Tennessee Valley Authority, Sequoyah Nuclear Plant, P.O. Box 2000, Soddy Daisy, Tennessee 37384

May 7, 2018

10 CFR 50.4

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

Sequoyah Nuclear Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327, 50-328, 72-034

Subject: **Annual Radiological Environmental Operating Report**

Enclosed is the Annual Radiological Environmental Operating Report for the period of January 1 to December 31, 2017. This report is being submitted as required by the respective Sequoyah Nuclear Plant (SQN), Units 1 and 2, Technical Specification 5.6.1 and SQN's Offsite Dose Calculation Manual Administrative Control Section 5.1, each of which specifies that the report be submitted prior to May 15th of each year.

There are no new regulatory commitments contained in this letter. If you have any questions concerning this matter, please contact Mr. Mike McBrearty at (423) 843-7170.

Respectfully,

Anthony L. Williams
Site Vice President
Sequoyah Nuclear Plant

Enclosure:
Annual Radiological Environmental Operating Report, Sequoyah Nuclear Plant, 2017

cc (Enclosure):

NRC Regional Administrator – Region II
NRC Resident Inspector – Sequoyah Nuclear Plant

ENCLOSURE

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT
SEQUOYAH NUCLEAR PLANT
2017

Annual Radiological Environmental Operating Report

Sequoyah Nuclear Plant 2017

Tennessee Valley Authority

May 2018

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EXECUTIVE SUMMARY

This report describes the Radiological Environmental Monitoring Program (REMP) conducted by the Tennessee Valley Authority (TVA) near the Sequoyah Nuclear Plant (SQN) during the 2017 monitoring period. The program is conducted in accordance with regulatory requirements to monitor the environment per 10 CFR 20, 10 CFR 50, and TVA procedures. The REMP includes the collection and subsequent determination of radioactive material content in environmental samples. Various types of samples are collected within the vicinity of the plant, including air, water, food crops, soil, fish and shoreline sediment, and direct radiation levels are measured. The radiation levels of these samples are measured and compared with results at control stations located outside the plant's vicinity and data collected at Sequoyah Nuclear Plant prior to operations (preoperational data). This report contains an evaluation of the potential impact of SQN operations on the environment and the general public.

Most of the radioactivity measured in environmental samples in the SQN program can be attributed to naturally occurring radioactive materials. In 2017, trace quantities of Cesium-137 (Cs-137) were measured in soil and fish samples. The concentrations were typical of the levels expected to be present in the environment from past nuclear weapons testing. The fallout from accidents at the Chernobyl plant in the Ukraine in 1986 and the Fukushima plant in Japan in 2011 may have also contributed to the low levels of Cs-137 measured in environmental samples. Tritium (H-3) was detected in some surface water, public drinking water and well water samples in 2017. Similar levels of tritium were detected in both control and indicator locations, indicating that any plant contribution to the natural background level is small. The measured levels were a small fraction of the EPA drinking water limit These levels of radioactive elements detected do not represent a significant contribution to the radiation exposure to members of the public.

INTRODUCTION

This report describes and summarizes the results of radioactivity measurements made near SQN and laboratory analyses of samples collected in the area. The measurements are made to comply with the requirements of 10 CFR 50, Appendix A, Criterion 64 and 10 CFR 50, Appendix I, Section IV.B.2, IV.B.3 and IV.C and to determine potential effects on public health and safety. This report satisfies the annual reporting requirements of SQN Technical Specification (TS) 5.6.1 and Offsite Dose Calculation Manual (ODCM) Administrative Control 5.1. In addition to reporting the data prescribed by specific requirements, other information is included to help correlate the significance of results measured by this monitoring program to the levels of environmental radiation resulting from naturally occurring radioactive materials.

Naturally Occurring and Background Radioactivity

Most materials in our world today contain trace amounts of naturally occurring radioactive materials. Potassium -40 (K-40), with a half-life of 1.3 billion years, is one of the most common radioactive materials found naturally in our environment. Approximately 0.01 percent of all potassium is radioactive K-40. Other examples of naturally occurring radioactive materials include isotopes of beryllium, bismuth, lead, thallium, thorium, uranium and radium, among others. Carbon-14 (C-14) and Hydrogen-3 (H-3, commonly called tritium) exist in the environment naturally but also as a result of nuclear power plant operations. These naturally occurring radioactive materials are in the soil, our food, our drinking water, and our bodies. The radiation from these materials makes up a part of the low-level natural background radiation. The remainder of the natural background radiation results from cosmic rays.

It is possible to get an idea of the relative hazard of different types of radiation sources by evaluating the amount of radiation the U.S. population receives from each general type of radiation source. The information below is primarily adapted from Reference 1 and Reference 2.

