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OCAN051201

May 7, 2012

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

SUBJECT: Annual Radiological Environmental Operating Report for 2011
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

REFERENCE: Entergy letter dated April 27, 2012, *Annual Radioactive Effluent Release Report for 2011* (OCAN041201)

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 2011 is enclosed.

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

The radionuclides detected by the radiological environmental monitoring program during 2011 were significantly below the regulatory limits. The operation of the ANO station during 2011 had no harmful 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 Annual Radioactive Effluent Release Report (Reference 1).

This letter contains no new commitments.

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

Sincerely,

ORIGINAL SIGNED BY STEPHENIE L. PYLE

SLP/rwc

Enclosure: Annual Radiological Environmental Operating Report for 2011

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Enclosure to

OCAN051201

**Annual Radiological Environmental
Operating Report for 2011**

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Summary

The Annual Radiological Environmental Operating Report (AREOR) presents data obtained through analyses of environmental samples collected for Arkansas Nuclear One's (ANO's) Radiological Environmental Monitoring Program (REMP) for the period January 1, 2011 through December 31, 2011. This report fulfills the requirements of ANO Unit 1 Technical Specification (TS) 5.6.2 and Unit 2 TS 6.6.2.

During 2011, as in previous years, ANO detected radionuclides attributable to plant operations at the discharge location (Station 8) where previously monitored liquid radioactive effluent from the plant is periodically discharged in accordance with the regulatory criteria established in the Offsite Dose Calculation Manual (ODCM). ANO personnel routinely monitor results from this area in order to note any trends. The review of results from this area indicates the following:

- Tritium levels in the surface water media continue to be below regulatory reporting limits and are consistent with concentrations that would typically be seen at this location as discussed in Section 2.3 of this AREOR.

Gross beta concentrations at the Station 14 (City of Russellville) indicator drinking water location continue to remain consistent with previous operational measurements and similar to the levels detected at the Station 57 (City of Danville) control drinking water location.

In 2011, ANO detected radioactivity attributed to the Fukushima Daiichi Nuclear Power Plant accident (March 11, 2011). CR-ANO-C-2011-00916

Radiological Environmental Monitoring Program

ANO established the REMP prior to the station 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 radiation directly. ANO also samples milk if milk-producing animals are present commercially within five miles 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 2011, ANO personnel collected environmental samples for radiological analysis. They compared results of indicator locations with control locations and previous studies and concluded that overall no significant relationship exists between ANO operation and effect on the plant environs. The review of 2011 data, in many cases, showed undetectable radiation levels in the environment and in all instances, no definable trends related to significant pathways associated with ANO.

Harmful Effects or Irreversible Damage

The REMP monitoring did not detect any harmful effects or evidence of irreversible damage in 2011. Therefore, no analysis or planned course of action to alleviate problems was necessary.

Reporting Levels

ANO's review indicates that no samples equaled or exceeded reporting levels for radioactivity concentration in environmental samples due to ANO effluents, as outlined in ODCM Table 2.6-3, when averaged over any calendar quarter. Therefore, 2011 results did not trigger any Radiological Monitoring Program special reports.

Radioactivity Not Attributable to ANO

The ANO REMP has detected radioactivity attributable to other sources. These include the 25th Chinese nuclear test explosion in 1980 and the radioactivity plume release due to reactor core degradation at the Chernobyl Nuclear Power Plant in 1986. Prior to 1981, the ANO REMP detected radioactivity resulting from nuclear weapons testing, with Cesium-137 continuing to be periodically detected. In 2011, ANO detected I-131 radioactivity attributed to the Fukushima Daiichi Nuclear Power Plant accident (March 11, 2011).

Comparison to Federal and State Programs

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 (ADH).

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 ADH 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.

Sample Deviations

- Milk

The REMP did not include milk sampling within five miles of ANO in 2011 due to unavailability. The ODCM requires collection of milk samples, if available commercially within 5 miles of the plant. ANO personnel collected vegetation samples to monitor the ingestion pathway, as specified in the ODCM, because of milk unavailability.

- Required Lower Limit of Detection (LLD) Values; the following REMP LLDs were not met on short lived isotopes;
 - REMP Station # 8 (discharge canal surface water), 5/31/11, (I-131)
 - REMP Station # 58, Ground Water Monitoring Well 4/19/11 (I-131, Ba-140, La-140, Nb-95)
 - REMP Station # 59, Ground Water Monitoring Well 4/19/11 (I-131, Ba-140, La-140, Nb-95)
 - REMP Station # 61, Ground Water Monitoring Well 4/19/11, 7/26/11 (I-131, Ba-140, La-140, Nb-95)

These missed LLDs are the result of the conditions identified in CR-HQN-2011-0545 and CR-RBS-2011-5352. The failure to meet the required LLD's on short lived isotopes was due to equipment availability and laboratory capacity. Actions were taken to prevent reoccurrence of this situation.

This condition carried over into the analysis of second quarter 2011 Non-REMP ground water samples as part of the site Ground Water Protection Initiative (GPI) program. All of the remaining LLD analyses taken in support of the GPI were less than the LLD as required by the ODCM and EN-CY-111,"Radiological Ground Water Monitoring Program."

- Except as identified above, LLDs during this reporting period were within the acceptable limits required by Table 2.6-2 of the ODCM.
- Air Samples

Listed below are air sampler deviations that occurred during 2011 due to electrical power outages and equipment failure. These deviations did not result in the exceedance of the LLD values specified in the ODCM. As described in footnote (a) to ODCM Table 2.6-1, deviations are permitted from the required sampling schedule due to malfunction of sampling equipment and other legitimate reasons.

Station	Sampling Period	Comment
06	01/04/2011 – 01/18/2011	On 1/18/11, the run time meter had failed. Run time meter replaced. (CR-ANO-C-2011-00164)
07	03/29/2011 – 04/12/2011	On 4-12-11, air sample pump discovered not operating. Replaced sample pump. (CR-ANO-C-2011-00954)
56	11/22/2011 – 12/06/2011	On 12-6-11, pump running with fewer than expected run time hours recorded. Indicates a power outage during sampling period. (CR-ANO-C-2011-03218)

- Missed Samples

No samples were missed during 2011.
- Unavailable Results

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

Program Modifications

ANO added an additional Storm Water Runoff collection station (STR-6) to the REMP per CR-ANO-C-2011-00424. Storm water sampling is designated as "Not required for ODCM compliance". No other modifications to the REMP were made during 2011.

Attachments

Attachment 1 contains results of air, TLD, water, sediment, fish, and food product samples collected in 2011. TLDs were analyzed by a vendor (AREVA). All remaining samples were analyzed by River Bend Station's (RBS) Environmental Laboratory.

Attachment 2 also contains RBS' participation in the interlaboratory comparison program during 2011.

Attachment 3 contains dose calculations performed for sediment using a generalized equation from Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1.

1.0 Introduction

1.1 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.

1.2 Pathways Monitored

The airborne, direct radiation, waterborne and ingestion pathways are monitored as required by the ODCM. A description of the ANO REMP utilized to monitor the exposure pathways is described in Table 1.1 and shown in Figures 1-1, 1-2 and 1-3.

Section 2.0 of this report provides a discussion of 2011 sampling results and Section 3.0 provides a summary of results for the monitored exposure pathways.

1.3 Land Use Census

ANO personnel conducts land use census biannually (once every two years) as required by ODCM Section 2.6.2. The latest land use census was conducted in 2011. 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 or ODCM. The most important criteria during this census are to determine location in each sector of the nearest:

- 1) Residence
- 2) Animal milked for human consumption
- 3) Garden of greater than 500 square feet producing fresh leafy (broadleaf) vegetables*

* ANO personnel did not perform a garden census since ODCM Section 2.6.2 allows the routine sampling of broadleaf vegetation in the highest D/Q sector near the site boundary in lieu of the garden census.

The method used by ANO personnel for conducting the land use census is as follows:

- ANO personnel conducted door-to-door (drive by) field surveys in order to locate the nearest resident in each meteorological sector.
- Consultation with local agricultural authorities is used for the identification of commercial milk providers within five-miles of the Unit-1 reactor building.
- As a result of these surveys, the following information is obtained in each meteorological sector:
 - 1) Nearest permanent residence
 - 2) Nearest milking animal
- ANO personnel identify locations on the map, measure distances to ANO (or use a GPS system) and record results.
- Locations, if any, are identified which yield a calculated dose or dose commitments greater than those currently calculated in the ODCM.
- ANO personnel compare results to previous census.

