Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-7826

Riley D. Keele, Jr.
Manager, Regulatory Assurance
Arkansas Nuclear One

0CAN052101

May 13, 2021

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

SUBJECT: Annual Radiological Environmental Operating Report for 2020

Arkansas Nuclear One – Units 1 and 2
NRC Docket Nos. 50-313, 50-368, and 72-13
Renewed Facility Operating License Nos. DPR-51 and NPF-6

Reference: Entergy Operations, Inc. (Entergy) letter to NRC, *Annual Radioactive Effluent Release Report for 2020*, Arkansas Nuclear One, Units 1 and 2 (0CAN042102), dated April 21, 2021

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 2020, is enclosed. This report fulfills the reporting requirements of the referenced TSs.

The radionuclides detected by the radiological environmental monitoring program during 2020, were significantly below the regulatory limits. The operation of the ANO station during 2020, had no harmful radiological effects nor resulted in any irreversible damage to the local environment.

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 sampling locations and a corresponding table providing the respective distances and directions from the reactor containment 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.

Respectfully,

ORIGINAL SIGNED BY RILEY D. KEELE, JR.

Riley D. Keele, Jr.

RDK/nbm

Enclosure: Annual Radiological Environmental Operating Report for 2020

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Arkansas Nuclear One
NRC Project Manager – Arkansas Nuclear One
Designated Arkansas State Official

Enclosure to

0CAN052101

Annual Radiological Environmental Operating Report for 2020

Plant: Arkansas Nuclear One	Page 1 of 63
	Year: 2020
Document Number: 0CAN052101	
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, 2020. This report fulfills the requirements of Arkansas Nuclear One Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2.

All required lower limit of detection (LLD) capabilities were achieved in all sample analyses during 2020, 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 2020 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 2020, 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 2020 data showed 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 2020, environmental sampling was performed for eight (8) media types addressed in the ODCM and for direct radiation. A total of 291 samples of the 292 scheduled were obtained. Of the scheduled samples, 99.6% 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 REMP Procedure EN-CY-130-01.

- Throughout Section 7.0 – Updated procedure in order to use new air sample stations, this includes units or measure, calibration process, and new steps for operation and sampling.
- Attachment 3 – Moved the TLD 137 location from the speed limit sign on Arkansas Highway 28 to a utility pole on the front lawn of the Morris R. Moore Arkansas National Guard Armory.

Changes made to ANO ODCM:

- (Table 4-1, Page 37) Moved the TLD 137 location from the speed limit sign on Arkansas Highway 28 to a utility pole on the front lawn of the Morris R. Moore Arkansas National Guard Armory.

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 2020 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 ft2 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.	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 16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the site boundary.	**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.

Table 3, Exposure Pathway – Waterborne			
Requirement	**Sample Point Description Distance and Direction**	**Sampling and Collection Frequency**	**Type and Frequency Of Analyses**
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