Table 1 - U.S. General Population Average Dose Equivalent Estimates

Source	millirem (mrem)[i] per Year per Person
Natural Background Dose Equivalent	
Cosmic	33
Terrestrial	21
In the body	29
Radon	228
Total	311
Medical (effective dose equivalent)	300
Nuclear energy	0.28
Consumer Products	13
TOTAL	624.28

[i] One-thousandth of a Roentgen Equivalent Man (rem). By comparison, the NRC's annual radiation dose limit for the public from any licensed activity, such as a nuclear plant, is 100 mrem

As can be seen from the data presented above, natural background radiation dose equivalent to the U.S. population exceeds that normally received from nuclear plants by several hundred times. Nuclear plant operations normally cause an insignificant dose when compared to the dose from natural background radiation. It should be noted that the use of radiation and radioactive materials for medical uses has resulted in a similar effective dose equivalent to the U.S. population as that caused by natural background cosmic and terrestrial radiation.

Electric Power Production

Nuclear power plants are similar in many respects to conventional coal burning (or other fossil fuel) electrical generating plants. The basic process behind electrical power production in power plants is that fuel is used to heat water to produce steam which provides the force to turn turbines and generators. In a nuclear power plant, the fuel is uranium and heat is produced in the reactor through the fission of the uranium. Nuclear plants include many complex systems to control the nuclear fission process and to safeguard against the possibility of reactor malfunction. The nuclear reactions produce radionuclides commonly referred to as fission and activation products. Very small amounts of these fission and activation products are released into the plant systems. This radioactive material can be transported throughout plant systems and some of it may be released to the environment.

Paths through which radioactivity from a nuclear power plant is routinely released are monitored. Liquid and gaseous effluent monitors record the radiation levels for each release. These monitors also provide alarm mechanisms to prompt termination of any release above limits.

Releases are monitored at the onsite points of release. The radiological environmental monitoring program, which measures the environmental radiation in areas around the plant, provides a confirmation

that releases are being properly controlled and monitored in the plant and that any resulting levels in the environment are within the established regulatory limits and a small fraction of the natural background radiation levels. In this way, the release of radioactive materials from the plant is tightly controlled, and verification is provided that the public is not exposed to significant levels of radiation or radioactive materials as the result of plant operations.

The SQN ODCM, which describes the program required by the plant technical specifications, prescribes limits for the release of radioactive effluents, as well as limits for doses to the general public from the release of these effluents.

The NRC's annual dose limit to a member of the public for all licensees is 100 mrem. The NRC's regulations for nuclear power plants require implementing a philosophy of "as low as reasonably achievable," where the dose to a member of the public from radioactive materials released to unrestricted areas is limited as follows:

Liquid Effluents

Total body	≤ 3 mrem/yr
Any organ	≤ 10 mrem/yr

Gaseous Effluents

Noble gases:

Gamma radiation	≤ 10 millirad (mrad)/yr
Beta radiation	≤ 20 mrad/yr

Particulates:

Any organ	≤ 15 mrem/yr

In addition to the NRC's regulations, the EPA limits the total dose to a member of the public due to nuclear fuel cycle facilities, including nuclear power plants. These limits, established in the Environmental Dose Standard of 40 CFR 190, are as follows:

Total body	≤ 25 mrem/yr
Thyroid	≤ 75 mrem/yr
Any other organ	≤ 25 mrem/yr

Appendix B to 10 CFR 20 presents annual average limits for the concentrations of radioactive materials released in gaseous and liquid effluents at the boundary of the unrestricted areas. Appendix E Table 6 of this report presents those limits for principal radionuclides associated with nuclear power plant effluents. The table also presents the concentrations of radioactive materials in the environment which would require a special report to the NRC and the nominal detection limits for those radionuclides. It should be noted that the levels of radioactive materials measured in the environment are typically below or only slightly above the nominal lower limit of detection.