TABLE 1.1
RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Airborne	<u>Radioiodine and Particulates</u> 2 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.	Continuous operation of sampler with sample collection as required by dust loading but at least once per 14 days.	Radioiodine Canister – Analyze at least once per 14 days for I-131. Particulate Sampler – Analyze for gross beta radioactivity following filter change.
	<u>Radioiodine and Particulates</u> 1 sample from the vicinity of a community having the highest calculated annual average groundlevel D/Q.	Station 1 (88° - 0.5 miles) - Near the meteorology tower.		
	<u>Radioiodine and Particulates</u> 1 sample from a control location 15 - 30 km (10 - 20 miles) distance.	Station 7 (210° - 19.0 miles) – Entergy Supply Yard on Highway 10 in Danville.		
	<u>Radioiodine and Particulates</u> One location sampled voluntarily by ANO.	Station 6 (111° - 6.8 miles) - Entergy local office in Russellville (305 South Knoxville Avenue).		
Direct Radiation	<u>Thermoluminescent dosimetry (TLDs)</u> 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.	Once per 92 days.	Gamma Dose – Once per 92 days.

TABLE 1.1 (continued)
RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	<p><u>TLDs</u></p> <p>16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the Site Boundary</p>	<p>Station 56 (264° - 0.4 miles) - West end of the sewage treatment plant.</p> <p>Station 108 (306° - 0.9 miles) - South on Flatwood Road on a utility pole.</p> <p>Station 109 (291° - 0.6 miles) - Utility pole across from the junction of Flatwood Road and Round Mountain Road.</p> <p>Station 110 (138° - 0.8 miles) - Bunker Hill Lane on the first utility pole on the left.</p> <p>Station 145 (28° - 0.6 miles) - Near west entrance to the RERTC on a utility pole.</p> <p>Station 146 (45° - 0.6 miles) - South end of east parking lot at RERTC on a utility pole.</p> <p>Station 147 (61° - 0.6 miles) - West side of Bunker Hill Road, approximately 100 yards from intersection with State Highway 333.</p> <p>Station 148 (122° - 0.6 miles) - Intersection of Bunker Hill Road with Scott Lane on county road sign post.</p>	Once per 92 days.	Gamma Dose – Once per 92 days.

TABLE 1.1 (continued)
RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	<p><u>TLDs</u></p> <p>16 inner ring stations with two or more dosimeters in each meteorological sector in the general area of the Site Boundary</p>	<p>Station 149 (156° - 0.5 miles) – On a utility pole on the south side of May Road.</p> <p>Station 150 (205° - 0.6 miles) – North side of May Road on a utility pole past the McCurley Place turn.</p> <p>Station 151 (225° - 0.4 miles) – West side of sewage treatment plant near the lake on a metal post.</p> <p>Station 152 (338° - 0.8 miles) – South side of State Highway 333 on a road sign post.</p>	Once per 92 days.	Gamma Dose – Once per 92 days.
	<p><u>TLDs</u></p> <p>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.</p>	<p>Station 6 (111° - 6.8 miles) - Entergy local office in Russellville (305 South Knoxville Avenue).</p> <p>Station 7 (210° - 19.0 miles) – Entergy Supply Yard on Highway 10 in Danville.</p> <p>Station 111 (120° - 2.0 miles) – Marina Road on a utility pole on the left just prior to curve.</p> <p>Station 116 (318° - 1.8 miles) - Highway 333 and Highway 64 in London on a utility pole north of the railroad tracks.</p>		

TABLE 1.1 (continued)
RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Direct Radiation	<p><u>TLDs</u></p> <p>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.</p>	<p>Station 125 (46° - 8.7 miles) - College Street on a utility pole at the southeast corner of the red brick school building.</p> <p>Station 127 (100° - 5.2 miles) - Arkansas Tech Campus on a utility pole across from Paine Hall.</p> <p>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.</p> <p>Station 153 (304° - 9.2 miles) - Knoxville Elementary School near the school entrance gate on a utility pole.</p>	Once per 92 days.	Gamma Dose – Once per 92 days.
Waterborne	<p><u>Surface Water</u></p> <p>1 indicator location (influenced by plant discharge)</p> <p>1 control location (uninfluenced by plant discharge)</p>	<p>Station 8 (166° - 0.2 miles) - Plant discharge canal.</p> <p>Station 10 (95° - 0.5 miles) – Plant intake canal.</p>	Once per 92 days.	Gamma isotopic and tritium analyses once per 92 days.
	<p><u>Drinking Water</u></p> <p>1 indicator location (influenced by plant discharge)</p> <p>1 control location (uninfluenced by plant discharge)</p>	<p>Station 14 (70° - 5.1 miles) - Russellville city water system from the Illinois Bayou.</p> <p>Station 57 (208° - 19.5 miles) - Danville public water supply treatment on Fifth Street.</p>	Once per 92 days.	I-131, gross beta, gamma isotopic and tritium analyses once per 92 days.

TABLE 1.1 (continued)
RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Waterborne	<u>Sediment</u> 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 once per 365 days.
Ingestion	<u>Milk</u> 1 indicator sample location within five-mile distance if commercially available. 1 control sample location at a distance of >five-miles when an indicator exists.	Currently, no available milking animals within 8 km of ANO.	Once per 92 days.	Gamma isotopic and I-131 analyses once per 92 days.
	<u>Fish</u> 1 sample of commercially and/or recreationally important species in vicinity of plant discharge. 1 sample of same 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 on edible portions once per 365 days.
	<u>Food Products</u> 1 sample of broadleaf (edible or non-edible) near the Site Boundary from one of the highest anticipated annual average groundlevel D/Q sectors, if milk sampling is not performed. 1 sample location of broadleaf vegetation (edible or non-edible) from a control location 15 – 30 km (10 – 20 miles) distant, if milk sampling is not performed.	Station 13 (273° - 0.5 miles) - West from ANO toward Gate 4 onto Flatwood Road. Station 55 (208° - 16.5 miles) – Intersection of Highway 27 and 154.	Three per 365 days.	Gamma. isotopic and I-131 analyses three times per 365 days

TABLE 1.1 (continued)
RADIOLOGICAL ENVIRONMENT SAMPLING PROGRAM

Exposure Pathway	Requirement	Sample Point Description, Distance and Direction	Sampling and Collection Frequency	Type and Frequency Of Analyses
Ground water	1 sample location of Groundwater from a control location up gradient from the protected area	Station 58 (GWM-1, 22° - 0.3 miles) – North of Protected Area on Owner Control Area (OCA). South of Outside Fab-Shop, west side of access road	Once per 92 days	Control, Tritium and Gamma Isotopic, once per 92 days.
	3 sample locations of Groundwater from indicator locations down gradient from the protected area.	Station 59 (GWM-2, 185° - 0.1 miles) – South of Protected Area on OCA. Near Security barriers and discharge canal.	Once per 92 days	Indicator, Tritium and Gamma Isotopic, once per 92 days.
		Station 60 (GWM-3, 206° - 0.1 miles) – South of Protected area on OCA. West of Station number 59 near wood line.	Once per 92 days	Indicator, Tritium and Gamma Isotopic, once per 92 days.
		Station 61 (GWM-4, 245° - 0.1 miles) – West of Protected Area on OCA. Edge of parking lot, east of equipment laydown area	Once per 92 days	Indicator, Tritium and Gamma Isotopic, once per 92 days.

