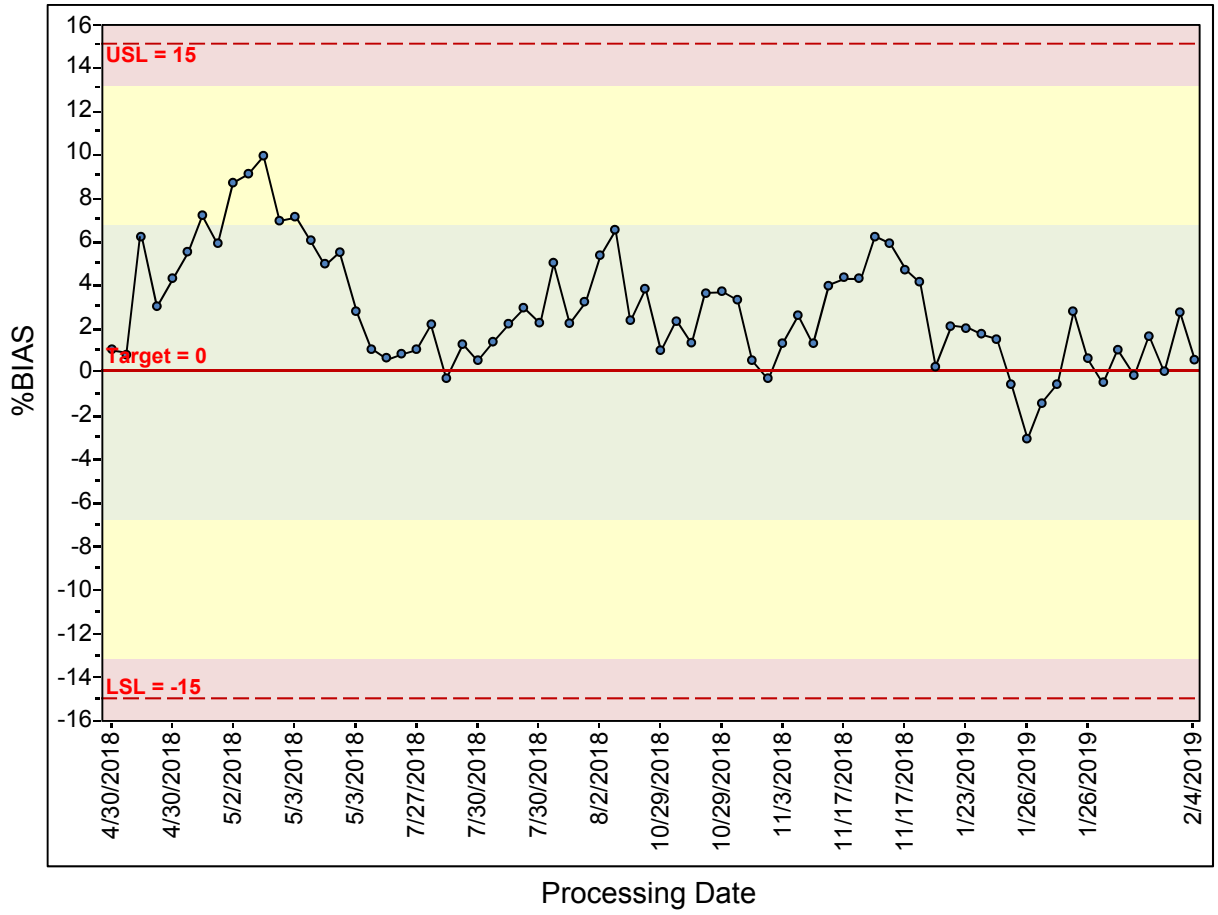
ISSUE PERIOD JANAURY - DECEMBER 2018

Attachment 4 **Page 10 of 13**

Environmental Dosimetry Company Interlaboratory Comparison Program Report

FIGURE 1

INDIVIDUAL ACCURACY ENVIRONMENTAL