SITE AND PLANT DESCRIPTION

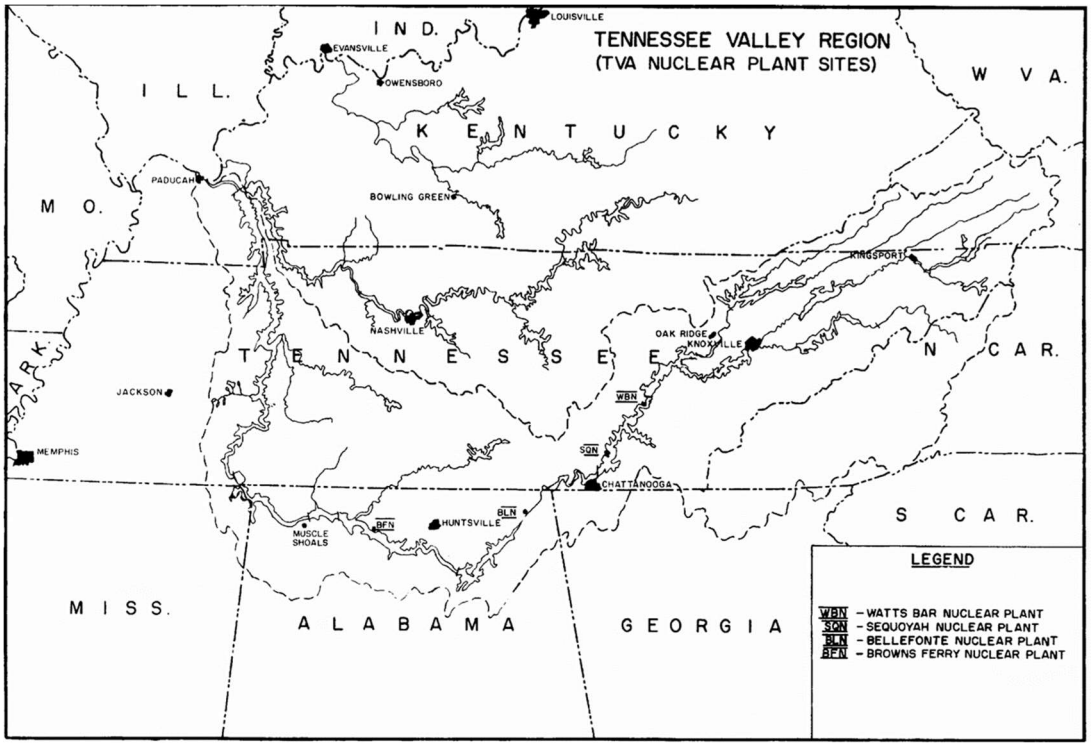
Sequoyah is located on a site near the geographical center of Hamilton County, Tennessee, on a peninsula on the western shore of Chickamauga Lake at Tennessee River Mile (TRM) 484.5. Figure 1 shows the site in relation to other TVA projects. The SQN site, containing approximately 525 acres, is approximately 7.5 miles northeast of the nearest city limit of Chattanooga, Tennessee, 14 miles west-northwest of Cleveland, Tennessee, and approximately 31 miles south-southwest of TVA's Watts Bar Nuclear Plant (WBN) site.

Population is distributed unevenly within 10 miles of the SQN site. Approximately 60 percent of the population is in the general area between 5 and 10 miles from the plant in the sectors ranging from the south, clockwise, to the northwest sector. This concentration is a reflection of suburban Chattanooga and the town of Soddy-Daisy. This area is characterized by considerable vacant land with scattered residential subdivisions. Residential subdivision growth has continued within the 10-mile radius of the plant. There is also some small-scale farming located within 5 miles of the plant.

Chickamauga Reservoir is one of a series of highly controlled multiple-use reservoirs located on the Tennessee River whose primary uses are flood control, navigation, and the generation of electric power. Secondary uses include industrial and public water supply and waste disposal, commercial fishing, and recreation. Public access areas, boat docks, and residential subdivisions have been developed along the reservoir shoreline.

SQN consists of two pressurized water reactors. Fuel was loaded in Unit 1 on March 1, 1980, and the unit achieved criticality on July 5, 1980. Fuel was loaded in Unit 2 in July 1981, and the unit achieved initial criticality on November 5, 1981.

Figure 1 – Tennessee Valley Region



RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Most of the radiation and radioactivity generated in a nuclear power reactor is contained within the reactor systems. Plant effluent radiation monitors are designed to monitor radionuclides released to the environment. Environmental monitoring is a final verification that the systems are performing as planned. The monitoring program is designed to monitor the pathways between the plant and the people in the immediate vicinity of the plant. Sample types are chosen so that the potential for detection of radioactivity in the environment will be maximized. The Radiological Environmental Monitoring Program (REMP) and sampling locations for SQN are outlined in Appendix A.

There are two primary pathways by which radioactivity can move through the environment to humans: air and water (see Figure 2). The air pathway can be separated into two components: the direct (airborne) pathway and the indirect (ground or terrestrial) pathway. The direct airborne pathway consists of direct radiation and inhalation by humans. In the terrestrial pathway, radioactive materials may be deposited on the ground or on plants and subsequently ingested by animals and/or humans. Human exposure through the liquid pathway may result from drinking water, eating fish, or by direct exposure at the shoreline. The types of samples collected in this program are designed to monitor these pathways.

Many factors were considered in determining the locations for collecting environmental samples. The locations for the atmospheric monitoring stations were determined from a critical pathway analysis based on weather patterns, dose projections, population distribution, and land use. Terrestrial sampling stations were selected after reviewing such things as the locations of dairy animals and gardens in conjunction with the air pathway analysis. Liquid pathway stations were selected based on dose projections, water use information, and availability of media such as fish and sediment. Table 4 lists the sampling stations and the types of samples collected from each. Modifications made to the SQN monitoring program in 2017 are reported in Appendix B. Deviations to the sampling program during 2017 are included in Appendix C.

To determine the amount of radioactivity in the environment prior to the operation of SQN, a preoperational radiological environmental monitoring program was initiated in 1971 and operated until the plant began operation in 1980. Measurements of the same types of radioactive materials that are measured currently were assessed during the preoperational phase to establish normal background levels for various radionuclides in the environment.