FIGURE 1-1
SAMPLE COLLECTION SITES – NEAR FIELD

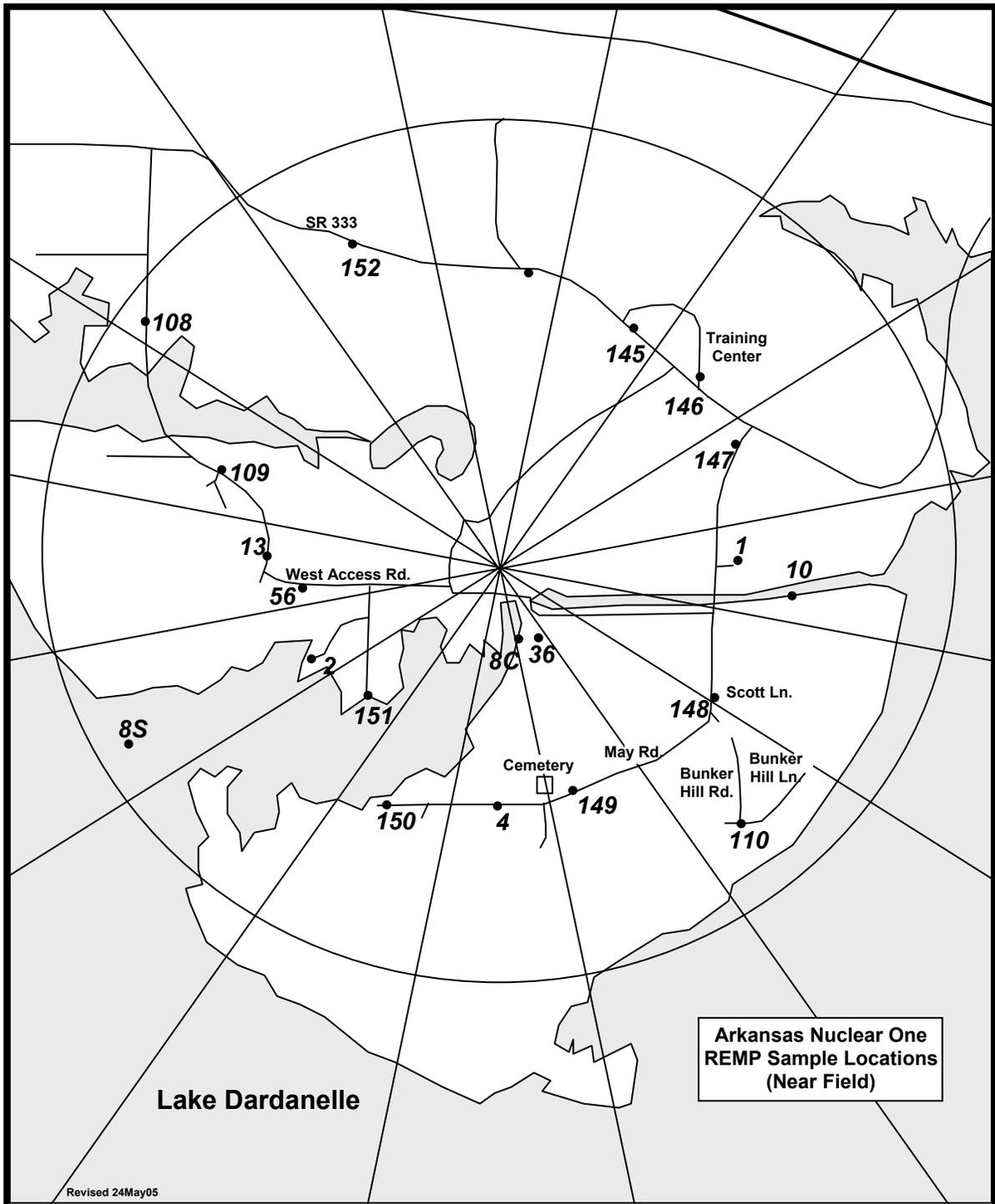


FIGURE 1-2
SAMPLE COLLECTION SITES – FAR FIELD

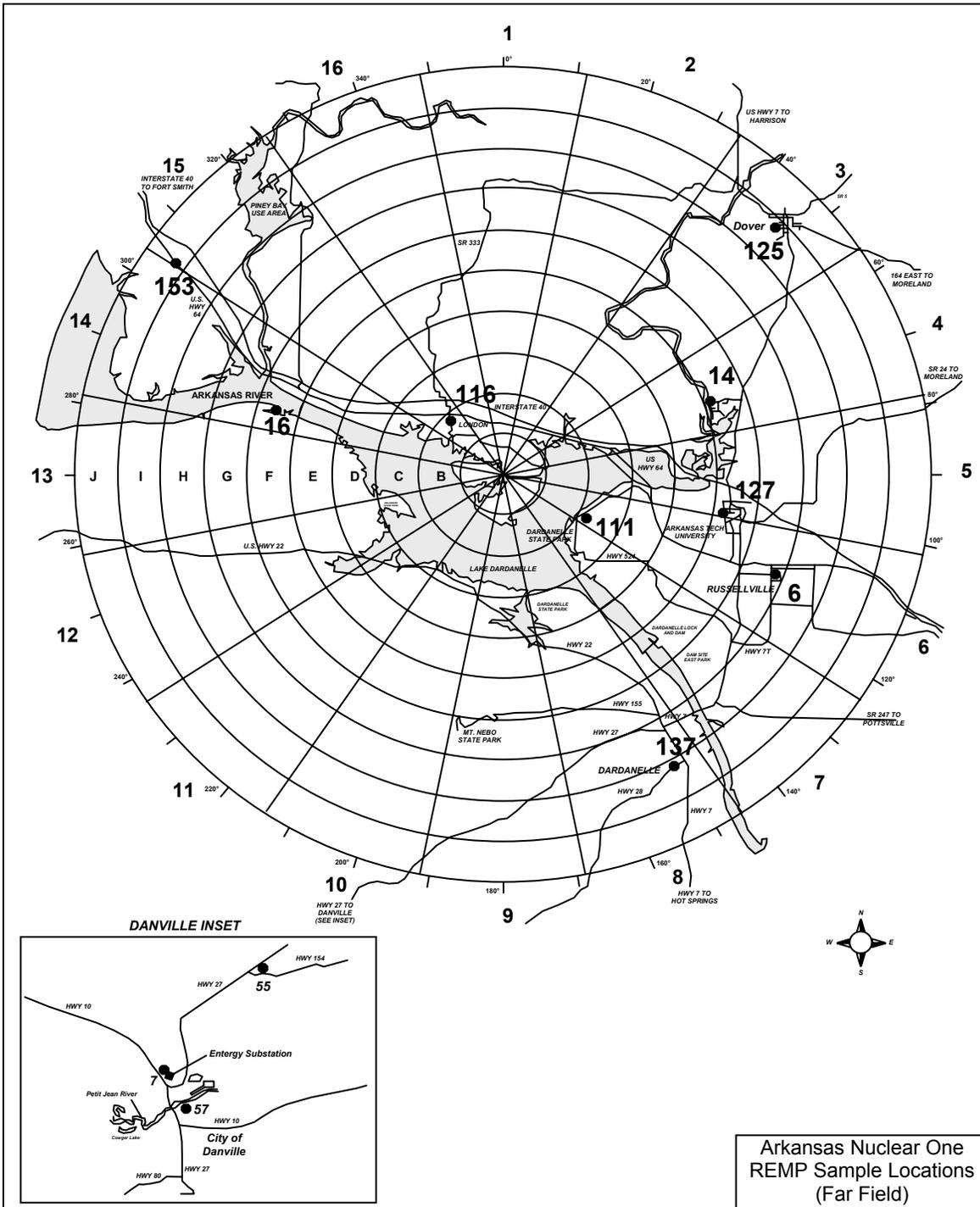
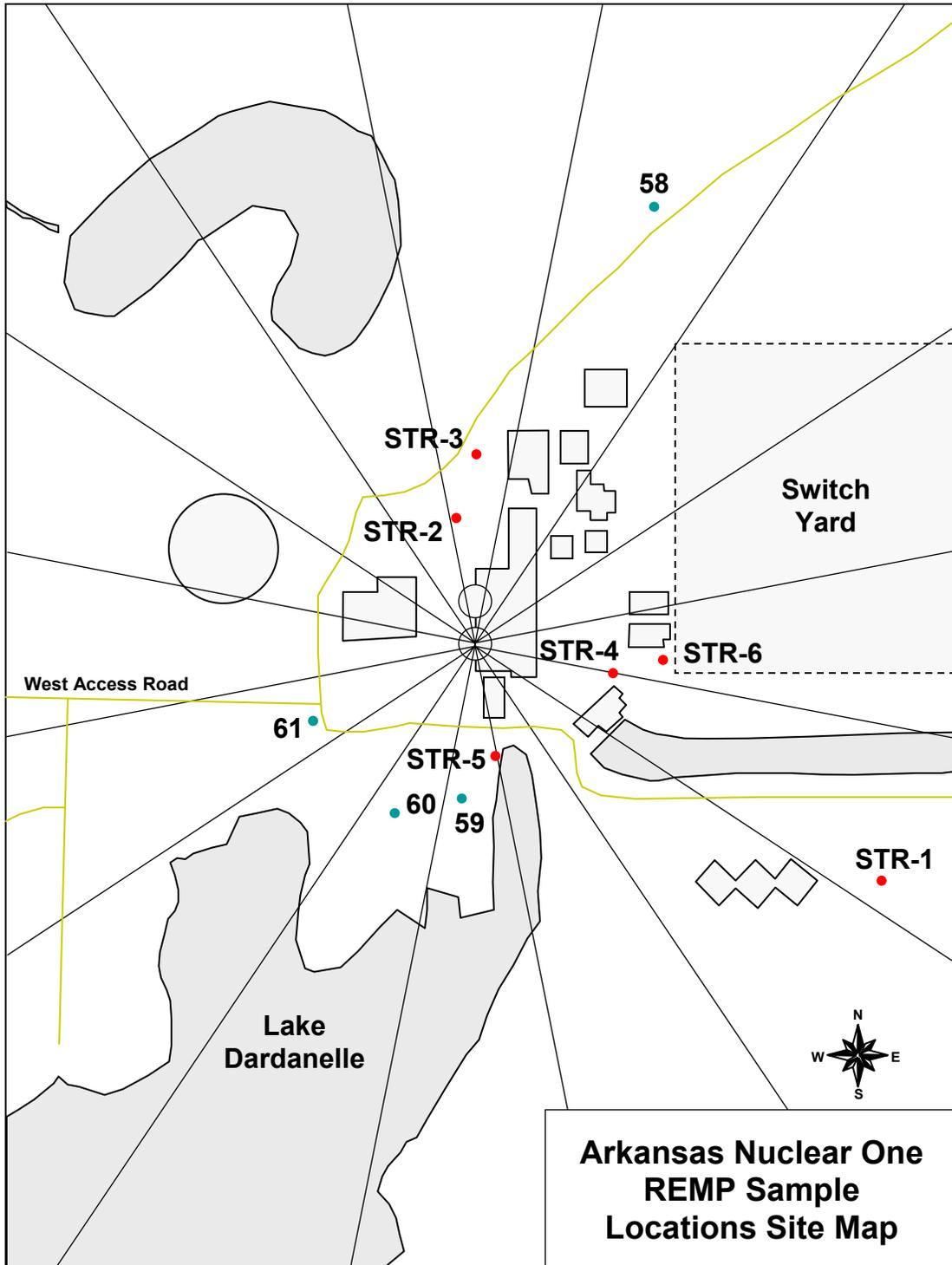


FIGURE 1-3
SAMPLE COLLECTION SITES – SITE MAP



2.0 Interpretation and Trends of Results

2.1 Air Particulate and Radioiodine Sample Results

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 (Mach 11, 2011).