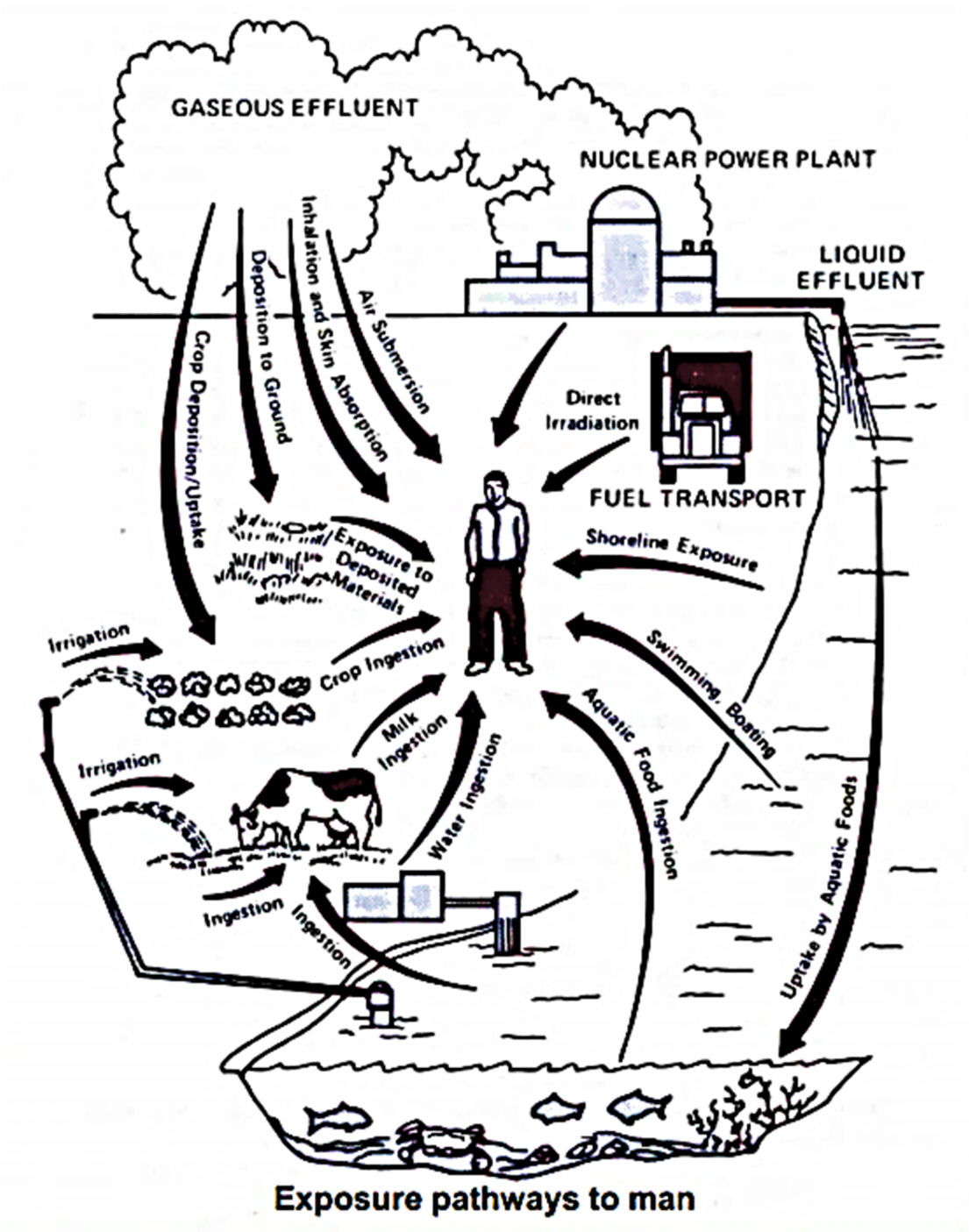


Figure 2, Sample Collection Sites –Near Field

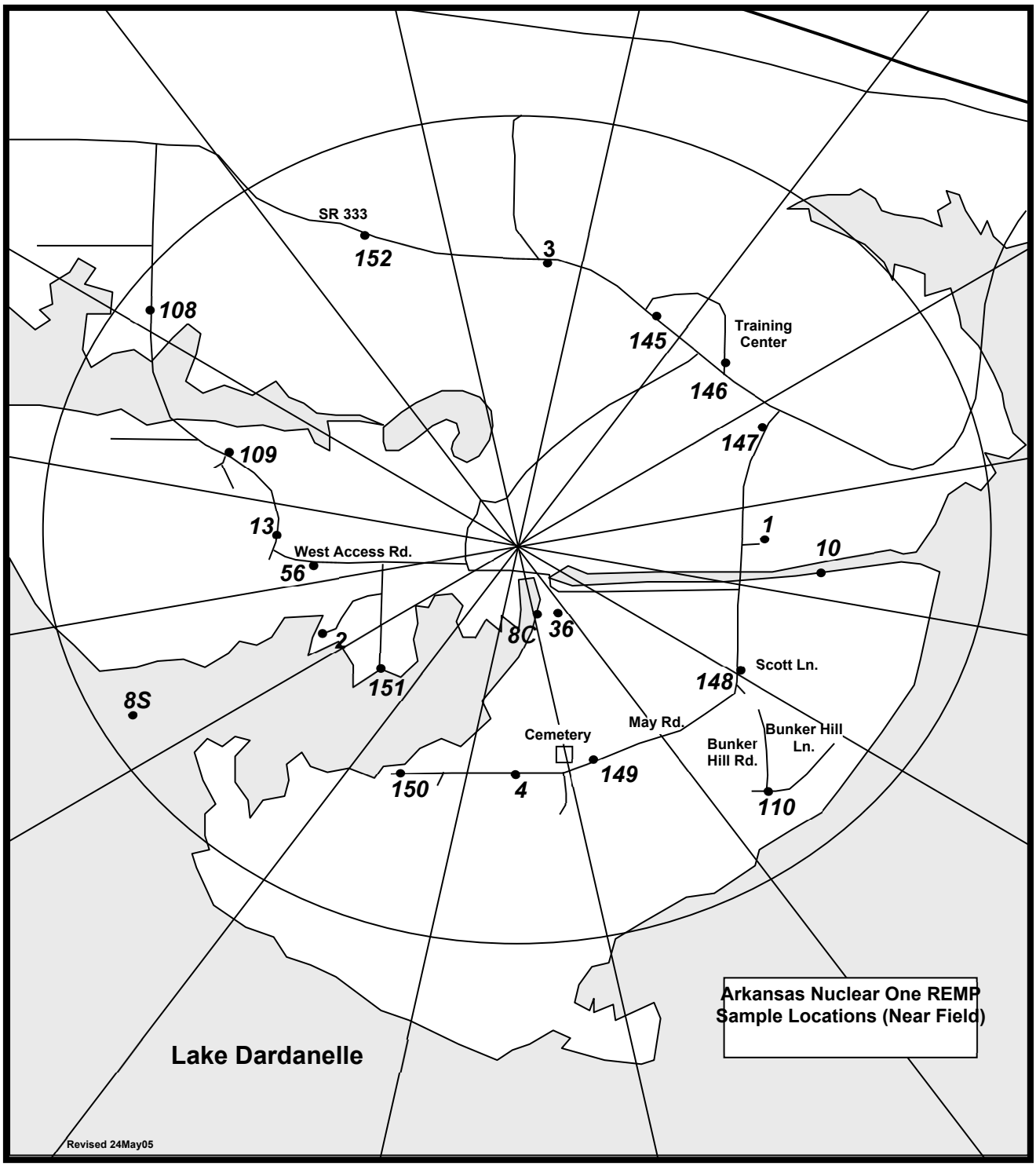


Figure 3, Sample Collection Sites - Far Field

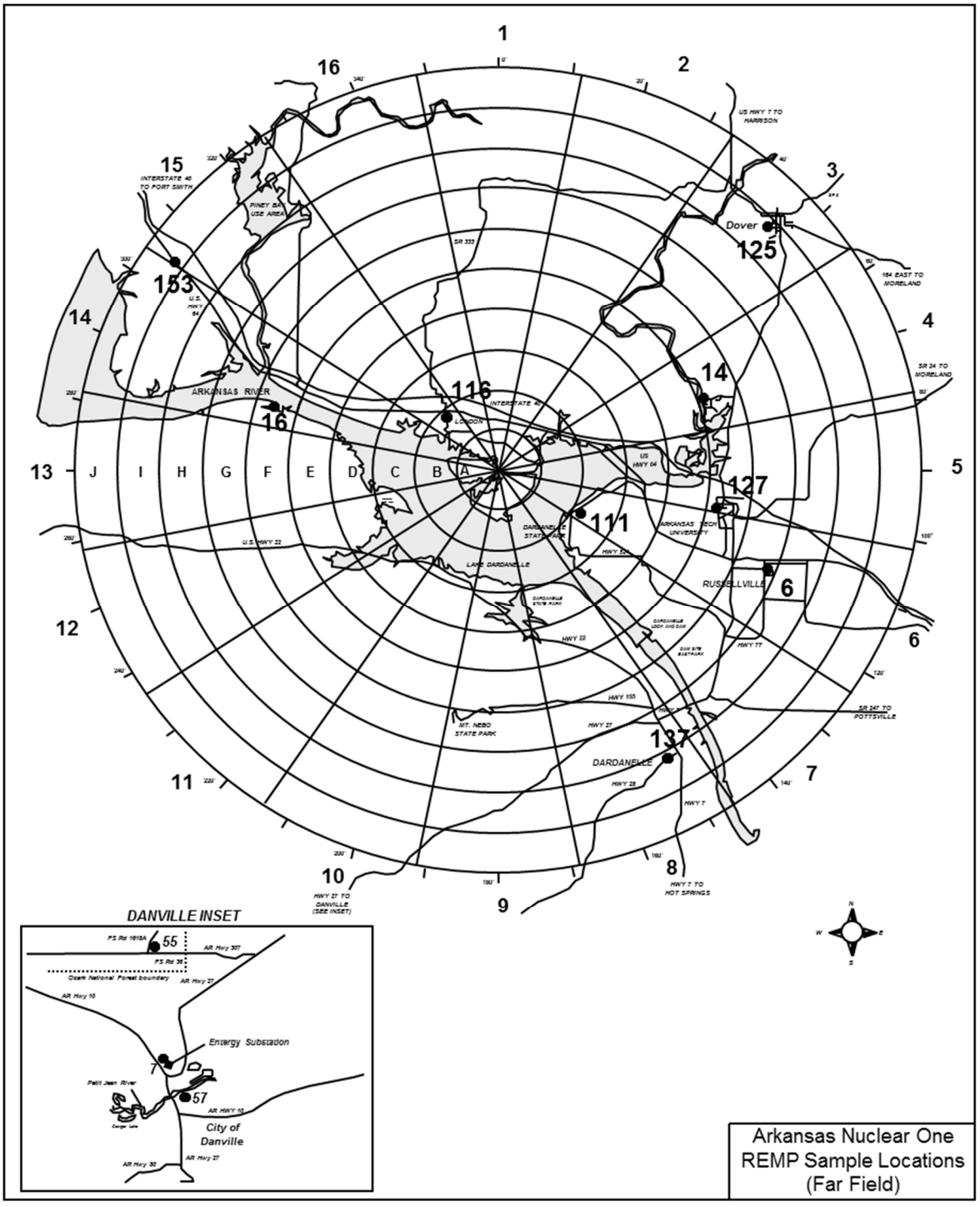
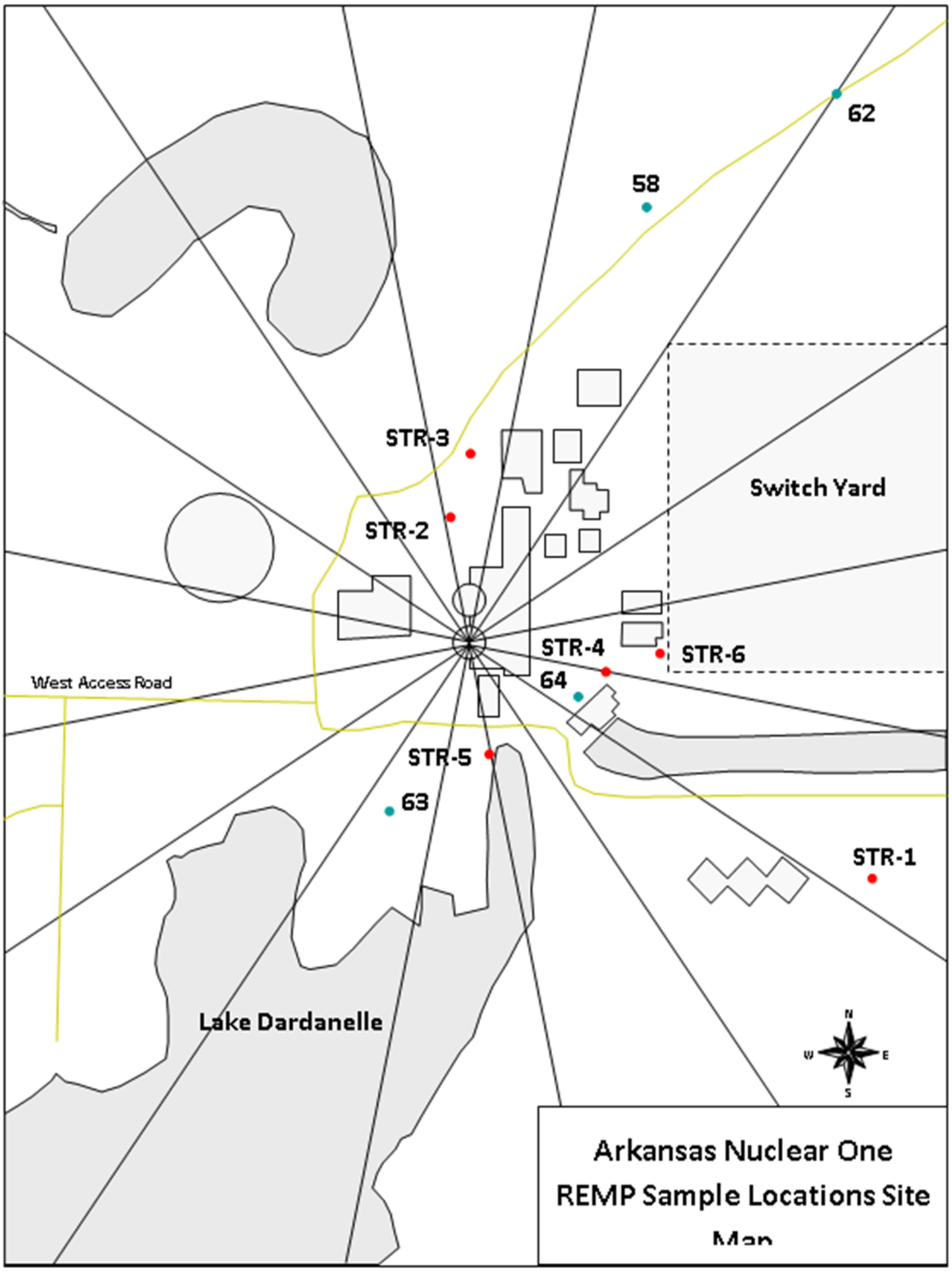


Figure 4, Sample Collection Sites -



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 2020 there were no samples above the LLD for I-131. Indicator gross beta air particulate results for 2020 were comparable to results obtained from 2010-2019 of the operational REMP, but less than 2013 when the annual average was 0.043. Also, the 2020 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
2010 – 2019 (Minimum Value)	0.017
2020 Average Value	0.017
2010 – 2019 (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 Table, includes gross beta concentrations and provides a comparison of the indicator and control means and ranges emphasizes 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 7.6 millirem (mrem) shown in Table 5 for 2020 is within the historical bounds of 2010 – 2019 annual average results, which have ranged from 7.6 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)
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
2019	7.7	6.9	6.9
2020	7.6	6.9	6.0

4.3 Waterborne Sample Results

Analytical results for 2020 drinking water and ground water samples were similar to those reported in previous years. Gamma radionuclides analytical results for 2020 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 2020, 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 2020. Results are reported as annual average pCi/l.