The preoperational monitoring program is a very important part of the overall program. During the 1950s, 1960s, and 1970s, atmospheric nuclear weapons testing released radioactive material to the environment causing increases in background radiation levels. Knowledge of preexisting radionuclide patterns in the environment permits a determination, through comparison and trending analyses, of the actual environmental impact of SQN operation.

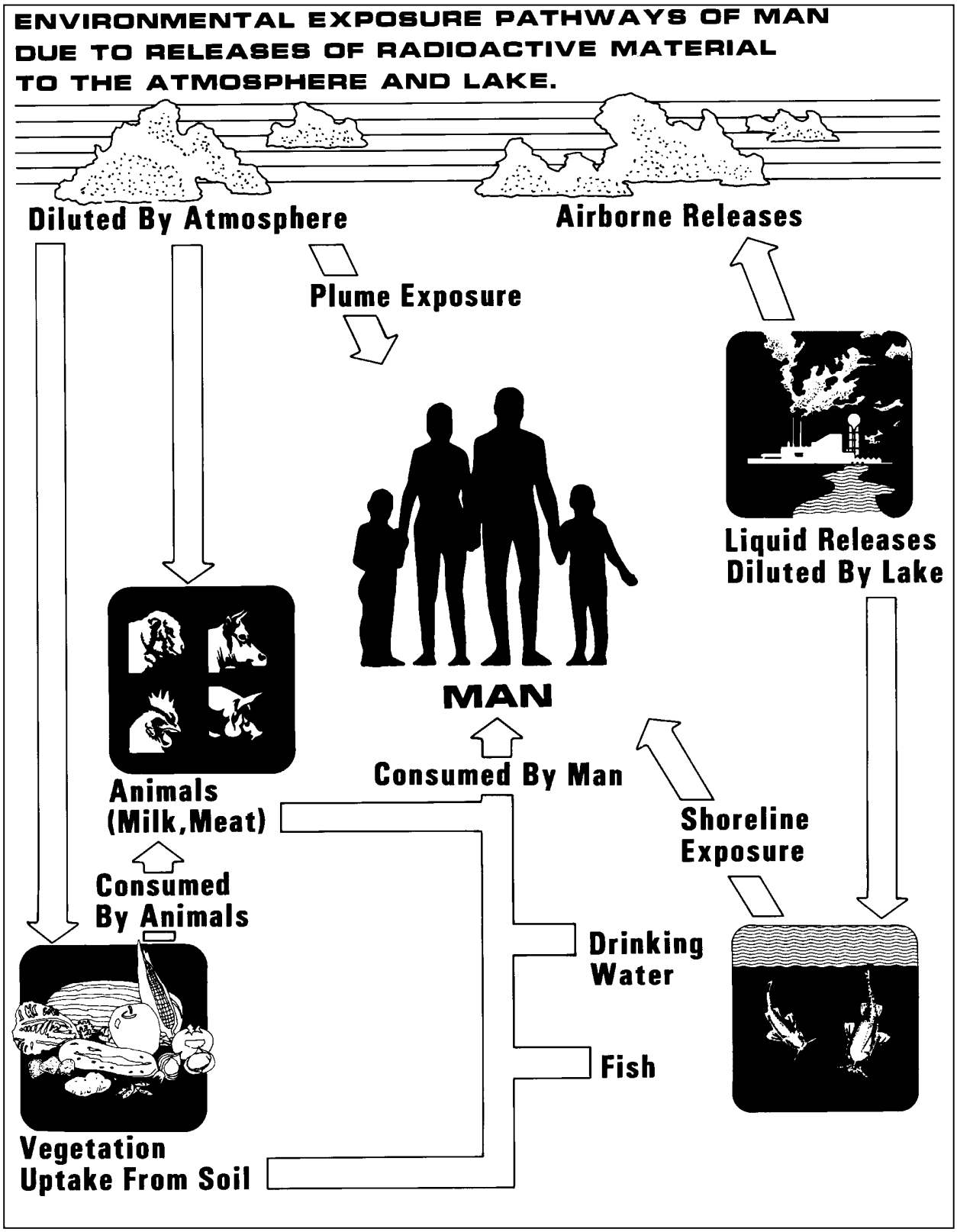
The determination of environmental impact during the operating phase also considers the presence of control stations that have been established in the environment. Results of environmental samples taken at control stations (far from the plant) are compared with those from indicator stations (near the plant) to aid in the determination of the impacts from SQN operation.