During 2011, Iodine-131 was detected in the radioiodine cartridges, as a result of the Fukushima Daiichi Nuclear Power Plant accident. As in past years, there were no other detections of I-131. Indicator gross beta air particulate results for 2011 were within the range of levels obtained in previous years of the operational REMP and well below preoperational levels as seen below. Results are reported as annual average picocuries per cubic meter (pCi/m³).

<u>Monitoring Period</u>	<u>Result</u>
2000 – 2010 (Minimum Value)	0.020
2011 Value	0.030
2000 – 2010 (Maximum Value)	0.032
Preoperational	0.050

In the absence of plant-related gamma radionuclides, gross beta activity is attributed to naturally occurring radionuclides. Table 3.1, which 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.

2.2 Thermoluminescent Dosimetry (TLD) Sample Results

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 3.1, 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 8.5 millirem (mrem) shown in Table 3.1 is within the historical bounds of 2000 – 2010 annual average results, which have ranged from 6.7 to 8.8 mrem. Overall, ANO concluded that the ambient radiation levels are not being affected by plant operations.

2.3 Water Sample Results

Analytical results for 2011 surface water and drinking water samples were similar to those reported in previous years.

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. However, the levels detected are consistent with concentrations that would typically be seen at this location as shown below. Results are reported as annual average picocurie per liter (pCi/l).

<u>Monitoring Period</u>	<u>Result</u>
2000 – 2010 (Minimum Value)	272.0
2011 Value	915.5
2000 – 2010 (Maximum Value)	1023.4
Preoperational	200.0

ANO personnel have noted no definable increasing trends associated with the tritium levels at the discharge location. Levels detected during 2011 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 2011 and levels of radionuclides remain similar to those obtained in previous operational years.

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, Iodine-131, gamma radionuclides and tritium. Gamma radionuclides, Iodine-131 and tritium concentrations were below the LLD limits at the indicator and control locations, which is consistent with preoperational and operational years. Gross beta concentrations at the indicator and control locations are similar as shown in Table 3.1. Listed below is a comparison of 2011 indicator results to preoperational and operational years. Results are reported as annual average pCi/l.

<u>Radionuclide</u>	<u>2011</u>	<u>2000 – 2010</u>	<u>Preoperational</u>
Gross Beta	1.84	2.84	2.0
Iodine-131	< LLD	< LLD	< LLD
Gamma	< LLD	< LLD	< LLD
Tritium	< LLD	< LLD	200.0

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 2011 and levels of radionuclides remain similar to those obtained in previous operational years.

Groundwater samples were collected from four REMP locations (1 control, and 3 indicator locations). During 2011, ANO incorporated sixteen additional groundwater monitoring wells into the sites Groundwater Protection Initiative (GPI) site program. Sample data was compiled, organized and is reviewed annually at a minimum 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 suites 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 actions/remediation is required.

Groundwater samples were analyzed for Tritium and Gamma radionuclides. Tritium and Gamma concentrations were below the LLD limits at the indicator and control locations. Listed below is a comparison of 2011 indicator results to past operational years. Results are reported as annual average pCi/l. REMP Groundwater data is captured in Tables 8.1 and 8.2. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway.

<u>Radionuclide</u>	<u>2011</u>	<u>2006 – 2010</u>
Iodine-131	< LLD	< LLD
Gamma	< LLD	< LLD
Tritium	< LLD	< LLD

2.4 Sediment Sample Results

Sediment samples were collected from two locations in 2011 and analyzed for gamma radionuclides. During 2011, CS-137 was detected at Station # 16 (control) at a level of 45.5 pCi/kg. As in past reports, this value is attributed to past weapons testing. (CR-ANO-C-2011-02976). Station # 16 was resampled which resulted in less than LLD values. Listed below is a comparison of 2011 indicator results to past operational years. Therefore, ANO operations had no significant impact on the environment or public by this waterborne pathway. Results are reported as pCi/kg.

<u>Monitoring Period</u>	<u>Result</u>
2000 – 2010 (Minimum Value)	41.79
2011 Value	661.0
2000 – 2010 (Maximum Value)	1170.0

Since reporting levels for radionuclides in sediment have not been established, an evaluation of potential dose to the public from this media was performed as shown in Attachment 3.

2.5 Milk Sample Results

Milk samples were not collected during 2011 due to the unavailability of indicator locations within five-miles of ANO.

2.6 Fish Sample Results

Fish samples were collected from two locations and analyzed for gamma radionuclides. In 2011, 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.

2.7 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 2011, food product samples were collected when available from two locations and analyzed for Iodine-131 and gamma radionuclides. The 2011 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.

2.8 Interlaboratory Comparison Results

RBS' Environmental Laboratory analyzed interlaboratory comparison samples for ANO to fulfill the requirements of ODCM Section 2.6.3. Attachment 2 contains these results.

2.9 Land Use Census Results

The latest land use census (performed in 2011) did not identify any new locations that yielded a calculated dose or dose commitment greater than those currently calculated (see Table 2.1).

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 2009, which is allowed by ODCM Section 2.6.2, in lieu of broadleaf vegetation sampling in the meteorological sector (Sector 13) with the highest D/Q.

TABLE 2.1
2011 LAND USE CENSUS

Nearest Residence Within Five Miles

Direction	Sector	Distance (miles)
N	1	0.9
NNE	2	1.3
NE	3	0.9
ENE	4	0.8
E	5	0.8
ESE	6	0.8
SE	7	0.8
SSE	8	0.8
S	9	0.8
SSW	10	0.7
SW	11	2.8
WSW	12	0.7
W	13	0.8
WNW	14	0.8
NW	15	1.0
NNW	16	0.9

3.0 Radiological Environmental Monitoring Program Summary

3.1 2011 Program Results Summary

Table 3.1 summarizes the 2011 REMP results. ANO personnel did not use values reported as less than LLD or activity attributed to the Fukushima Daiichi Nuclear Power Plant accident when determining ranges and means for indicator and control locations.

TABLE 3.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Name of Facility: ANO - Units 1 and 2 **Docket No:** 50-313 and 50-368.

Location of Facility: Pope County, Arkansas **Reporting Period:** January - December 2011

Sample Type (Units)	Type / Number of Analyses ^a	LLD ^b	Indicator Locations Mean (°F) ^c [Range]	Location with Highest Annual Mean		Control Locations Mean (°F) ^c [Range]	Number of Non-Routine Results ^e
				Location ^d	Mean (°F) ^c [Range]		
Air Particulates (pCi/m ³)	GB / 130	0.01	0.030 (78 / 78) [0.016 – 0.050]	Station 1 (88°, 0.5 mi)	0.031 (26 / 26) [0.016 - 0.050]	0.027 (52 / 52) [0.017 - 0.047]	0
Airborne Iodine (pCi/ m ³)	I-131 / 122*	0.07	< LLD	N/A	N/A	< LLD	0
Inner Ring TLDs (mR/Qtr)	Gamma / 64	(f)	8.5 (64 / 64) [6.1 – 10.3]	Station 56 (264°, 0.4 mi)	10.3 (4 / 4) [9.8 – 10.8]	N/A	0
Special Interest TLDs (mR/Qtr)	Gamma / 28	(f)	7.6 (28 / 28) [5.3 – 8.8]	Station 116 (318°, 1.8 mi)	8.8 (4 / 4) [8.2 – 9.5]	N/A	0
		(f)		Station 127 (100°, 5.2 mi)	8.8 (4 / 4) [8.3 – 9.7]	N/A	0
		(f)		Station 137 (151°, 8.2 mi)	8.8 (4 / 4) [8.3 – 9.5]	N/A	0
Control TLD (mR/Qtr)	Gamma / 4	(f)	N/A	N/A	N/A	6.9 (4 / 4) [5.9 – 8.2]	0

* Fukushima Accident contributors removed from calculations.