Monitoring Period	Result
2010 – 2019 (Minimum Value)	427.0
2020 Value	707.0
2010 – 2019 (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 2020 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 2020 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 2020 are summarized in table below. Results are reported as annual average pCi/L. The indicator location has historically shown gross beta above MDC but less than LLD, while the control location is below MDC and LLD. However, in 2020 the fourth quarter sample at the indicator was 1.88 pCi/L. This is above MDC bus less than LLD. The first through third quarters 2020 samples were less than MDC and LLD. The value for Gross Beta at the control location in 2020 was 2.07 pCi/L.

Radionuclide	2020	2019	2010 – 2018**	Preoperational
Gross Beta	1.72	1.97*	2.37	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 2019, gross beta was 1.97 pCi/L which is >MDC, but <LLD.

** Average of the results from the years 2010-2018.

ANO personnel have noted no definable trends associated with drinking water results at the indicator location. Therefore, the operation of Arkansas Nuclear One had no definable impact on this waterborne pathway during 2020 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 and gamma concentrations were below the LLD limits at all four locations. Listed below is a comparison of 2020 indicator results to past operational years. Results are reported as annual average pCi/l. REMP Groundwater data are captured in the table below. Arkansas Nuclear One operations had no significant impact on the environment or public by this waterborne pathway.

Radionuclide	2020	2010 – 2019
Iodine-131	< LLD	< LLD
Gamma	< LLD	< LLD
Tritium	< LLD	< LLD
Gross Beta	3.18*	3.50**

* Average for Indicator and control wells for 2020.

** Only 2014-2019 gross beta data available for review as historical data. Value is historical average.

4.4 Soil Sample Results - Example

Sediment samples were collected from two locations in 2020 and analyzed for gamma radionuclides. Listed below is a comparison of 2020 indicator results to the 2010 – 2019 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
2010 – 2019 (Minimum Value)	65.55
2020 Value	<LLD
2010 – 2019 (Maximum Value)	661.0

Sediment samples were collected from two locations in 2020 and analyzed for gamma radionuclides. Although Cesium-137 has been detected in years prior to 2020, all gamma radionuclides from 2020 samples were below detectable limits. These results are consistent with previous year's results. 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 2020 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 2020, 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 2020, food product samples were collected when available from two locations and analyzed for Iodine-131 and gamma radionuclides. The 2020 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

The latest land use census (performed in 2019) did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated Table 6, Land Use Census – [2019] Nearest Residence Within Five Miles.

One cattle farm was observed in the NNE sector. An interview with the owner was performed and he stated that the cattle were for breeding. ANO personnel chose not to perform a garden census in 2019, 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 – [2019] Nearest Residence Within Five Miles

Sector	Direction	Range (Miles)				Comment
		Nearest Residence	Garden	Meat	Nearest Milk Animal	
1	N	0.9	N/A	>5	>5	None
2	NNE	1.3	N/A	2.8	>5	1
3	NE	0.9	N/A	>5	>5	None
4	ENE	0.8	N/A	>5	>5	None
5	E	0.8	N/A	>5	>5	None
6	ESE	0.8	N/A	>5	>5	None
7	SE	0.8	N/A	>5	>5	None
8	SSE	0.8	N/A	>5	>5	None
9	S	0.8	N/A	>5	>5	None
10	SSW	0.7	N/A	>5	>5	None
11	SW	2.8	N/A	>5	>5	None
12	WSW	0.7	N/A	>5	>5	None
13	W	0.8	N/A	>5	>5	None
14	WNW	0.8	N/A	>5	>5	None
15	NW	1.0	N/A	>5	>5	None
16	NNW	0.9	N/A	>5	>5	None

#	Comment
1	While performing the LUC, a cattle farm was identified. A phone interview was performed with the owner of the farm. The owner stated the cattle were mainly for breeding purposes but could provide an animal for consumption. The meat pathway is not required per ANO ODCM.

4.7 Interlaboratory Comparison Results

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

5.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

1. Table 7, Radiological Environmental Monitoring Program Summary, summarizes data for the 2020 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 / 130	0.01	0.0175(78 / 78) [0.0166 – 0.0184]	Station 6 (88°,0.5 mi)	0.0192 (26 / 26) [0.0103 - 0.0331]	0.0171 (52 / 52) [0.0165 - 0.0192]	9
Airborne Iodine (pCi/ m^3)	I-131 / 130	0.07	< LLD	N/A	N/A	< LLD	9
Inner Ring TLDs (mR/Qtr)	Gamma / 64	[Note 6]	7.6 (64 / 64) [5.1 – 9.4]	Station 56 (264°, 0.4 mi)	9.4 (4 / 4) [8.3 – 11.2]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma / 28	[Note 6]	6.9 (28 / 28) [5.1 – 8.5]	Station 116 (318° - 1.8 mi)	8.5 (4 / 4) [8.1 – 9.1]	N/A	1
Control TLD (mR/Qtr)	Gamma / 4	[Note 6]	N/A	N/A	N/A	6.0 (4 / 4) [5.3 – 6.9]	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	707.0 (4 / 4) [370 – 986]	Station 8 (166°, 0.2 mi)	707.0 (4 / 4) [370 – 986]	< 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	1.72 (4 / 4) [1.57 – 1.88]	Station 57 (208°, 19.5 mi)	2.07 (4 / 4) [1.74 – 2.35]	2.07 (4 / 4) [1.74 – 2.35]	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
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

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]		
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 Units 1 and 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 Units 1 and 2 ODCM Table 2.5-1.

Attachment 1

Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
1	Air Sample	Air Station 2	04/21/2020	Suspected Power Loss	Air Station 2 was 1.9 hours short. This was due to suspected power loss. CR-ANO-C-2020-1223.
2	Air Sample	Air Station 6	05/05/2020	Suspected Power Loss	Air station # 6 lost power for 5.17 hours. The power loss was due to severe storms. CR-ANO-C-2020-1334.
3	Air Sample	Air Station 6	05/19/2020	Suspected Power Loss	Air station # 6 lost power for 14 hours during the two-week sample collection period. CR-ANO-C-2020-1479.
4	Air Sample	Air Station 2	06/02/2020	Power Loss	Station 2 was 23.25 hours less than expected. This was due to air station 2 losing power on 5/27 at 1532. Chemistry was notified by the installed air station monitoring system that power had been lost to the station. The power loss was due to strong thunderstorms that blew through the area on 5/27/20. Entergy Arkansas was contacted, and power outage report was submitted to get powered restored. The monitoring system notified chemistry that power was restored on 5/28 at 1416 and chemistry staff went and verified shortly after the notification was received. CR-ANO-C-2020-1593.

Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
5	Air Sample	Air Station 6	06/02/2020	Run-Time Totalizer Failure	While performing the biweekly Air Particulate & Iodine Sampling in accordance Air Station 6 has had 3 consecutive sampling events where the run-time hours were lower than expected (CR-ANO-C-2020-1223, CR-ANO-C-2020-1334, & CR-ANO-C-2020-1479). The installed monitoring system never indicated a power failure at the air station except for on 4/28/20 when power was lost due to a storm (CR-ANO-C-2020-1334). On 5/20/20 chemistry staff went to investigate the issue. It was determined that there had been no power outages and that the totalizer was not advancing appropriately. The faulty run-time totalizer was replaced with a verified functional totalizer. The sampling event that occurred on 6/2/20 had the correct run-time hours as expected at Station 6. CR-ANO-C-2020-1596.
6	Air Sample	Air Station 6 and 56	06/30/2020	Run-Time Totalizer Failure	While collecting REMP air particulate and iodine samples from monitoring stations IAW EN-CY-130-01, it was determined that station #6 and #56 did not show the appropriate amount of runtime on the totalizer. There was no indication of power loss and the totalizer was observed advancing during sampling. CR-ANO-C-2020-1851.
7	TLD	TLD 137	07/15/2020	Missing TLD	The 2nd quarter TLD number 137 (located near Dardanelle National Guard Armory) was missing. TLD cage was present but top cap was missing. CR-ANO-C-2020-1982.
8	Air Sample	Air Station 1	08/11/2020	Power Loss	Air station #1 had a power loss on 8-4-20 @ 19:32 hrs and was restored on 8-5-20 @ 08:08 hrs. Second power loss event was on 8-9-20 @ 06:12 hrs and power was restored on 8-9-20 at 09:18 hrs. Run time loss was due to GFCI trip on both occasions. Air station #6 had a run time loss of 1 hr and 13 minutes due to temporary power loss. CR-ANO-C-2020-2236.