In 2017, the sample analysis was performed by two separate laboratories. Samples collected prior to June 30, 2017 were analyzed by Tennessee Valley Authority's (TVA's) Environmental Radiological Monitoring and Instrumentation (ERM&I) group located at the Western Area Radiological Laboratory (WARL) in Muscle Shoals, Alabama, except for the Strontium-89/90 (Sr-89, Sr-90) analysis of soil samples which is performed by a contract laboratory. Beginning in July 2017, GEL Laboratories, LLC, based in Charleston, SC performed all the radiochemistry analyses of the SQN REMP samples. Analyses are conducted in accordance with written and approved procedures and are based on industry established standard analytical methods. A summary of the analysis techniques and methodology is presented in Appendix D.

The radiation detection devices and analysis methods used to determine the radionuclide content of samples collected in the environment are very sensitive and capable of detecting small amounts of radioactivity. The sensitivity of the measurement process is defined in terms of the lower limit of detection (LLD). A description of the nominal LLDs for the ERM&I laboratory and GEL is presented in Appendix E.

Each laboratory applies a comprehensive quality assurance (QA)/quality control (QC) program to monitor laboratory performance throughout the year. One of the key purposes of the QA/QC program is to provide early identification of any problems in the measurement process so they can be corrected in a timely manner. This program includes instrument checks and QC sample analysis to ensure that the radiation detection instruments are functioning and being used properly. As part of an interlaboratory comparison program, the laboratory participated in a blind sample program administrated by Eckert & Ziegler Analytics. A complete description of the program is presented in Appendix F. Data tables summarizing the sample analysis results are presented in Appendix H.

Figure 2 – Environmental Exposure Pathways



DIRECT RADIATION MONITORING

Direct radiation levels are measured at various monitoring points around the plant site. These measurements include contributions from cosmic radiation, radioactivity in the ground, fallout from atmospheric nuclear weapons tests conducted in the past, and any radioactivity that may be present from plant operations. Because of the relatively large variations in background radiation as compared to the small levels from the plant, contributions from the plant may be difficult to distinguish.

Measurement Techniques

The Landauer InLight environmental dosimeter is used in the radiological environmental monitoring program for the measurement of direct radiation. This dosimeter contains four elements consisting of aluminum oxide detectors with open windows as well as plastic and copper filters. The dosimeter is processed using optically stimulated luminescence (OSL) technology to determine the amount of radiation exposure.

The dosimeters are placed approximately one meter above the ground, with two at each monitoring location. Sixteen monitoring points are located around the plant near the site boundary, one location in each of the 16 compass sectors. One monitoring point is also located in each of the 16 compass sectors at a distance of approximately four to five miles from the plant.

Dosimeters are also placed at additional monitoring locations out to approximately 32 miles from the site. The dosimeters are exchanged every three months. The dosimeters are sent to Landauer InLight for processing and results reporting. The values are corrected for transit and shielded background exposure. An average of the two dosimeter results is calculated for each monitoring point. The system meets or exceeds the performance specifications outlined in American National Standards Institute (ANSI) N545-1975 and Health Physics Society (HPS) Draft Standard N13.29 for environmental applications of dosimeters.

Results

The results for environmental dosimeter measurements are normalized to a standard quarter (91.25 days or 2190 hours). The monitoring locations are grouped according to the distance from the plant. The first group consists of all monitoring points within 2 miles of the plant. The second group is made up of all locations greater than 2 miles from the plant. Past data have shown that the average results from the locations more than 2 miles from the plant are essentially the same. Therefore, for purposes of this report, monitoring points 2 miles or less from the plant are identified as “onsite” stations and locations greater than 2 miles are considered “offsite.”

The quarterly and annual gamma radiation levels determined from the dosimeters deployed around SQN in 2017 are summarized in Table 2. For comparison purposes, the average direct radiation measurements made in the preoperational phase of the monitoring program are also shown.

Table 2 - Average External Gamma Radiation Levels at Various Distances from Sequoyah Nuclear Plant for Each Quarter – 2017[a]