TABLE 3.1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Sample Type (Units)	Type / Number of Analyses ^a	LLD ^b	Indicator Locations Mean (°F) ^c [Range]	Location with Highest Annual Mean		Control Locations Mean (°F) ^c [Range]	Number of Non-Routine Results ^e
				Location ^d	Mean (°F) ^c [Range]		
Surface Water (pCi/l)	H-3 / 8	3000	1017.0 (3 / 4) [651.0 – 1718.0]	Station 8 (166°, 0.2 mi)	1017.0 (3 / 4) [651.0 – 1718.0]	< 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 3.1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Sample Type (Units)	Type / Number of Analyses ^a	LLD ^b	Indicator Locations Mean (°F) ^c [Range]	Location with Highest Annual Mean		Control Locations Mean (°F) ^c [Range]	Number of Non-Routine Results ^e
				Location ^d	Mean (°F) ^c [Range]		
Drinking Water (pCi/l)	GB / 8	4	2.13 (2 / 4) [1.92 – 2.34]	Station 14 (70°, 5.1 mi)	1.55 (4 / 4) [0.63 – 2.30]	2.19 (3 / 4) [0.98 – 3.62]	0
	I-131 / 8	1.0	< 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	
Bottom Sediment (pCi/kg)	GS / 3						
	Cs-134	150	< LLD	N/A	< LLD	< LLD	0
	Cs-137	180	661 (1/1)	Station 8 (243°, 0.9 mi)	661 (1/1)	45.5 (2/2)	0
	Mn-54	None	29.3 (1/1)				

TABLE 3.1 (continued)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Sample Type (Units)	Type / Number of Analyses ^a	LLD ^b	Indicator Locations Mean (°F) ^c [Range]	Location with Highest Annual Mean		Control Locations Mean (°F) ^c [Range]	Number of Non-Routine Results ^e
				Location ^d	Mean (°F) ^c [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	< 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

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

^b LLD = Required lower limit of detection based on ANO Units 1 and 2 ODCM Table 2.6-2.

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

^d Locations are specified (1) by name and (2) degrees relative to reactor site.

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

^f LLD is not defined in ANO Units 1 and 2 ODCM Table 2.6-2.

Annual Radiological Environmental Operating Report for 2011

ATTACHMENT 1

SUMMARY OF MONITORING RESULTS

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Table 1.1

Sample Type: Air Particulate

Analysis: Gross Beta

Units: pCi/m³

Start Date	End Date	Station 1* (Indicator)	Station 2 (Indicator)	Station 56 (Indicator)	Station 6 (Control)	Station 7 (Control)
Required LLD →		<u>0.01</u>	<u>0.01</u>	<u>0.01</u>	<u>0.01</u>	<u>0.01</u>
12/21/2010	01/04/2011	0.033	0.040	0.037	0.029	0.035
01/04/2011	01/18/2011	0.047	0.044	0.046	0.033	0.047
01/18/2011	02/01/2011	0.044	0.043	0.041	0.034	0.042
02/01/2011	02/15/2011	0.028	0.026	0.028	0.021	0.026
02/15/2011	03/01/2011	0.025	0.023	0.022	0.017	0.022
03/01/2011	03/15/2011	0.024	0.025	0.025	0.022	0.025
03/15/2010	03/29/2011	0.031	0.027	0.030	0.024	0.028
03/29/2010	04/12/2011	0.027	0.025	0.023	0.024	0.017
04/12/2011	04/26/2011	0.020	0.018	0.019	0.017	0.021
04/26/2011	05/10/2011	0.024	0.021	0.021	0.018	0.019
05/10/2011	05/24/2011	0.016	0.017	0.016	0.018	0.019
05/24/2011	06/07/2011	0.026	0.026	0.026	0.022	0.025
06/07/2011	06/21/2011	0.026	0.026	0.027	0.023	0.026
06/21/2011	07/05/2011	0.027	0.024	0.028	0.021	0.026
07/05/2011	07/19/2011	0.026	0.024	0.025	0.022	0.026
07/19/2011	08/02/2011	0.026	0.024	0.026	0.021	0.025
08/02/2011	08/16/2011	0.026	0.026	0.025	0.020	0.025
08/16/2011	08/30/2011	0.037	0.038	0.038	0.032	0.036
08/30/2011	09/13/2011	0.042	0.040	0.038	0.037	0.033
09/13/2011	09/27/2011	0.034	0.039	0.033	0.027	0.031
09/27/2011	10/11/2011	0.037	0.035	0.033	0.030	0.036
10/11/2011	10/25/2011	0.035	0.033	0.033	0.029	0.032
10/25/2011	11/08/2011	0.037	0.036	0.035	0.031	0.035
11/08/2011	11/22/2011	0.028	0.026	0.027	0.024	0.026
11/22/2011	12/06/2011	0.034	0.032	0.033	0.026	0.035
12/06/2011	12/20/2011	0.050	0.047	0.045	0.036	0.044

* Station with highest annual mean.

Table 1.2

Sample Type: Radioiodine Cartridge Analysis: Iodine-131 Units: pCi/m³

Start Date	End Date	Station 1* (Indicator)	Station 2 (Indicator)	Station 56 (Indicator)	Station 6 (Control)	Station 7 (Control)
<u>Required LLD</u> →		<u>0.07</u>	<u>0.07</u>	<u>0.07</u>	<u>0.07</u>	<u>0.07</u>
12/21/2010	01/04/2011	< 0.019	< 0.024	< 0.016	< 0.020	< 0.020
01/04/2011	01/18/2011	< 0.025	< 0.020	< 0.020	< 0.022	< 0.023
01/18/2011	02/01/2011	< 0.022	< 0.020	< 0.016	< 0.021	< 0.018
02/01/2011	02/15/2011	< 0.015	< 0.020	< 0.017	< 0.016	< 0.013
02/15/2011	03/01/2011	< 0.041	< 0.035	< 0.022	< 0.035	< 0.015
03/01/2011	03/15/2011	< 0.027	< 0.027	< 0.028	< 0.018	< 0.021
03/15/2010	03/29/2011	0.068**	0.071**	0.076**	0.062**	0.090**
03/29/2010	04/12/2011	0.035**	< 0.034	0.037**	0.040**	< 0.032
04/12/2011	04/26/2011	< 0.025	< 0.020	< 0.023	< 0.015	< 0.024
04/26/2011	05/10/2011	< 0.019	< 0.018	< 0.023	< 0.021	< 0.026
05/10/2011	05/24/2011	< 0.020	< 0.025	< 0.020	< 0.021	< 0.026
05/24/2011	06/07/2011	< 0.021	< 0.019	< 0.046	< 0.022	< 0.021
06/07/2011	06/21/2011	< 0.016	< 0.013	< 0.017	< 0.019	< 0.018
06/21/2011	07/05/2011	< 0.021	< 0.017	< 0.021	< 0.016	< 0.018
07/05/2011	07/19/2011	< 0.015	< 0.021	< 0.018	< 0.016	< 0.017
07/19/2011	08/02/2011	< 0.021	< 0.024	< 0.026	< 0.024	< 0.022
08/02/2011	08/16/2011	< 0.017	< 0.020	< 0.017	< 0.016	< 0.020
08/16/2011	08/30/2011	< 0.012	< 0.011	< 0.012	< 0.012	< 0.011
08/30/2011	09/13/2011	< 0.018	< 0.017	< 0.018	< 0.013	< 0.016
09/13/2011	09/27/2011	< 0.013	< 0.022	< 0.013	< 0.013	< 0.011
09/27/2011	10/11/2011	< 0.010	< 0.014	< 0.013	< 0.010	< 0.015
10/11/2011	10/25/2011	< 0.018	< 0.021	< 0.016	< 0.014	< 0.020
10/25/2011	11/08/2011	< 0.010	< 0.011	< 0.015	< 0.015	< 0.018
11/08/2011	11/22/2011	< 0.019	< 0.017	< 0.014	< 0.016	< 0.012
11/22/2011	12/06/2011	< 0.016	< 0.017	< 0.015	< 0.018	< 0.020
12/06/2011	12/20/2011	< 0.016	< 0.026	< 0.026	< 0.022	< 0.021

* Station with highest annual mean.

** identifies Fukushima Nuclear Power Plant influence.

Table 2.1

Sample Type: Thermoluminescent Dosimeters Analysis: Gamma Dose Units: mrem/Qtr

Inner Ring (Indicators)					
Station	1st Qtr '11 (mrem)	2nd Qtr '11 (mrem)	3rd Qtr '11 (mrem)	4th Qtr '11 (mrem)	Annual Mean '11 (mrem)
1	9.0	8.4	9.7	9.0	9.0
2	8.8	8.3	9.2	9.0	8.8
3	5.6	5.7	7.1	6.0	6.1
4	8.3	8.4	8.9	8.4	8.5
*56	10.8	9.8	10.6	10.0	10.3
108	8.8	9.2	9.9	9.4	9.3
109	8.9	8.3	10.4	9.9	9.4
110	8.6	7.7	9.3	8.8	8.6
145	8.5	7.3	8.9	8.7	8.4
146	8.9	8.2	8.7	8.8	8.7
147	7.1	6.7	7.9	7.4	7.3
148	8.9	7.7	9.4	8.7	8.7
149	7.8	7.6	8.7	8.0	8.0
150	9.2	7.3	8.9	8.8	8.6
151	8.1	8.4	9.3	9.5	8.8
152	6.9	6.8	7.6	7.7	7.3

* Station with highest annual mean.