Attachment 1

Sample Deviations

Table 8, Sample Deviations Table

Comment No.	Sample Media Affected	Sample Location	Date	Problem	Evaluation / Actions
9	Air Sample	Air Station 1	09/08/2020	Power Loss	Chemistry noted that Air Station#1 near the Met Tower had a 6 hour delta in the run time for the two week sampling period. This was due to the GFCI tripped on 8-31-20 at ~0030 and power was reset at 0630 the same day. CR-ANO-C-2020-2472.
10	Air Sample	Air Station 1 and 6	09/22/2020	Power Loss	While performing Bi-weekly air Monitoring(REMP) sampling chemistry documented short run times for the two-week sampling period than normal on Air Stations #1 and #6. This was expected and accounted for during the replacement and troubleshooting on station #1 power loss events due to GFCI trips on this station were: 9/10/20 1440 to 1520 9/13/20 0200 to 0900 9/14 0050 to 0150 Chemistry had GFCI replaced and replaced Sampling pump on this station with no further issues noted at this time. Station #6 was due to external power loss in the sampling area on 9/9/20 from 1300 - 1600, power was restored, and no further issues noted. CR-ANO-C-2020-2615. Deviation was captured in 2020 AREOR. See attached deviation table.

Attachment 2

Monitoring Results Tables

Table 9, Air Particulate Data Summary Table

Analysis: Gross Beta				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6[Note 1] (Control)**	**Station 7 (Control)**
REQUIRED LLD ➔		**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
12/31/2019	1/14/2020	1.14E-02	1.27E-02	1.17E-02	1.03E-02	1.05E-02
1/14/2020	1/28/2020	2.23E-02	1.77E-02	1.46E-02	1.76E-02	1.87E-02
1/28/2020	2/11/2020	9.13E-03	1.24E-02	1.07E-02	1.24E-02	1.35E-02
2/11/2020	2/25/2020	1.74E-02	1.68E-02	1.50E-02	1.59E-02	1.59E-02
2/25/2020	3/10/2020	1.33E-02	1.31E-02	1.20E-02	1.27E-02	1.65E-02
3/10/2020	3/24/2020	9.49E-03	1.09E-02	8.50E-03	1.16E-02	1.09E-02
3/24/2020	4/7/2020	1.57E-02	1.80E-02	1.54E-02	1.95E-02	1.60E-02
4/7/2020	4/21/2020	1.31E-02	1.18E-02 [Note 2]	1.06E-02	1.34E-02	1.31E-02
4/21/2020	5/5/2020	1.72E-02	1.78E-02	1.55E-02	1.70E-02 [Note 2]	1.50E-02
5/5/2020	5/19/2020	1.13E-02	1.49E-02	1.20E-02	1.46E-02 [Note 2]	1.36E-02
5/19/2020	6/2/2020	1.27E-02	8.95E-03 [Note 2]	1.30E-02	1.30E-02 [Note 2]	1.09E-02
6/2/2020	6/16/2020	1.65E-02	1.76E-02	1.46E-02	1.65E-02	1.57E-02
6/16/2020	6/30/2020	1.99E-02	1.91E-02	2.32E-02[Note 2]	2.48E-02 [Note 2]	1.63E-02
6/30/2020	7/14/2020	1.79E-02	1.67E-02	1.38E-02	1.67E-02	1.50E-02
7/14/2020	7/28/2020	1.30E-02	1.71E-02	8.55E-03	1.26E-02	1.62E-02
7/28/2020	8/11/2020	2.37E-02 [Note 2]	2.15E-02	2.26E-02	2.32E-02	2.16E-02
8/11/2020	8/25/2020	2.33E-02	2.55E-02	2.68E-02	2.57E-02	2.52E-02
8/25/2020	9/8/2020	1.68E-02 [Note 2]	1.60E-02	1.53E-02	1.92E-02	1.84E-02
9/8/2020	9/22/2020	2.82E-02 [Note 2]	3.52E-02	3.02E-02	3.31E-02 [Note 2]	3.47E-02
9/22/2020	10/6/2020	1.07E-02	2.07E-02	2.05E-02	1.90E-02	1.79E-02
10/6/2020	10/20/2020	1.72E-02	2.70E-02	2.50E-02	2.99E-02	2.55E-02
10/20/2020	11/3/2020	9.71E-03	1.75E-02	1.85E-02	1.86E-02	9.44E-03
11/3/2020	11/17/2020	1.75E-02	2.42E-02	2.61E-02	2.40E-02	1.60E-02
11/17/2020	12/1/2020	1.21E-02	1.74E-02	1.82E-02	2.04E-02	1.22E-02
12/1/2020	12/15/2020	2.41E-02	2.52E-02	3.04E-02	3.09E-02	1.65E-02

Monitoring Results Tables

Table 9, Air Particulate Data Summary Table

Analysis: Gross Beta				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6[Note 1] (Control)**	**Station 7 (Control)**
12/15/2020	12/29/2020	2.71E-02	2.36E-02	2.57E-02	2.57E-02	1.50E-02
Station Yearly Average		**1.66E-02**	**1.84E-02**	**1.76E-02**	**1.92E-02**	**1.65E-02**

[Note 1] – Station with highest annual mean.
[Note 2] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table,

Table 10, Radioiodine Cartridge Data Table Summary

Analysis: I-131				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6 (Control)**	**Station 7 (Control)**
12/31/2019	1/14/2020	< 2.24E-02	< 2.25E-02	< 1.88E-02	< 2.23E-02	< 2.22E-02
1/14/2020	1/28/2020	< 1.89E-02	< 1.89E-02	< 1.89E-02	< 1.88E-02	< 1.58E-02
1/28/2020	2/11/2020	< 2.78E-02	< 2.79E-02	< 2.80E-02	< 1.15E-02	< 2.76E-02
2/11/2020	2/25/2020	< 2.33E-02	< 2.33E-02	< 2.33E-02	< 1.56E-02	< 2.32E-02
2/25/2020	3/10/2020	< 3.00E-02	< 3.00E-02	< 3.00E-02	< 1.26E-02	< 2.99E-02
3/10/2020	3/24/2020	< 2.66E-02	< 2.66E-02	< 2.66E-02	< 2.66E-02	< 2.22E-02
3/24/2020	4/7/2020	< 2.23E-02	< 2.23E-02	< 2.24E-02	< 2.23E-02	< 1.13E-02
4/7/2020	4/21/2020	< 1.77E-02	< 1.77E-02 [Note 1]	< 1.49E-02	< 1.78E-02	< 1.77E-02
4/21/2020	5/5/2020	< 1.63E-02	< 1.64E-02	< 1.64E-02	< 7.53E-03 [Note 1]	< 1.62E-02
5/5/2020	5/19/2020	< 2.93E-02	< 2.94E-02	< 2.46E-02	< 3.05E-02 [Note 1]	< 2.92E-02
5/19/2020	6/2/2020	< 1.72E-02	< 1.84E-02 [Note 1]	< 1.71E-02	< 1.03E-02 [Note 1]	< 1.73E-02
6/2/2020	6/16/2020	< 1.91E-02	< 1.90E-02	< 1.12E-02	< 1.74E-02	< 1.88E-02
6/16/2020	6/30/2020	< 2.46E-02	< 2.46E-02	< 1.63E-02 [Note 1]	< 2.86E-02 [Note 1]	< 2.44E-02
6/30/2020	7/14/2020	< 4.28E-02	< 4.27E-02	< 4.28E-02	< 4.20E-02	< 1.78E-02
7/14/2020	7/28/2020	< 2.42E-02	< 2.42E-02	< 2.42E-02	< 1.02E-02	< 2.41E-02
7/28/2020	8/11/2020	< 1.58E-02 [Note 1]	< 3.59E-02	< 3.58E-02	< 3.57E-02	< 3.53E-02
8/11/2020	8/25/2020	< 3.78E-02	< 1.59E-02	< 3.79E-02	< 3.78E-02	< 3.77E-02
8/25/2020	9/8/2020	< 1.67E-02 [Note 1]	< 3.90E-02	< 3.89E-02	< 3.88E-02	< 3.86E-02

Attachment 2 **Page 3 of 15**

Monitoring Results Tables

Table 10, Radioiodine Cartridge Data Table Summary

Analysis: I-131				Units: pCi/m^3		
Start Date	**End Date**	**Station 1 (Indicator)**	**Station 2 (Indicator)**	**Station 56 (Indicator)**	**Station 6 (Control)**	**Station 7 (Control)**
9/8/2020	9/22/2020	< 2.68E-02 [Note 1]	< 2.61E-02	< 2.61E-02	< 2.62E-02 [Note 1]	< 1.08E-02
9/22/2020	10/6/2020	< 2.70E-02	< 2.70E-02	< 2.70E-02	< 2.69E-02	< 2.69E-02
10/6/2020	10/20/2020	< 2.16E-02	< 2.17E-02	< 1.82E-02	< 2.16E-02	< 2.13E-02
10/20/2020	11/3/2020	< 7.97E-03	< 7.91E-03	< 7.90E-03	< 7.89E-03	< 7.84E-03
11/3/2020	11/17/2020	< 2.52E-02	< 2.54E-02	< 1.07E-02	< 2.51E-02	< 2.51E-02
11/17/2020	12/1/2020	< 2.91E-02	< 2.91E-02	< 2.91E-02	< 1.22E-02	< 2.89E-02
12/1/2020	12/15/2020	< 1.85E-02	< 1.86E-02	< 1.86E-02	< 7.77E-03	< 1.85E-02
12/15/2020	12/29/2020	< 1.51E-02	< 3.59E-02	< 3.59E-02	< 3.59E-02	< 3.57E-02
Station Yearly Average		**<LLD**	**<LLD**	**<LLD**	**<LLD**	**<LLD**