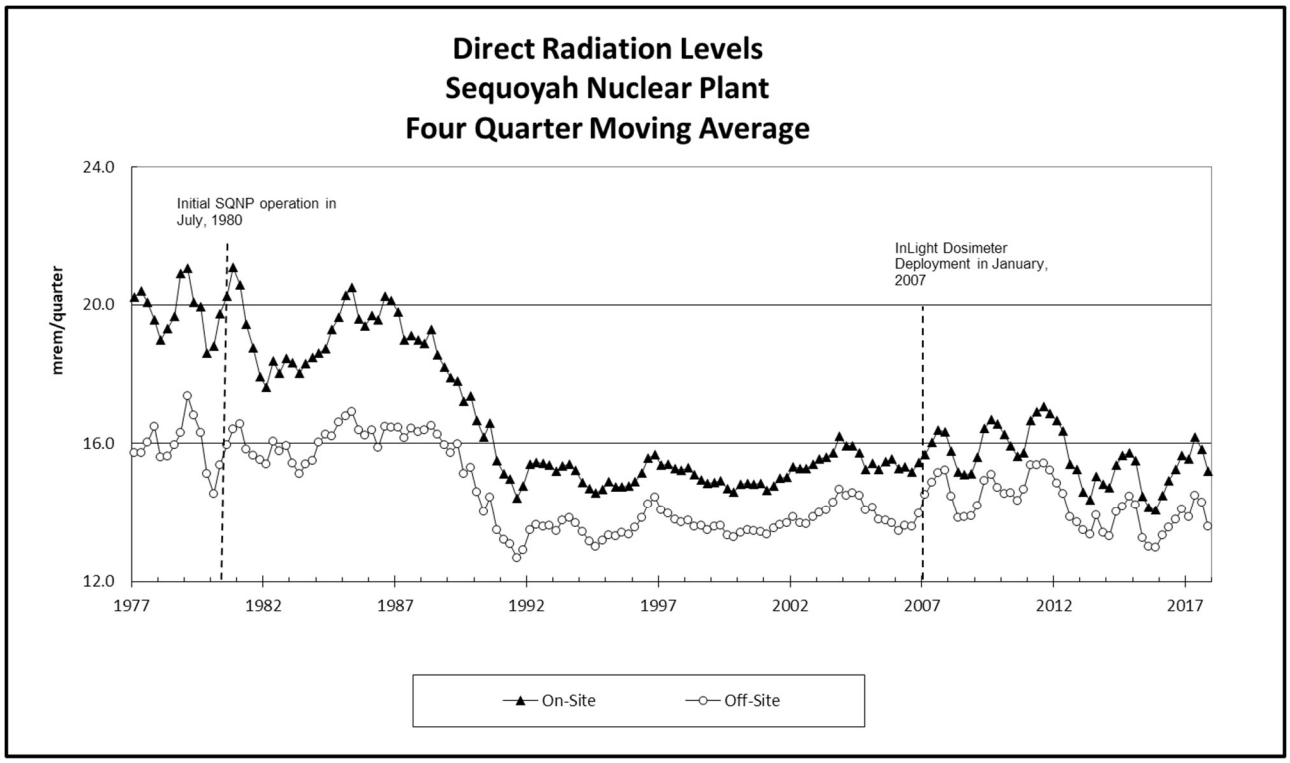
	Average External Gamma Radiation Levels					
	Q1 [a] (mrem/qtr)	Q2 (mrem/qtr)	Q3 (mrem/qtr)	Q4 (mrem/qtr)	Annual (mrem/yr)	Preoperational (mR/yr)
Average 0-2 miles (onsite)[b]	14.7	17.5	15.6	13.1	60.8[c]	79
Average >2 miles (offsite)[b]	12.7	15.9	14.4	11.4	54.4	63

NOTES

a. Field periods normalized to one standard quarter (2190 hours)
b. Average of the individual measurements in the set
c. The 6.4 mrem/yr excess for onsite locations falls below the 25 mrem total body limit for 40 CFR 190.

The data in Table 2 indicates that the average quarterly direct radiation levels at the SQN onsite stations are approximately 1.6 mrem/quarter higher than levels at the offsite stations. This equates to 6.4 mrem/year detected at the onsite locations. This value falls below the EPA limit of 25 mrem/year total body. The difference in onsite and offsite averages is consistent with levels measured for the preoperational and construction phases of TVA nuclear power plant sites where the average levels onsite were slightly higher than levels offsite. Figure 3 compares plots of the data from the onsite stations with those from the offsite stations over the period from 1977 through 2017. The new Landauer InLight Optically Stimulated Luminescence (OSL) dosimeters were deployed since 2007 replacing the Panasonic UD-814 dosimeters used during the previous years.

Figure 3 – Average Quarterly Direct Radiation



The data in Table 12 contain the results of the individual monitoring stations. The results reported in 2017 are consistent with historical and preoperational results, indicating that the direct radiation levels are not influenced by the operation of SQN. There is no indication that SQN activities increased the background radiation levels normally observed in the areas surrounding the plant.

ATMOSPHERIC MONITORING

The atmospheric monitoring network is divided into three groups identified as local, perimeter, and remote. Four local air monitoring stations are located on or adjacent to the plant site in the general directions of greatest wind frequency. Four perimeter air monitoring stations are located between 6 to 11 miles from the plant, and two air monitors are located out to 15 miles and used as control or baseline stations. The monitoring program and the locations of monitoring stations are identified in the tables and figures of Appendix A.

Results from the analysis of samples in the atmospheric pathway are presented in Table 13, Table 14 and Table 15. Radioactivity levels identified in this reporting period are consistent with background and preoperational program data. There is no indication of an increase in atmospheric radioactivity due to SQN operations.

Sample Collection and Analysis

Air particulates are collected by continuously sampling air at a flow rate of approximately 2 cubic feet per minute (cfm) through a 2-inch glass fiber filter. The sampling system consists of a Vacuum Florescent Display (VFD), a brushless motor, and a precision-machined mechanical differential pressure flow sensor. It is equipped with automatic flow control, on-board data storage, and various alarm notifications. This system is housed in a weather resistant environmental enclosure approximately 3 feet by 2 feet by 4 feet. The filter is contained in a sampling head mounted on the outside of the monitoring building. The filter is replaced weekly. Each filter is analyzed for gross beta activity about 3 days after collection to allow time for the radon daughters to decay. Every 4 weeks composites of the filters from each location are analyzed by gamma spectroscopy.