Table 2.2

Sample Type: Thermoluminescent Dosimeters Analysis: Gamma Dose Units: mrem/Qtr

Special Interest Areas - (Population Centers & Schools)					
Station	1st Qtr '11 (mrem)	2nd Qtr '11 (mrem)	3rd Qtr '11 (mrem)	4th Qtr '11 (mrem)	Annual Mean '11 (mrem)
6	7.6	7.0	7.7	7.2	7.4
111	5.7	6.0	6.0	6.0	5.9
*116	8.3	8.2	9.5	9.0	8.8
125	5.2	5.2	5.7	5.0	5.3
*127	8.4	8.8	9.7	8.3	8.8
*137	8.8	8.3	9.5	8.6	8.8
153	7.6	7.8	9.9	8.7	8.5

* Stations with highest annual mean.

Special Interest Areas – (Control)					
Station	1st Qtr '11 (mrem)	2nd Qtr '11 (mrem)	3rd Qtr '11 (mrem)	4th Qtr '11 (mrem)	Annual Mean '11 (mrem)
7	6.9	5.9	8.2	6.7	6.9

Table 3.1

Sample Type: Surface Water

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
	<u>Required LLD</u> →		<u>15</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>30</u>	<u>15</u>	<u>15</u>	<u>18</u>	<u>60</u>	<u>15</u>
Station 8 (Indicator)	12/31/2010	01/31/2011	< 5.29	< 4.45	< 4.62	< 4.22	< 9.49	< 6.50	< 7.12	< 8.12	< 4.82	< 4.03	< 22.12	< 8.67
Station 10 (Control)	12/31/2010	01/31/2011	< 4.90	< 5.15	< 12.63	< 4.53	< 11.16	< 8.53	< 12.16	< 10.90	< 6.13	< 5.30	< 25.14	< 10.57
Station 8 (Indicator)	01/31/2011	02/28/2011	< 5.04	< 5.66	< 11.11	< 4.28	< 9.62	< 7.24	< 9.32	< 5.81	< 4.65	< 6.44	< 17.40	< 3.51
Station 10 (Control)	01/31/2011	02/28/2011	< 3.49	< 4.75	< 6.37	< 3.84	< 9.76	< 5.21	< 7.89	< 6.31	< 4.75	< 3.81	< 17.57	< 6.94
Station 8 (Indicator)	02/28/2011	03/31/2011	< 3.94	< 3.08	< 6.51	< 3.24	< 9.22	< 4.07	< 5.72	< 6.43	< 3.42	< 3.98	< 17.99	< 7.46
Station 10 (Control)	02/28/2011	03/31/2011	< 5.83	< 4.37	< 4.79	< 3.07	< 9.66	< 4.17	< 8.17	< 6.10	< 4.68	< 5.65	< 15.35	< 6.33
Station 8 (Indicator)	03/31/2011	04/30/2011	< 2.98	< 3.51	< 7.37	< 3.33	< 8.43	< 4.78	< 6.94	< 14.92	< 3.48	< 3.72	< 26.47	< 8.94
Station 10 (Control)	03/31/2011	04/30/2011	< 4.82	< 4.76	< 9.23	< 3.49	< 8.59	< 5.43	< 8.65	< 14.58	< 4.09	< 4.35	< 38.05	< 11.86
Station 8 (Indicator)	04/30/2011	05/31/2011	< 2.02	< 2.56	< 5.94	< 2.05	< 3.57	< 3.46	< 3.98	< 15.22*	< 2.47	< 1.82	< 23.27	< 9.14
Station 10 (Control)	04/30/2011	05/31/2011	< 1.99	< 2.09	< 6.09	< 2.13	< 4.29	< 2.84	< 4.33	< 14.21	< 2.45	< 2.24	< 22.53	< 8.68
Station 8 (Indicator)	05/31/2011	06/30/2011	< 4.74	< 4.26	< 9.14	< 4.37	< 8.47	< 4.23	< 7.98	< 13.06	< 4.08	< 3.72	< 25.90	< 11.03
Station 10 (Control)	05/31/2011	06/30/2011	< 3.04	< 3.04	< 7.97	< 2.74	< 7.36	< 5.03	< 5.50	< 9.66	< 3.95	< 3.60	< 26.43	< 5.53
Station 8 (Indicator)	06/30/2011	07/31/2011	< 2.94	< 3.46	< 7.48	< 3.31	< 7.68	< 4.37	< 6.45	< 9.25	< 4.26	< 3.86	< 20.04	< 7.55
Station 10 (Control)	06/30/2011	07/31/2011	< 4.04	< 3.67	< 9.94	< 3.56	< 8.57	< 5.88	< 6.44	< 8.96	< 4.02	< 4.17	< 23.03	< 8.62
Station 8 (Indicator)	07/31/2011	08/31/2011	< 5.74	< 4.88	< 11.90	< 4.94	< 6.52	< 6.00	< 9.20	< 6.37	< 4.61	< 5.62	< 25.60	< 7.78
Station 10 (Control)	07/31/2011	08/31/2011	< 4.91	< 5.51	< 7.16	< 5.69	< 12.20	< 8.29	< 12.20	< 6.66	< 4.56	< 4.26	< 31.80	< 10.40
Station 8 (Indicator)	08/31/2011	09/30/2011	< 7.07	< 7.15	< 15.20	< 7.27	< 12.50	< 7.71	< 12.50	< 12.80	< 5.69	< 6.78	< 33.80	< 13.80
Station 10 (Control)	08/31/2011	09/30/2011	< 5.21	< 4.58	< 10.60	< 4.90	< 9.89	< 6.46	< 9.40	< 8.60	< 6.16	< 7.04	< 23.00	< 8.31
Station 8 (Indicator)	09/30/2011	10/31/2011	< 3.87	< 3.37	< 10.50	< 3.91	< 6.99	< 4.52	< 7.66	< 14.50	< 3.79	< 4.34	< 36.60	< 14.40
Station 10 (Control)	09/30/2011	10/31/2011	< 3.60	< 3.41	< 6.36	< 4.03	< 7.51	< 5.85	< 8.49	< 13.70	< 3.54	< 3.44	< 26.20	< 8.28
Station 8 (Indicator)	10/31/2011	11/30/2011	< 4.76	< 5.42	< 13.60	< 13.80	< 10.60	< 6.01	< 9.46	< 9.75	< 4.70	< 4.59	< 30.30	< 9.54
Station 10 (Control)	10/31/2011	11/30/2011	< 4.84	< 5.43	< 11.80	< 5.66	< 12.00	< 6.32	< 10.70	< 7.33	< 4.96	< 6.27	< 23.40	< 12.70
Station 8 (Indicator)	11/30/2011	12/31/2011	< 6.47	< 5.41	< 11.20	< 5.31	< 10.40	< 7.47	< 11.30	< 11.10	< 4.67	< 5.88	< 31.20	< 14.50
Station 10 (Control)	11/30/2011	12/31/2011	< 5.78	< 4.10	< 8.43	< 4.96	< 10.20	< 5.60	< 9.02	< 9.65	< 4.27	< 5.88	< 34.40	< 13.10

* identifies a missed LLD value.

Table 3.2

Sample Type: Surface Water

Analysis: Tritium

Units: pCi/l

Location	Begin Date	End Date	H-3
		<u>Required LLD</u> →	<u>3000</u>
Station 8 (Indicator)	12/31/2010	03/31/2011	651
Station 10 (Control)	12/31/2010	03/31/2011	< 432
Station 8 (Indicator)	03/31/2011	06/30/2011	1718
Station 10 (Control)	03/31/2011	06/30/2011	< 405
Station 8 (Indicator)	06/30/2011	09/30/2011	< 653
Station 10 (Control)	06/30/2011	09/30/2011	< 654
Station 8 (Indicator)	09/30/2011	12/31/2011	682
Station 10 (Control)	09/30/2011	12/31/2011	< 639

Table 4.1

Sample Type: Drinking Water Analysis: Gross Beta, Iodine-131, Gamma Isotopic Units: pCi/l