[Note 1] – Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table,

Monitoring Results Tables

Table 11, Thermoluminescent Dosimeters – Inner Ring

Analysis: Gamma Dose			Units: mrem		
Station	**1st Qtr [2020]**	**2nd Qtr [2020]**	**3rd Qtr [2020]**	**4th Qtr [2020]**	**Annual Mean [2020]**
1	7.6	8.6	8.4	8.8	**8.4**
2	6.3	6.7	8.0	8.7	**7.4**
3	4.8	4.5	5.1	5.9	**5.1**
4	7.1	6.9	7.8	8.1	**7.5**
56[Note 1]	**8.7**	**8.3**	**9.5**	**11.2**	**9.4**
108	8.2	7.4	8.6	8.7	**8.2**
109	7.0	8.2	8.5	8.8	**8.1**
110	7.5	7.2	7.8	8.4	**7.7**
145	6.8	7.0	7.2	7.8	**7.2**
146	6.7	6.8	7.5	7.8	**7.2**
147	6.5	6.7	6.5	7.5	**6.8**
148	7.0	7.3	8.0	8.5	**7.7**
149	6.6	6.6	11.3	7.3	**8.0**
150	8.1	8.6	8.7	9.3	**8.7**
151	7.3	8.0	8.5	8.5	**8.1**
152	5.7	6.2	6.4	6.7	**6.3**

[Note 1] – Station with highest annual mean.

Monitoring Results Tables

Table 12, Thermoluminescent Dosimeters – Special Interest Areas

Analysis: Gamma Dose			Units: mrem		
Station	**1st Qtr [2020]**	**2nd Qtr [2020]**	**3rd Qtr [2020]**	**4th Qtr [2020]**	**Annual Mean [2020]**
6	7.0	6.6	6.5	7.5	**6.9**
111	5.0	4.6	4.9	6.0	**5.1**
116[Note 1]	**8.3**	**8.5**	**8.1**	**9.1**	**8.5**
125	4.8	5.0	4.9	7.9	**5.7**
127	6.6	7.3	6.7	7.9	**7.1**
137	7.3	0 [Note 2]	7.4	8.5	**7.7**
153	6.0	6.7	7.5	7.6	**7.0**

[Note 1] – Station with highest annual mean.
[Note 2] - Reference Attachment 1, Sample Deviations, Table 8, Sample Deviations Table

Table 13, Thermoluminescent Dosimeters – Control

Analysis: Gamma Dose			Units: mrem		
Station	**1st Qtr [2020]**	**2nd Qtr [2020]**	**3rd Qtr [2020]**	**4th Qtr [2020]**	**Annual Mean [2020]**
7	5.3	5.8	5.9	6.9	**6.0**

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)	12/31/2019	01/31/2020	< 1.69	< 1.86	< 4.40	< 1.62	< 3.42	< 1.92	< 3.18	< 8.97	< 1.73	< 1.73	< 16.2	< 5.17
Station 10 (Control)	12/31/2019	01/31/2020	< 8.57	< 8.30	< 18.0	< 8.78	< 15.1	< 7.88	< 12.7	< 9.84	< 9.24	< 6.29	< 39.2	< 7.66
Station 8 (Indicator)	01/31/2020	02/28/2020	< 1.76	< 1.99	< 4.05	< 1.71	< 3.48	< 2.11	< 3.41	< 8.01	< 1.87	< 1.90	< 15.5	< 4.78
Station 10 (Control)	01/31/2020	02/28/2020	< 5.41	< 5.30	< 13.5	< 6.82	< 10.3	< 5.84	< 12.3	< 8.19	< 6.98	< 5.82	< 26.8	< 8.23
Station 8 (Indicator)	02/28/2020	03/31/2020	< 1.82	< 2.02	< 4.47	< 2.03	< 3.90	< 2.10	< 3.40	< 8.12	< 1.79	< 1.84	< 16.1	< 5.25
Station 10 (Control)	02/28/2020	03/31/2020	< 6.04	< 5.35	< 10.6	< 6.07	< 12.6	< 4.25	< 9.83	< 6.00	< 7.23	< 6.52	< 17.9	< 9.15
Station 8 (Indicator)	03/31/2020	04/30/2020	< 1.44	< 1.67	< 3.69	< 1.51	< 2.97	< 1.73	< 3.10	< 9.01	< 1.57	< 1.65	< 16.2	< 5.36
Station 10 (Control)	03/31/2020	04/30/2020	< 5.27	< 4.86	< 11.9	< 8.49	< 13.1	< 6.03	< 13.3	< 11.2	< 7.47	< 7.12	< 32.0	< 7.90
Station 8 (Indicator)	04/30/2020	05/31/2020	< 1.64	< 1.98	< 4.21	< 1.97	< 3.71	< 2.13	< 3.40	< 7.34	< 1.93	< 1.94	< 15.3	< 5.68
Station 10 (Control)	04/30/2020	05/31/2020	< 7.94	< 7.11	< 11.4	< 5.60	< 8.99	< 6.90	< 11.9	< 8.86	< 7.12	< 8.85	< 26.4	< 10.1

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**
Station 8 (Indicator)	05/31/2020	06/30/2020	< 1.80	< 2.14	< 4.96	< 1.88	< 3.90	< 2.20	< 3.68	< 12.2	< 2.06	< 1.85	< 20.7	< 6.81
Station 10 (Control)	05/31/2020	06/30/2020	< 5.72	< 7.11	< 11.7	< 5.96	< 13.1	< 5.38	< 12.8	< 9.56	< 6.98	< 6.62	< 24.6	< 8.03
Station 8 (Indicator)	06/30/2020	07/31/2020	< 1.59	< 1.78	< 4.21	< 1.70	< 3.08	< 1.86	< 3.27	< 11.6	< 1.71	< 1.70	< 17.9	< 6.43
Station 10 (Control)	06/30/2020	07/31/2020	< 5.65	< 6.73	< 17.1	< 9.65	< 13.5	< 6.62	< 12.8	< 8.90	< 7.70	< 6.86	< 27.2	< 9.19
Station 8 (Indicator)	07/31/2020	08/31/2020	< 2.41	< 2.99	< 6.06	< 2.55	< 4.92	< 3.01	< 5.17	< 14.3	< 2.82	< 2.90	< 26.0	< 7.45
Station 10 (Control)	07/31/2020	08/31/2020	< 5.05	< 5.00	< 15.9	< 6.98	< 10.9	< 6.59	< 9.00	< 8.67	< 6.44	< 5.93	< 25.8	< 7.94
Station 8 (Indicator)	08/31/2020	09/30/2020	< 1.66	< 1.80	< 4.23	< 1.65	< 3.79	< 2.18	< 3.47	< 8.43	< 2.06	< 1.79	< 16.4	< 5.98
Station 10 (Control)	08/31/2020	09/30/2020	< 6.34	< 6.05	< 11.4	< 7.39	< 13.3	< 8.41	< 9.42	< 8.39	< 8.01	< 6.23	< 26.5	< 10.5
Station 8 (Indicator)	09/30/2020	10/31/2020	< 1.67	< 1.83	< 4.10	< 1.69	< 3.40	< 1.85	< 3.21	< 9.31	< 1.73	< 1.66	< 15.9	< 5.04
Station 10 (Control)	09/30/2020	10/31/2020	< 5.75	< 5.94	< 11.2	< 7.01	< 10.8	< 5.69	< 10.4	< 8.48	< 6.66	< 7.04	< 27.4	< 5.10

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**
Station 8 (Indicator)	10/31/2020	11/30/2020	< 1.65	< 1.92	< 4.68	< 1.60	< 3.41	< 2.08	< 3.30	< 14.0	< 1.79	< 1.71	< 21.1	< 6.35
Station 10 (Control)	10/31/2020	11/30/2020	< 2.79	< 2.80	< 6.04	< 2.58	< 5.23	< 2.96	< 5.15	< 5.72	< 2.85	< 2.73	< 15.0	< 5.23
Station 8 (Indicator)	11/30/2020	12/31/2020	< 1.95	< 2.39	< 5.03	< 2.08	< 4.25	< 2.31	< 4.19	< 11.2	< 1.98	< 1.83	< 19.7	< 6.69
Station 10 (Control)	11/30/2020	12/31/2020	< 8.06	< 9.06	< 16.4	< 7.93	< 13.7	< 7.22	< 13.2	< 10.2	< 5.04	< 7.43	< 31.1	< 11.1

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)	12/31/2019	03/31/2020	**514**[1]
Station 10 (Control)	12/31/2019	03/31/2020	< 357
Station 8 (Indicator)	03/31/2020	06/30/2020	**986**[2]
Station 10 (Control)	03/31/2020	06/30/2020	<359
Station 8 (Indicator)	06/30/2020	09/30/2020	<370
Station 10 (Control)	06/30/2020	09/30/2020	<372
Station 8 (Indicator)	09/30/2020	12/31/2020	**958**
Station 10 (Control)	09/30/2020	12/31/2020	<303