Gaseous radioiodine is sampled using a commercially available cartridge containing Triethylenediamine (TEDA)-impregnated charcoal. This system is designed to collect iodine in both the elemental form and as organic compounds. The cartridge is in the same sampling head and downstream of the air particulate filter. The cartridge is changed at the same time as the particulate filter and samples the same volume of air. Each cartridge is analyzed for I-131 by gamma spectroscopy.

Results

The results from the analysis of air particulate samples are summarized in Table 13. Gross beta activity in 2017 was consistent with levels reported in previous years. The average gross beta activity measured for air particulate samples was 0.027 pCi/m^3. The annual averages of the gross beta activity in air particulate filters at these stations for the period 1977-2017 are presented in Figure 7. Increased levels due to fallout from atmospheric nuclear weapons testing are evident in the years prior to 1981 and a small increase from the Chernobyl accident can be seen in 1986. These patterns are consistent with data from monitoring programs conducted by TVA at other nuclear power plant construction sites. In 2017, the annual average gross beta particulate activity has increased slightly, but the levels are still far below historical values.

Only natural radioactive materials were identified by the monthly gamma spectral analysis of the air particulate samples. As shown in Table 14, I-131 was not detected in any charcoal cartridge samples collected in 2017.

TERRESTRIAL MONITORING

Terrestrial monitoring is accomplished by collecting samples of environmental media that may transport radioactive material from the atmosphere to humans. For example, radioactive material may be deposited on a vegetable garden and be ingested along with the vegetables or it may be deposited on pasture grass where dairy cattle are grazing. When the cow ingests the radioactive material, some of it may be transferred to the milk and consumed by humans who drink the milk. Therefore, samples of milk, soil, and food crops are collected and analyzed to determine potential impacts from exposure through this pathway. The results from the analysis of these samples are shown in Table 16 and Table 17.

A land use survey is conducted annually between April and October to identify the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of 16 meteorological sectors within 5 miles from the plant. This land use survey satisfies the requirements 10 CFR 50, Appendix I, Section IV.B.3. From data produced by the land use survey, radiation doses are projected for individuals living near the plant. Doses from air submersion are calculated for the nearest residence in each sector, while doses from drinking milk or eating foods produced near the plant are calculated for the areas with milk-producing animals and gardens, respectively. These dose projections are hypothetical extremes and do not represent actual doses to the general public. The results of the 2017 land use survey are presented in Appendix G.

Sample Collection and Analysis

In previous years, there was a milk consumption pathway at one location applicable to SQN and was monitored via milk or vegetation samples at the location. In 2017, SQN learned that the milk pathway was no longer applicable. The only milk producing animal had been sold. As a result, SQN is not reporting the results of any milk or vegetation sample analysis for 2017. The land use census will continue to monitor if the milk pathway becomes applicable to SQN again.

Soil samples are collected annually from the air monitoring locations. The samples are collected with either a “cookie cutter” or an auger type sampler. After drying and grinding, the sample is analyzed by gamma spectroscopy and for Sr-89 and Sr-90.

Samples representative of food crops raised in the area near the plant are obtained from individual gardens. Types of foods may vary from year to year due to changes in the local vegetable gardens. Samples of cabbage, corn, pears, potatoes, green beans, and tomatoes were collected from local vegetable gardens and/or farms. Samples of the same food products grown in areas that would not be affected by the plant were obtained from area produce markets as control samples. The edible portion of each sample is analyzed by gamma spectroscopy.

Results

The gamma analysis of soil samples detected trace levels of Cs-137. The concentrations of Cs-137 are consistent with levels previously reported from fallout. All other radionuclides reported were naturally occurring isotopes. No Sr-89 or Sr-90 was identified in SQN soil samples in 2017. The soil analysis data are provided in Table 16.

A plot of the annual average Cs-137 concentrations in soil is presented in Figure 8. The concentrations of Cs-137 in soil are steadily decreasing due to the cessation of weapons testing in the atmosphere, the 30-year half-life of Cs-137 and transport through the environment.

Radionuclides reported in food samples were all naturally occurring. Analysis of these samples indicated no contribution from plant activities. The results are reported in Table 17.

LIQUID PATHWAY MONITORING

Potential exposures from the liquid pathway can occur from drinking water, ingestion of edible fish, or from direct radiation exposure from radioactive materials deposited in the river sediment. The monitoring program includes the collection of samples of surface water, groundwater, drinking water supplies, fish, and shoreline sediment. Samples from the reservoir are collected both upstream and downstream from the plant.