Location	Collection Date	Gross Beta	I-131	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
	Required LLD →	4.0	1.0	15	15	30	15	30	15	30	15	18	60	15
Station 14 (Indicator)	03/15/2011	< 1.25	< 0.82	< 5.16	< 3.93	< 8.27	< 2.85	< 9.53	< 4.73	< 5.25	< 4.59	< 4.26	< 19.09	< 6.55
Station 57 (Control)	03/15/2011	1.93	< 0.83	< 2.68	< 4.09	< 6.83	< 2.65	< 5.16	< 4.31	< 6.78	< 4.14	< 4.00	< 20.95	< 5.55
Station 14 (Indicator)	06/07/2011	2.34	< 0.89	< 3.38	< 2.82	< 7.19	< 3.07	< 7.50	< 3.70	< 6.79	< 3.47	< 3.14	< 21.11	< 7.79
Station 57 (Control)	06/07/2011	0.98	< 0.87	< 3.90	< 3.65	< 8.70	< 2.40	< 8.33	< 8.31	< 4.11	< 3.84	< 4.11	< 20.08	< 9.71
Station 14 (Indicator)	09/13/2011	< 1.86	< 0.89	< 4.91	< 4.74	< 3.30	< 5.21	< 6.28	< 4.86	< 7.61	< 4.21	< 5.40	< 24.80	< 10.20
Station 57 (Control)	09/13/2011	< 1.87	< 0.94	< 6052	< 5.72	< 13.00	< 3.72	< 12.80	< 4.98	< 11.80	< 6.41	< 4.96	< 23.10	< 7.13
Station 14 (Indicator)	12/20/2011	1.92	< 0.95	< 4.57	< 5.64	< 13.30	< 6.90	< 11.40	< 5.87	< 11.10	< 5.64	< 5.16	< 24.90	< 7.67
Station 57 (Control)	12/20/2011	3.62	< 0.87	< 5.61	< 5.90	< 8.82	< 3.95	< 9.92	< 5.87	< 6.70	< 4.28	< 4.62	< 31.00	< 11.90

Table 4.2

Sample Type: Drinking Water Analysis: Tritium Units: pCi/l

Location	Collection Date	H-3
	Required LLD →	2000
Station 14 (Indicator)	03/15/2011	< 511
Station 57 (Control)	03/15/2011	< 517
Station 14 (Indicator)	06/07/2011	< 403
Station 57 (Control)	06/07/2011	< 412
Station 14 (Indicator)	09/13/2011	< 605
Station 57 (Control)	09/13/2011	< 604
Station 14 (Indicator)	12/20/2011	< 642
Station 57 (Control)	12/20/2011	< 640

Table 5.1

Sample Type: Sediment Analysis: Gamma Isotopic Units: pCi/kg

Location	Collection Date	Cs-134	Cs-137	Mn-54
	Required LLD →	150	180	N/A
Station 8 (Indicator)	10/13/2011	< 24.10	661	29.30
Station 16 (Control)*	10/25/2011	< 14.60	45.5	N/A
Station 16 (Control)**	11/23/2011	< 18.30	< 20.60	N/A

* Positive Cs-137 detection. Back ground detection from past weapons testing. CR-ANO-C-2011 02976.

** Station # 16 resample after positive Cs-137 detection.

Table 6.1

Sample Type: 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)	9/29/2011	< 14.20	< 15.00	< 45.20	< 15.80	< 23.90	< 11.10	< 11.50
Station 16 (Control)	9/27/2011	< 11.70	< 12.10	< 39.30	< 7.99	< 26.00	< 6.98	< 7.48

Table 7.1

Sample Type: Food Products Analysis: Iodine-131, Gamma Isotopic Units: pCi/kg

Location	Collection Date	I-131	Cs-134	Cs-137
	<u>Required LLD</u> →	<u>60</u>	<u>60</u>	<u>80</u>
Station 13 (Indicator)	06/16/2011	< 57.91	< 25.78	< 35.86
Station 55 (Control)	06/16/2011	< 59.89	< 40.59	< 46.61
Station 13 (Indicator)	07/18/2011	< 44.42	< 31.73	< 35.47
Station 55 (Control)	07/18/2011	< 40.05	< 38.88	< 36.13
Station 13 (Indicator)	08/29/2011	< 40.40	< 43.80	< 36.50
Station 55 (Control)	08/29/2011	< 29.90	< 22.90	< 26.10

Table 8.1

Sample Type: Groundwater

Analysis: Iodine-131, Gamma Isotopic

Units: pCi/l

Sample #	Collection Date	I-131	Mn-54	Co-58	Fe-59	Co-60	Zn-65	Nb-95	Zr-95	Cs-134	Cs-137	Ba-140	La-140
	Required LLD →	15	15	15	30	15	30	15	30	15	18	60	15
58*	02/08/2011	< 14.97	< 4.99	< 5.37	< 9.48	< 4.98	< 10.22	< 7.29	< 9.22	< 4.71	< 4.52	< 32.78	< 10.89
59	02/08/2011	< 11.50	< 4.22	< 4.66	< 10.08	< 4.43	< 8.16	< 5.46	< 7.57	< 4.33	< 4.10	< 26.06	< 7.83
60	03/07/2011	< 12.15	< 8.49	< 6.91	< 12.77	< 8.81	< 12.33	< 8.72	< 11.94	< 8.24	< 9.25	< 42.16	< 14.47
61	02/08/2011	< 14.91	< 5.38	< 4.53	< 9.69	< 4.45	< 9.29	< 5.60	< 8.84	< 5.76	< 4.78	< 29.98	< 11.31
58*	04/19/2011	Missed	< 6.74	< 10.03	< 29.66	< 5.62	< 12.27	Missed	< 18.12	< 4.70	< 4.83	Missed	Missed
59	04/19/2011	Missed	< 4.66	< 6.91	< 24.96	< 3.70	< 11.22	Missed	< 13.33	< 4.68	< 4.43	Missed	Missed
60	04/19/2011	< 14.87	< 1.06	< 1.23	< 3.17	< 1.05	< 2.26	< 1.98	< 2.44	< 1.07	< 1.09	< 21.05	< 8.16
61	04/19/2011	Missed	< 3.89	< 6.95	< 26.84	< 3.07	< 9.18	Missed	< 14.16	< 3.80	< 3.09	Missed	Missed
58*	08/11/2011	< 12.60	< 2.16	< 1.99	< 4.98	< 1.94	< 4.50	< 3.14	< 5.21	< 1.53	< 1.99	< 20.80	< 6.36
59	07/26/2011	< 11.26	< 4.01	< 4.71	< 8.06	< 3.42	< 8.92	< 5.68	< 7.04	< 4.68	< 4.30	< 21.28	< 8.00
60	07/26/2011	< 12.28	< 3.31	< 3.20	< 6.23	< 3.06	< 5.55	< 4.07	< 5.34	< 3.20	< 2.66	< 25.28	< 7.82
61	07/26/2011	< 8.53	< 2.68	< 3.95	< 7.38	< 3.55	< 8.13	< 5.20	< 5.13	< 3.74	< 3.65	< 18.92	< 7.07
58*	11/30/2011	< 11.00	< 3.63	< 4.98	< 11.30	< 4.22	< 8.30	< 5.12	< 7.42	< 4.62	< 4.85	< 36.00	< 14.50
59	11/29/2011	< 14.60	< 4.00	< 4.58	< 8.21	< 5.01	< 9.23	< 5.70	< 8.08	< 3.99	< 5.47	< 24.60	< 13.20
60	11/29/2011	< 13.30	< 4.16	< 4.51	< 11.60	< 3.81	< 9.09	< 5.92	< 9.58	< 4.09	< 4.79	< 26.60	< 13.30
61	11/29/2011	< 13.10	< 4.50	< 5.32	< 10.50	< 4.43	< 10.10	< 6.99	< 8.58	< 4.97	< 6.28	< 32.70	< 11.80

* Identifies Control Locations

Missed identifies missed LLDs on short lived isotopes, (CR-HQN-2011-0545 and CR-RBS-2011-5352)

Table 8.2

Sample Type: Groundwater Analysis: Tritium Units: pCi/l

Location	Collection Date	H-3
	<u>Required LLD</u> →	<u>3000</u>
Station 58 (Control)	03/07/2011	< 396
Station 59 (Indicator)	03/08/2011	< 391
Station 60 (Indicator)	03/07/2011	< 390
Station 61 (Indicator)	03/08/2011	< 420
Station 58 (Control)	04/19/2011	< 403
Station 59 (Indicator)	04/19/2011	< 403
Station 60 (Indicator)	04/19/2011	< 403
Station 61 (Indicator)	04/19/2011	< 404
Station 58 (Control)	07/27/2011	< 717
Station 59 (Indicator)	07/26/2011	< 645
Station 60 (Indicator)	07/26/2011	< 651
Station 61 (Indicator)	07/26/2011	< 700
Station 58 (Control)	11/30/2011	< 655
Station 59 (Indicator)	11/29/2011	< 656
Station 60 (Indicator)	11/29/2011	< 658
Station 61 (Indicator)	11/29/2011	< 660

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ATTACHMENT 2

INTERLABORATORY COMPARISON PROGRAM

Table 9.1

Sample Type: Interlaboratory Comparison Analysis: Iodine-131, Gamma Isotopic
 Calendar Year: 2011

1st Quarter dated March 17, 2011

Analytics E7481-125			Gross Beta in Water		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/L	RBS 1-s pCi/L	Ref Lab Value pCi/L	Ref Lab uncertainty pCi/L	Resolution	RBS/Ref Lab Ratio	Pass/Fail
Cs-137	199	19	247	4.13	59.8	0.80	Pass (1)