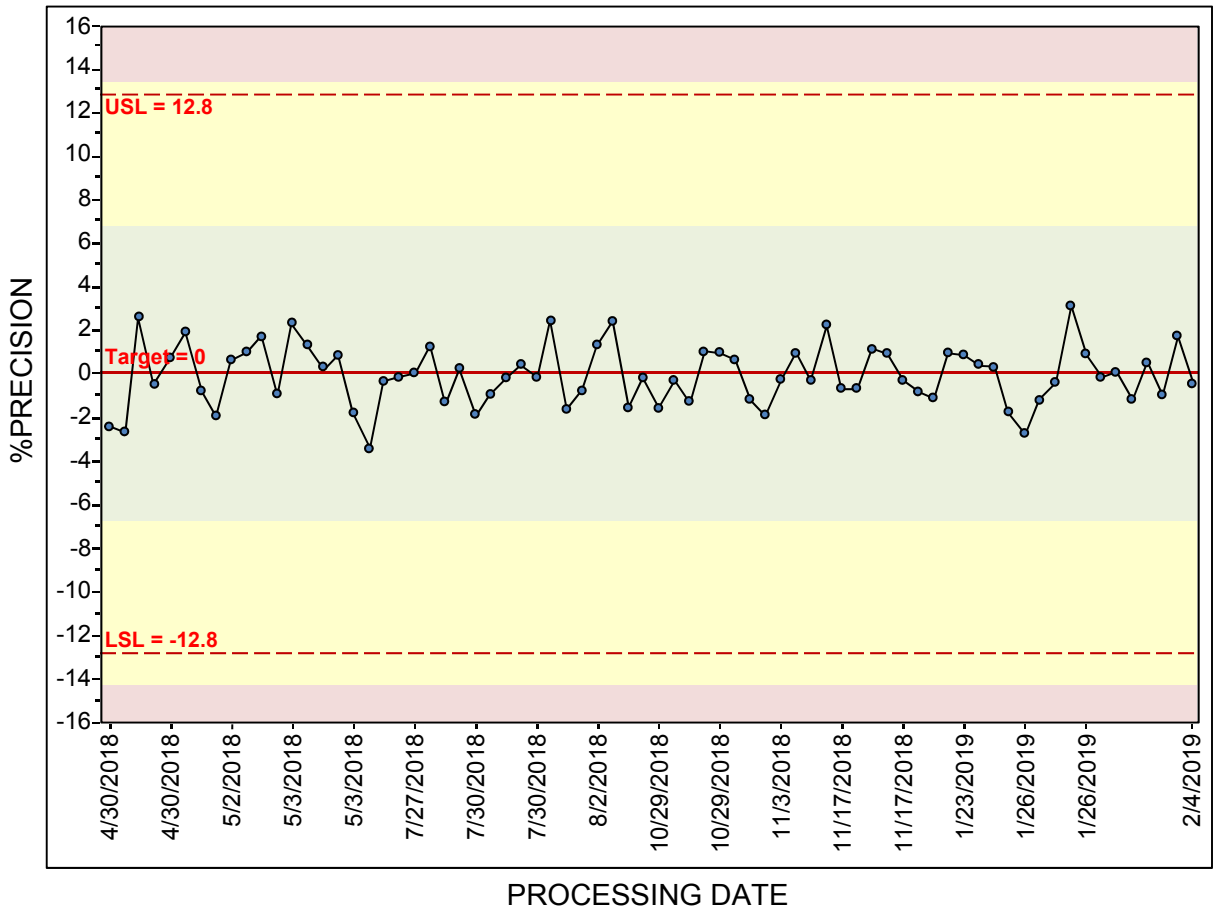


Attachment 4 **Page 11 of 13**

Environmental Dosimetry Company Interlaboratory Comparison Program Report

FIGURE 2

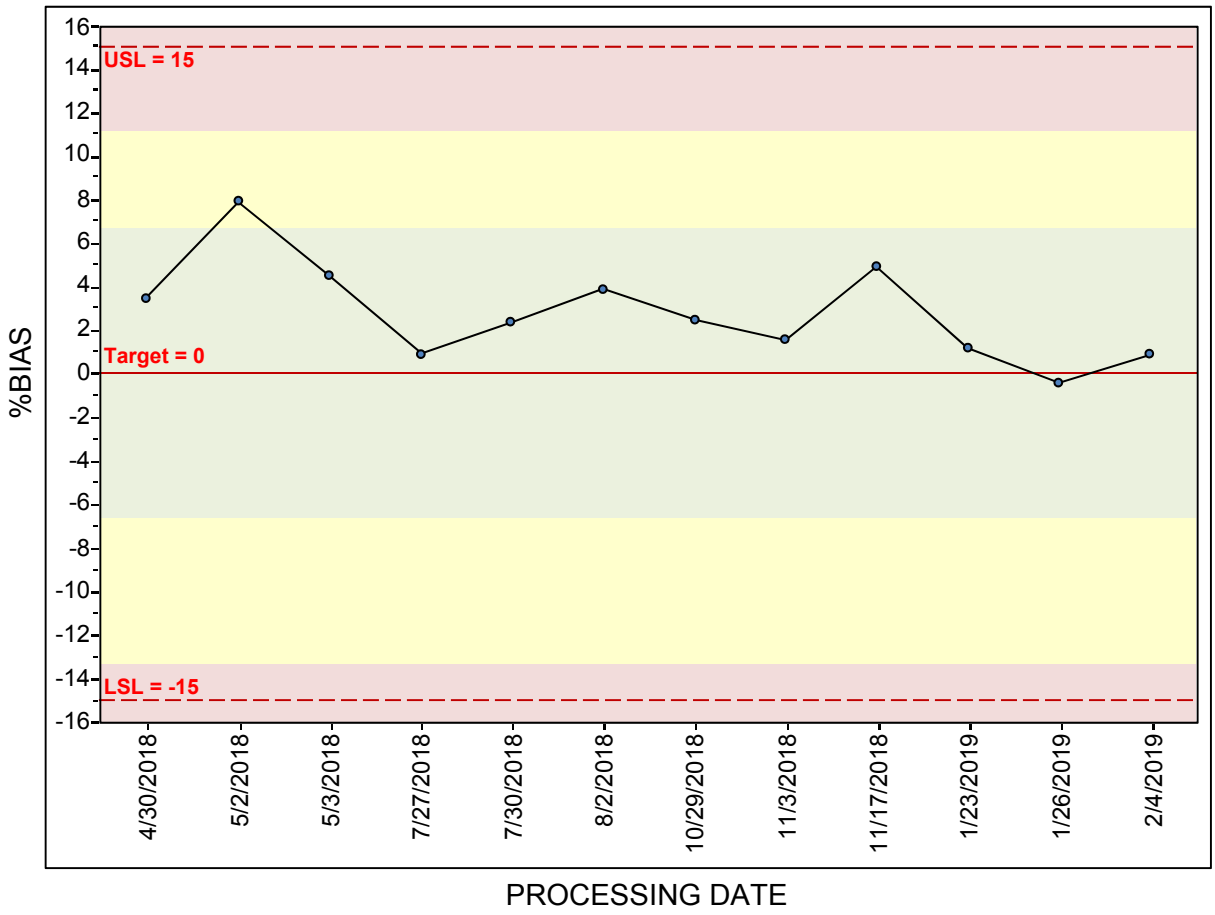
INDIVIDUAL PRECISION ENVIRONMENTAL



Environmental Dosimetry Company Interlaboratory Comparison Program Report

FIGURE 3

MEAN ACCURACY ENVIRONMENTAL



Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report

FIGURE 4

SEABROOK CO-LOCATE ACCURACY