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)	01/07/2020	< 1.57	< 4.47	< 5.48	< 8.71	< 4.67	< 8.85	< 5.10	< 8.06	<0.566	< 5.46	< 4.46	< 16.9	< 4.66
Station 57 (Control)	01/07/2020	2.34	< 4.31	< 4.81	< 10.6	< 4.90	< 10.4	< 4.50	< 6.98	< 0.393	< 5.51	< 5.05	< 17.7	< 5.99
Station 14 (Indicator)	04/04/2020	< 1.72	< 6.73	< 5.94	< 10.5	< 7.85	< 12.4	< 6.27	<11.1	<0.576	< 7.89	< 6.47	<20.1	< 6.09
Station 57 (Control)	04/04/2020	< 1.74	< 7.17	< 8.30	< 15.6	< 8.01	< 12.2	< 6.10	< 12.8	<0.518	< 8.94	< 9.01	< 24.3	< 8.66
Station 14 (Indicator)	7/13/2020	< 1.70	< 8.28	< 7.97	< 10.2	< 7.13	< 14.6	< 8.68	< 14.3	< 0.565	< 9.76	< 7.19	< 41.7	< 7.94
Station 57 (Control)	7/13/2020	1.85	< 7.28	< 7.45	< 17.6	< 6.67	< 14.2	< 7.29	< 11.7	< 0.794	< 7.29	< 6.72	< 31.8	< 7.92
Station 14 (Indicator)	10/06/2020	1.88	< 3.60	< 6.18	< 12.5	< 6.32	< 12.2	< 6.25	< 11.1	< 0.765	< 7.86	< 7.27	< 21.4	< 4.32
Station 57 (Control)	10/06/2020	2.35	< 6.20	< 5.93	< 11.5	< 5.25	< 13.0	< 6.08	< 9.87	< 0.654	< 6.35	< 6.65	< 23.6	< 7.90

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)	01/07/2020	< 302
Station 57 (Control)	01/07/2020	< 295
Station 14 (Indicator)	04/04/2019	< 332
Station 57 (Control)	04/04/2019	< 336
Station 14 (Indicator)	07/13/2020	< 377
Station 57 (Control)	07/13/2020	< 387
Station 14 (Indicator)	10/06/2020	< 352
Station 57 (Control)	10/06/2020	< 349

Table 18, Sediment

Analysis: Gamma Isotopic **Units: pCi/kg**

Location	Collection Date	Cs-134	Cs-137
	REQUIRED LLD ➔	**150**	**180**
Station 8 (Indicator)	05/22/2020	< 82.3	< 101
Station 16 (Control)	05/22/2020	< 110	< 123

Monitoring Results Tables

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)	03/06/2020	< 49.8	< 56.8	< 126	< 78.2	< 161	< 72.8	< 69.9
Station 16 (Control)	5/22/2020	< 77.0	< 65.9	< 142	< 96.4	< 144	< 50.2	< 83.2

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)	06/16/2020	< 56.1	< 47.3	< 40.2
Station 55 (Control)	06/16/2020	< 38.2	< 33.9	< 38.4
Station 13 (Indicator)	07/14/2020	< 53.0	< 26.4	< 26.2
Station 55 (Control)	07/14/2020	< 46.4	< 33.1	< 29.8
Station 13 (Indicator)	08/11/2020	< 55.0	< 34.4	< 35.3
Station 55 (Control)	08/11/2020	< 48.1	< 37.0	< 31.3

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)	03/13/2020	**2.47**	< 4.70E	< 4.64	< 9.36	< 4.57	< 8.48	< 5.02	< 7.92	< 10.2	< 5.00	< 4.62	< 26.5	< 8.70
Station 62 (Control)	03/12/2020	< 1.43	< 4.71	< 5.55	< 10.7	< 4.72	< 11.6	< 5.14	< 10.9	< 11.4	< 6.11	< 5.75	< 23.4	< 11.1
Station 63 (Indicator)	03/12/2020	< 2.24	< 4.80	< 4.30	< 10.1	< 5.24	< 8.51	< 4.78	< 6.84	< 10.7	< 5.34	< 4.12	< 24.5	< 9.71
Station 64 (Indicator)	03/13/2020	< 3.25	< 6.02	< 5.66	< 11.5	< 6.06	< 13.4	< 8.52	< 11.3	< 11.0	< 6.16	< 6.43	< 31.8	< 10.5
Station 58 (Control)	06/09/2020	<1.67	< 6.91	< 7.68	< 13.3	< 7.59	< 9.56	< 7.31	< 12.8	< 13.6	< 6.64	< 6.28	< 24.7	< 10.2
Station 62 (Control)	06/09/2020	<2.92	< 6.95	< 5.66	< 10.3	< 7.64	< 8.49	< 6.86	< 13.1	< 11.3	< 7.73	< 5.94	< 31.5	< 8.36
Station 63 (Indicator)	06/09/2020	**5.31**	< 4.91	< 5.46	< 10.4	< 6.94	< 9.69	< 5.47	< 9.60	< 9.74	< 5.63	< 4.79	< 29.3	< 11.6
Station 64 (Indicator)	06/10/2020	**2.60**	< 5.63	< 7.31	< 11.9	< 8.46	< 13.3	< 7.15	< 10.3	< 11.5	< 7.37	< 5.96	< 33.0	< 9.59

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)	09/18/2020	<1.90	< 7.62	< 9.09	< 15.7	< 8.29	< 19.9	< 10.2	< 14.5	< 14.7	< 6.70	< 8.03	< 39.5	< 13.8
Station 62 (Control)	09/18/2020	<3.87	< 5.88	< 7.54	< 16.5	< 6.77	< 15.0	< 6.82	< 11.0	< 13.9	< 8.02	< 7.74	< 40.3	< 9.68
Station 63 (Indicator)	09/18/2020	**8.33**	< 8.54	< 7.73	< 17.1	< 4.24	< 19.0	< 8.32	< 10.6	< 11.9	< 8.59	< 8.60	< 34.1	< 10.4
Station 64 (Indicator)	09/09/2020	<3.26	< 4.17	< 4.03	< 10.6	< 4.08	< 9.68	< 5.45	< 8.53	< 14.6	< 5.21	< 4.37	< 27.8	< 10.5
Station 58 (Control)	12/08/2020	<1.97	< 9.76	< 10.7	< 21.2	< 10.2	< 25.7	< 14.1	< 23.0	< 13.0	< 10.3	< 10.3	< 43.3	< 13.7
Station 62 (Control)	12/08/2020	<2.75	< 7.68	< 6.92	< 15.8	< 7.38	< 14.3	< 8.27	< 12.8	< 8.50	< 9.38	< 7.30	< 33.7	< 8.95
Station 63 (Indicator)	12/08/2020	<3.66	< 5.81	< 6.44	< 14.3	< 6.54	< 17.7	< 5.92	< 11.8	< 9.48	< 7.25	< 7.75	< 36.4	< 5.74
Station 64 (Indicator)	12/09/2020	**3.39**	< 8.74	< 8.30	< 18.1	< 9.90	< 19.3	< 12.3	< 16.6	< 12.0	< 11.5	< 9.90	< 37.5	< 12.5

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

Monitoring Results Tables

Table 22, Groundwater – Tritium

Analysis: H-3		Units: pCi/L
Location	**Collection Date**	**H-3**
REQUIRED LLD ➔		**3000**
Station 58 (Control)	03/13/2020	< 355
Station 62 (Control)	03/12/2020	< 361
Station 63 (Indicator)	03/12/2020	< 346
Station 64 (Indicator)	03/13/2020	< 395
Station 58 (Control)	06/09/2020	<336
Station 62 (Control)	06/09/2020	<331
Station 63 (Indicator)	06/09/2020	<330
Station 64 (Indicator)	06/10/2020	<325
Station 58 (Control)	09/18/2020	<366
Station 62 (Control)	09/18/2020	<376
Station 63 (Indicator)	09/18/2020	<384
Station 64 (Indicator)	09/09/2020	<373
Station 58 (Control)	12/08/2020	<327
Station 62 (Control)	12/08/2020	<302
Station 63 (Indicator)	12/08/2020	<312
Station 64 (Indicator)	12/09/2020	<339

1.0 SUMMARY

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

The TBE Laboratory analyzed Performance Evaluation (PE) samples of air particulate (AP), 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 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 US EPA, National Environmental Laboratory Accreditation Conference (NELAC), state-specific Performance Testing (PT) program requirements or ERA's SOP for the Generation of Performance Acceptance Limits, as applicable. The acceptance limits are either determined by a regression equation specific to each analyte or a fixed percentage limit promulgated under the appropriate regulatory document.

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.