3rd Quarter dated Sept. 15, 2011

Analytics E8137-125			Gross Beta filter		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/filter	RBS 1-s pCi/filter	Ref Lab Value pCi/filter	Ref Lab uncertainty pCi/filter	Resolution	RBS/Ref Lab Ratio	Pass/Fail
Cs-137	84.2	1.41	82.1	1.37	59.9	1.03	Pass

Analytics E8136-125			H-3 in water		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/L	RBS 1-s pCi/L	Ref Lab Value pCi/L	Ref Lab uncertainty pCi/L	Resolution	RBS/Ref Lab Ratio	Pass/Fail
H-3	9060	419	9010	151	59.7	1.01	Pass

Table 9.1 (continued)

Sample Type: Interlaboratory Comparison

Analysis: Tritium, Gamma Isotopic

Analytics E8138-125			Gamma Filter		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/filter	RBS 1-s pCi/filter	Ref Lab Value pCi/filter	Ref Lab uncertainty pCi/filter	Resolution	RBS/Ref Lab Ratio	Pass/Fail
Ce-141	58.2	2.80	59.6	0.995	59.7	0.98	Pass
Cr-51	188	11.9	202	3.38	59.8	0.93	Pass
Cs-134	94.3	4.20	115	1.91	60.2	0.82	Pass
Cs-137	101	4.20	102	1.70	60.0	0.99	Pass
Co-58	83.9	3.90	87.1	1.45	60.1	0.96	Pass
Mn-54	134	4.00	135	2.25	60.0	0.99	Pass
Fe-59	52.1	2.60	49.0	0.818	59.9	1.06	Pass
Zn-65	157	6.40	161	2.69	59.9	0.97	Pass
Co-60	134	4.50	140	2.34	59.8	0.95	Pass

Analytics E8139-125			Gamma Soil		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/g	RBS 1-s pCi/g	Ref Lab Value pCi/g	Ref Lab uncertainty pCi/g	Resolution	RBS/Ref Lab Ratio	Pass/Fail
Ce-141	0.174	.0110	0.168	.00280	60	1.04	Pass
Cr-51	0.556	.0450	0.569	.00950	59.9	0.98	Pass
Cs-134	0.271	.0110	0.322	.00580	55.5	0.84	Pass
Cs-137	0.347	.0170	0.375	.00625	60	0.93	Pass
Co-58	0.221	.0110	0.245	.00409	59.9	0.90	Pass
Mn-54	0.357	.0100	0.379	.00633	59.9	0.94	Pass
Fe-59	0.142	.00100	0.138	.00230	60	1.03	Pass
Zn-65	0.423	.0350	0.454	.00758	59.9	0.93	Pass
Co-60	0.361	.0180	0.395	.00659	59.9	0.91	Pass

Table 9.1 (continued)

Sample Type: Interlaboratory Comparison

Analysis: Tritium, Gamma Isotopic

4th Quarter dated Dec. 8, 2011

Analytics E7480-125			Gamma in Water		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/L	RBS 1-s pCi/L	Ref Lab Value pCi/L	Ref Lab uncertainty pCi/L	Resolution	RBS/Ref Lab Ratio	Pass/Fail
I-131	94.0	17.0	88.7	1.48	59.9	1.06	Pass
Ce-141	n/a	n/a	n/a	n/a	n/a	n/a	n/a (2)
Cr-51	599	91.0	566	9.45	59.9	1.06	Pass
Cs-134	164	11.0	171	2.86	59.8	0.96	Pass
Cs-137	223	17.0	210	3.50	60	1.06	Pass
Co-58	216	15.0	221	3.69	59.9	0.98	Pass
Mn-54	255	13.0	241	4.02	60.0	1.06	Pass
Fe-59	188	20.0	183	3.06	59.8	1.03	Pass
Zn-65	309	29.0	291	4.87	59.8	1.06	Pass
Co-60	284	16.0	270	4.51	59.9	1.05	Pass

Analytics E7483-125			Gamma in Milk		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/L	RBS 1-s pCi/L	Ref Lab Value pCi/L	Ref Lab uncertainty pCi/L	Resolution	RBS/Ref Lab Ratio	Pass/Fail
I-131	91.0	16.0	90.2	1.51	59.7	1.01	Pass
Ce-141	n/a	n/a	n/a	n/a	n/a	n/a	n/a (2)
Cr-51	532	76.0	566	9.45	59.9	0.94	Pass
Cs-134	160	11.0	171	2.86	59.8	0.93	Pass
Cs-137	216	10.0	210	3.50	60	1.03	Pass
Co-58	206	13.0	221	3.69	59.9	0.93	Pass
Mn-54	237	12.0	241	4.02	60.0	0.98	Pass
Fe-59	192	18.0	183	3.06	59.8	1.05	Pass
Zn-65	304	22.0	291	4.87	59.8	1.04	Pass
Co-60	265	16.0	270	4.51	59.9	0.98	Pass

Table 9.1 (continued)

Analytics E7482-125			I-131 cartridge		Range of 0.80 to 1.25		
Nuclide	RBS Mean pCi/each	RBS 1-s pCi/each	Ref Lab Value pCi/each	Ref Lab uncertainty pCi/each	Resolution	RBS/Ref Lab Ratio	Pass/Fail
I-131	90.0	8.00	89.7	1.50	59.8	1.00	Pass

- (1) Analysis result for Gross Beta in Water, Environmental cross check E-7481-125, was outside the passing ratio of agreement in the performance of the 2011 Interlaboratory Comparison Program as determined on 2/29/12. The reference lab's known value was 247 pCi/L with a passing ratio for agreement of 0.80 to 1.25 thus producing control limits of 197.6 to 308.8 pCi/L. The RBS average value was 156 pCi/L making the ratio of agreement 0.63. CR-RBS-2012-01845 was generated.

Preparation for reanalysis of the same source material was begun on 3/1/12. RBS results obtained on 3/12/12 indicate an average of 199 pCi/L, decay corrected to an assay date of 3/17/11. The same ratio of agreement applies (passing 0.80 – 1.25) therefore indicating a passing result for the reanalysis with a 0.80 ratio of agreement.

Although the reanalysis passed, the reference lab, Eckert & Ziegler/Analytics (EZA), was contacted to verify that other participants did not have similar issues indicating a low bias and/or possible source problems. EZA reported that none of the other participants experienced any problems.

The most probable cause of the low sample result was sample preparation error during mixing, transfer, or evaporation of the sample. Analytics was contacted to obtain a quote for a standard of known value (Gross Beta in Water) which the RBS lab will prepare and analyze along with future samples for the analyses of Gross Beta in Water. ESP-8-068 will be revised to reflect this change.

- (2) Ce-141 was unavailable at the reference lab for the mixed gamma matrix for the 4th quarter milk and water.

Table 9.1 (continued)

CHEMISTRY SURVEILLANCE PROGRAM
RADIOCHEMISTRY QUALITY CONTROL ACCEPTANCE CRITERIA

This attachment provides criteria for comparing results of capability tests and verification measurements. The criteria are based on an empirical relationship which combines prior experience and the accuracy needs of this program.

In these criteria, the judgment limits are variable in relation to the comparison of the NRC Reference Laboratory's value to its associated uncertainty. As that ratio, referred to in this program as "Resolution", increases the acceptability of a licensee's measurement should be more selective. Conversely, poorer agreement must be considered acceptable as the resolution decreases.

RESOLUTION⁽¹⁾	RATIO FOR AGREEMENT⁽²⁾
< 4	No Comparison
4 to 7	0.5 to 2.0
8 to 15	0.6 to 1.66
16 to 50	0.75 to 1.33
51 to 200	0.80 to 1.25
> 200	0.85 to 1.18

⁽¹⁾ Resolution = (NRC Reference Value/Reference Uncertainty)

⁽²⁾ Ratio = (Licensee Value/NRC Reference Value)

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ATTACHMENT 3

SEDIMENT DOSE CALCULATIONS

Sediment Sample Results

Dose calculation for the discharge sediment was performed using generalized equation found in Regulatory Guide 1.109, Revision 1, Appendix A as follows:

$$R = (40) \times (C) \times (U) \times (D) \times (W)$$

- R = Annual dose to skin or total body in mrem/year;
- 40 = Area-mass conversion factor given in Appendix A of Rg 1.109 in kg/m²;
- C = 2011 maximum radionuclide concentration in pCi/kg;
- U = Maximum exposure time given in Table E-5 of RG 1.109 (67 hours for teenager);
- D = External dose conversion factor for standing on contaminated ground given in Table E-6 of RG 1.109 in mrem/hr per pCi/m², and
- W = Shore-width factor (0.1) given in Table A-2 of RG 1.109.

Radionuclide	2011 Maximum Concentration	Conversion Factor For Skin	Total Skin Dose	Conversion Factor For Total Body	Total Body Dose
Cs-137*	661	4.90 E-09	8.68 E-04	4.20 E-09	7.44 E-04
TOTAL			8.68 E-04		7.44 E-04

* Dose from Sediment in mrem/year