4. For the TBE laboratory, 126 out of 133 analyses performed met the specified acceptance criteria. Seven analyses did not meet the specified acceptance criteria for the following reasons and were addressed through the TBE Corrective Action Program. A summary is found below:

   a. The MAPEP February 2020 AP U-233/234 and U-238 results were evaluated as *Not Acceptable*. The reported value for U-233/234 was 0.0416 ± 0.0102 Bq/sample and the known result was 0.075 Bq/sample (acceptance range 0.053 - 0.098). The reported value for U-238 was 0.0388 ± 0.00991 Bq/sample and the known result was 0.078 Bq/sample (acceptance range 0.055 - 0.101). This sample was run as the workgroup duplicate and had RPD's of 10.4% (U-234) and 11.7% (U-238). After the known results were obtained, the sample was relogged. The filter was completely digested with tracer added originally; the R1 results were almost identical. It was concluded that the recorded tracer amount was actually double, causing the results to be skewed. Lab worksheets have been modified to verify actual tracer amount vs. LIMS data. TBE changed vendors for this cross-check to ERA MRAD during the 2nd half of 2020. Results were acceptable at 97.8% for U-234 and 106% for U-238. (NCR 20-13)

   b. The Analytics September 2020 milk Sr-89 result was evaluated as *Not Acceptable*. The reported value was 62.8 pCi/L and the known result was 95.4 (66%). All QC data was reviewed and there were no anomalies. This was the first failure for milk Sr-89 since 2013 and there have only been 3 upper/lower boundary warnings since that time. It is believed that there may have been some Sr-89 loss during sample prep. The December 2020 result was at 92% of the known. (NCR 20-19)

   c. The ERA October 2020 water I-131 result was evaluated as *Not Acceptable*. The reported value was 22.9 pCi/L and the known result was 28.2 (acceptance range 23.5 - 33.1). The reported result was 81% of the known, which passes TBE QC criteria. This was the first failure for water I-131. (NCR 20-17)

   d. The ERA October 2020 water Gross Alpha and Gross Beta results were evaluated as *Not Acceptable*. The reported/acceptable values and ranges are as follows:

	Reported	Known	Range
Gross Alpha	40.0	26.2	13.3-34.7
Gross Beta	47.5	69.1	48.0-76.0

   All QC data was reviewed with no anomalies and a cause for failure could not be determined. This was the first failure for water Gross Beta. A Quick Response follow-up cross-check was analyzed as soon as possible with acceptable results at 96.8% for Gross Alpha and 102% for Gross Beta. (NCR 20-18)

e. The MAPEP August 2020 soil Ni-63 result was evaluated as *Not Acceptable*. The reported value was 438 ± 21.1 Bq/kg and the known result was 980 Bq/kg (acceptance range 686 - 1274). It is believed that some Ni-63 loss occurred during the sample prep step. (NCR 20-20)

f. The Analytics September 2019 soil Cr-51 sample was evaluated as Not Acceptable. TBE's reported result of 0.765 ± 0.135 pCi/g exceeded the upper acceptance range (140% of the known result of 0.547 pCi/g). The TBE result was within the acceptable range (0.63 - 0.90 pCi/g) with the associated error. The Cr-51 result is very close to TBE's normal detection limit. In order to get a reportable result, the sample must be counted for 15 hours (10x longer than client samples). There is no client or regulatory requirement for this nuclide and TBE will remove Cr-51 from the reported gamma nuclides going forward. (NCR 19-27)

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.

ENVIRONMENTAL DOSIMETRY COMPANY
ANNUAL QUALITY ASSURANCE STATUS REPORT
January - December 2019
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 period100% (72/72) of the individual dosimeters, evaluated against the EDC internal performance acceptance criteria (high-energy photons only), met the criterion for accuracy and 100% (72/72) met the criterion for precision (Table 1). In addition, 100% (12/12) of the dosimeter sets evaluated against the internal tolerance limits met EDC acceptance criteria (Table 2) and 100% (6/6) of independent testing passed the performance criteria (Table 3). Trending graphs, which evaluate performance statistic for high-energy photon irradiations and co-located stations are given in Appendix A.

One internal assessment and one external audit were performed in 2020.There was one deficiency issued in the external audit.

2.0 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:

2.1 QC Program

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:

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 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:

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

   Where:

   H'_i = the reported exposure for the i^{th} 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 period100% (72/72) of the individual dosimeters, evaluated against these criteria, met the tolerance limits for accuracy and 100% (72/72) met the criterion for precision. A graphical interpretation is provided in Figures 1 and 2.

Table 2 provides the 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)

During this annual period, one EDC Condition Report was issued. CR 1-2020 was issued to document the deficiency from the DTE Energy Audit 20-003.

6.0 STATUS OF AUDITS/ASSESSMENTS

1. Internal

   EDC Internal Quality Assurance Assessment was conducted during the fourth quarter 2020. There were no findings identified.

2. External

   DTE Energy Audit 20-003 was conducted on July 28-30, 2020. There was one deficiency identified.

7.0 PROCEDURES AND MANUALS REVISED DURING JANUARY - DECEMBER 2018

Manual 1 was revised on September 28, 2020.

Several procedures were reissued with no changes as part of the 5-year review cycle.

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, 2020.

2. EDC Manual 1, Quality System Manual, Rev. 4, September 28, 2020.

Attachment 4 **Page 8 of 14**

Environmental Dosimetry Company Interlaboratory Comparison Program Report

TABLE 1

PERCENTAGE OF INDIVIDUAL DOSIMETERS THAT PASSED EDC INTERNAL CRITERIA JANUARY – DECEMBER 2019[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 2019[1], [2]

Process Date	Exposure Level	Mean Bias %	Standard Deviation %	Tolerance Limit +/- 15%
4/28/2020	37	1.8	1.2	Pass
5/02/2020	94	2.9	1.4	Pass
5/20/2020	56	-0.5	1.4	Pass
7/28/2020	72	4.1	0.6	Pass
8/07/2020	111	4.0	1.3	Pass
9/24/2020	25	-4.6	1.2	Pass
10/24/2020	35	5.2	1.6	Pass
10/28/2020	60	1.6	0.7	Pass
11/18/2020	91	0.5	1.6	Pass
01/21/2021	31	3.8	1.7	Pass
02/09/2021	83	0.3	0.8	Pass
02/16/2021	46	5.3	1,5	Pass

[1]This table summarizes results of tests conducted by EDC for TLDs issued in 2020.
[2]Environmental dosimeter results are free in air.

Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report

TABLE 3

SUMMARY OF INDEPENDENT DOSIMETER TESTING
JANUARY – DECEMBER 2019[(1), (2)]

Issuance Period	Client	Mean Bias %	Standard Deviation %	Pass / Fail
1st Qtr. 2020	Millstone	-3.8	3.0	Pass
2nd Qtr.2020	Seabrook	0.5	1.4	Pass
2nd Qtr.2020	Millstone	-3.0	1.6	Pass
3rd Qtr. 2020	Millstone	0.4	2.6	Pass
4th Qtr.2020	PSEG(PNNL)	-3.2	0.9	Pass
4th Qtr.2020	Seabrook	6.9	1.9	Pass
4th Qtr.2020	SONGS	-8.4	1.3	Pass
4th Qtr.2020	Millstone	3.0	1.9	Pass

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

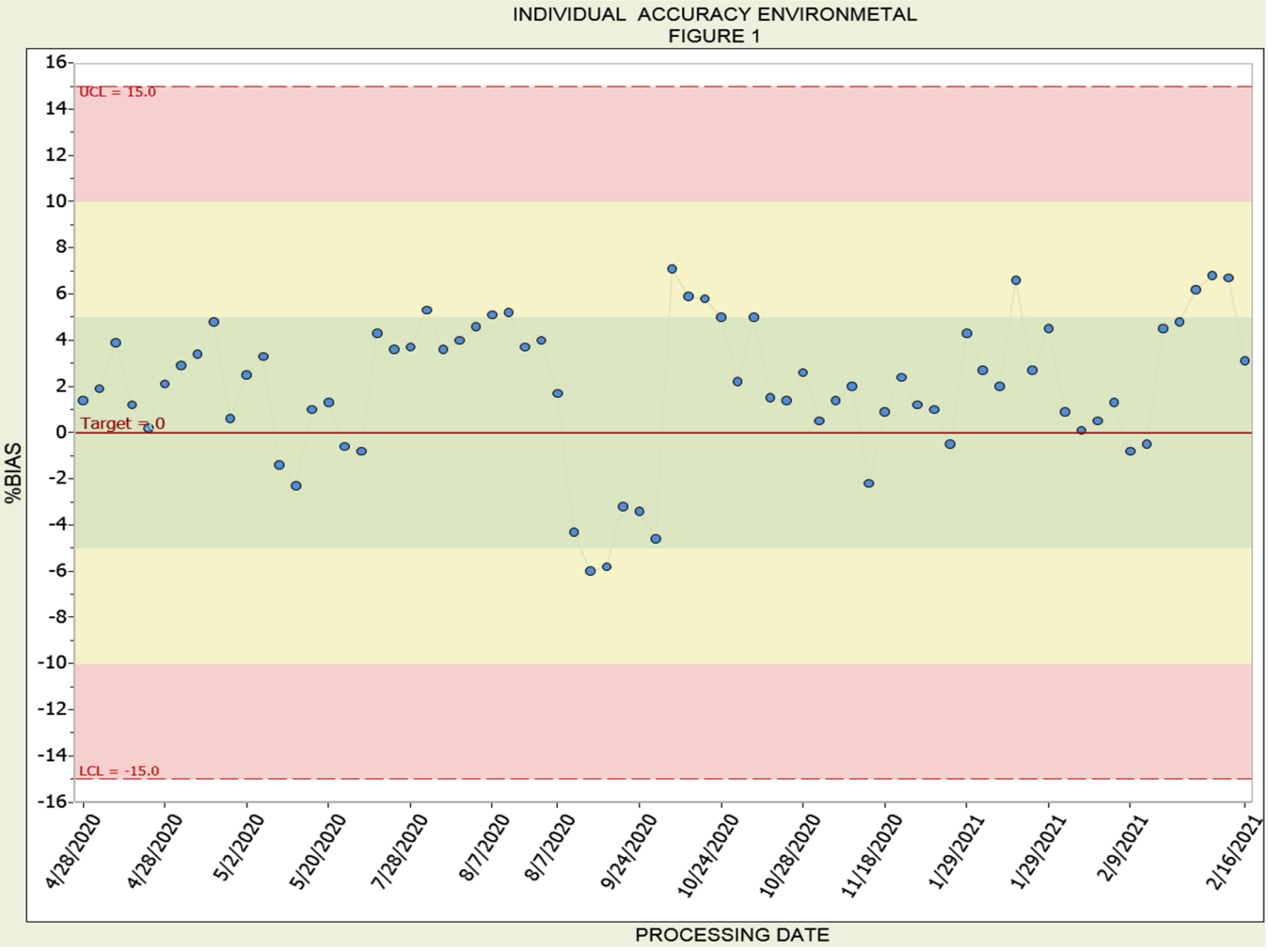
APPENDIX A

DOSIMETRY QUALITY CONTROL TRENDING GRAPHS

ISSUE PERIOD JANAURY - DECEMBER 2019

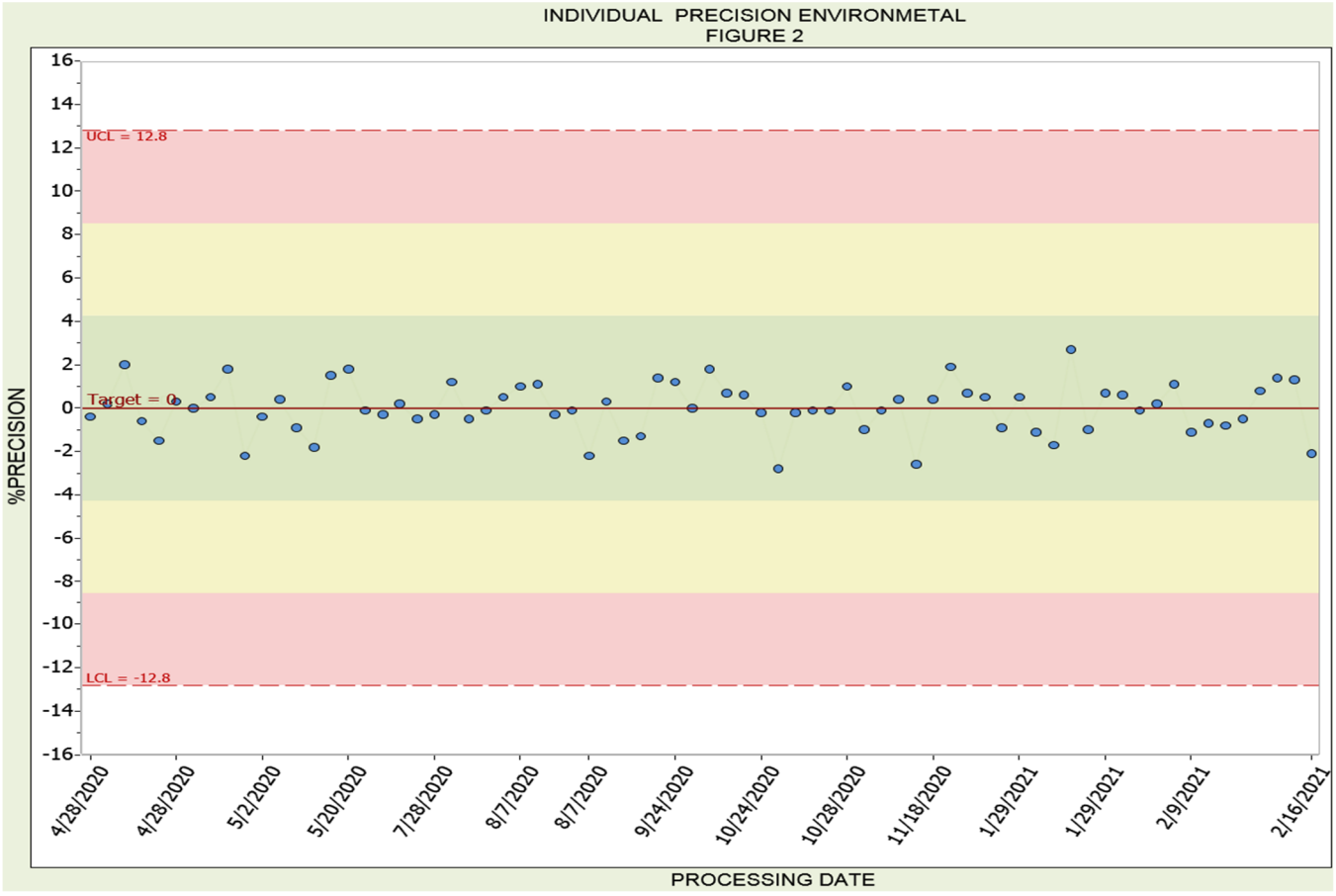
Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report



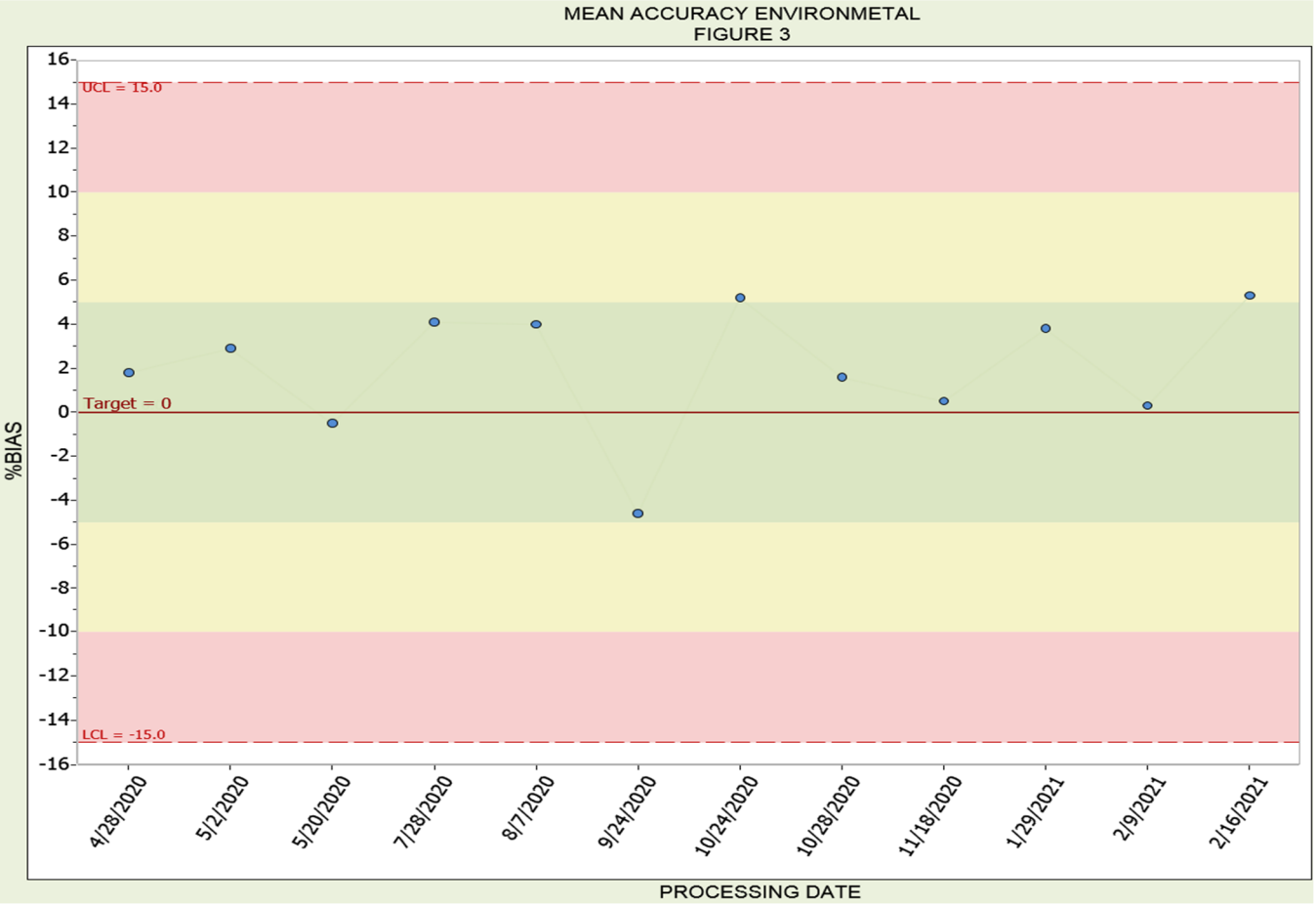
Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report



Attachment 4

Environmental Dosimetry Company Interlaboratory Comparison Program Report



Environmental Dosimetry Company Interlaboratory Comparison Program Report