Sample Collection and Analysis

Samples of surface water are collected from the Tennessee River downstream and upstream of the plant using automatic sampling systems. A timer turns on the system at least once every 2 hours and the sample is collected into a composite jug. A 1-gallon sample is removed from the composite jug at 4-week intervals and the remaining water in the jug is discarded. The composite sample is analyzed for gamma emitting radionuclides and gross beta activity. A quarterly composite sample is analyzed for tritium.

Samples are collected by an automatic sampling system at the first downstream drinking water intake and at the water intake for the city of Dayton located approximately 20 miles upstream. At other selected locations, grab samples are collected from drinking water systems which use the Tennessee River as their source. The drinking water samples are analyzed every 4 weeks by gamma spectroscopy and for gross beta activity. A quarterly composite sample from each station is analyzed for tritium. Additional tritium analyses are performed on samples from two of the locations that are shared with the Watts Bar monitoring program. The sample collected at the water intake for the city of Dayton also serves as control sample for surface water.

Groundwater is sampled from an onsite well using an automatic composite sampler and a grab sample is collected quarterly from a private well in an area unaffected by SQN. Gamma spectroscopy and tritium analyses are performed monthly on samples from the onsite well and gross beta analysis is performed on a quarterly composite sample. The samples from the offsite well are analyzed by gamma spectroscopy and for tritium and gross beta activity.

Samples of commercial and game fish species are collected semiannually from each of two reservoirs: the reservoir on which the plant is located (Chickamauga Reservoir) and the upstream reservoir (Watts Bar Reservoir). The samples are collected using a combination of netting techniques and electrofishing. Samples are prepared from filleted fish. After drying and grinding, the samples are analyzed by gamma spectroscopy.

Samples of shoreline sediment are collected from two downstream recreational use areas and one upstream location. The samples are dried and ground and analyzed by gamma spectroscopy.

Results

There were no fission or activation product radionuclides identified from the gamma spectroscopy analyses performed on surface water samples. Tritium activity above the nominal LLD value was measured in samples of surface water. The tritium concentrations in samples from the indicator location averaged 576 pCi/liter and samples from the control location averaged 432 pCi/liter. These tritium concentrations are considered background and represent only a small fraction of the Environmental

Protection Agency (EPA) drinking water limit of 20,000 pCi/liter. The values were consistent with previously reported values. Gross beta activity above the nominal LLD value was measured in some of the surface water samples. The gross beta concentrations in samples from the indicator locations was 2.2 pCi/L. The average gross beta concentration for control locations saw a significant increase to 4.1 pCi/L. This increase is attributed to one verified positive result at the control location of 6.0 pCi/L. Only 2 of 12 control gross beta results were positive, so this greatly skewed the results. All other values were consistent with previously reported levels. A summary table of the results is shown in Table 18.

There were no fission or activation product radionuclides identified by the gamma analysis of drinking water samples. Tritium activity above the nominal LLD value was measured in drinking water samples. The tritium concentrations in samples from the indicator locations averaged 533 pCi/liter and samples from the control location averaged 432 pCi/liter. These tritium levels represented only a small fraction of the EPA drinking water limit of 20,000 pCi/liter. The values were consistent with previously reported values. Average gross beta activity was 2.6 pCi/liter for the downstream stations and 4.1 pCi/liter for the upstream station (which is the same location and samples as discussed above for surface water). The indicator location results were consistent with previously reported values. The results are shown in Table 19.

No fission or activation products were detected by the gamma analyses performed on groundwater samples from the REMP monitoring locations. Tritium was detected in samples collected from the onsite monitoring well at an average of 293 pCi/liter. No gross beta activity was detected for indicator location samples. The average gross beta concentration in samples from the offsite well was 7.8 pCi/liter. These gross beta levels are representative of the levels typically found in groundwater. The results from the analysis of groundwater samples are presented in Table 20.

Cesium-137 was identified in one fish sample collected from the control and one sample collected from the indicator location. The Cs-137 concentration in the control was 0.019 pCi/kg, and in the indicator was 0.018 pCi/kg. All other radionuclides reported were naturally occurring isotopes. The results are summarized in Table 21.

No fission or activation products were detected by the gamma analyses performed on shoreline sediment samples from the REMP monitoring locations. All other radionuclides reported were naturally occurring isotopes. Results from the analysis of shoreline sediment samples are shown in Table 22.

ASSESSMENT AND EVALUATION

Potential doses to the public are estimated from measured effluents using computer models. These models were developed by TVA and are based on methodology provided by the NRC in Regulatory Guide 1.109 for determining the potential dose to individuals and populations living near a nuclear power plant. The results of the effluent dose calculations are reported in the Annual Radioactive Effluent Release Report. The doses calculated are a representation of the dose to a "maximum exposed individual." Some of the factors used in these calculations (such as ingestion rates) are maximum expected values which will tend to overestimate the dose to this "hypothetical" person. The calculated maximum doses due to plant effluents are small fractions of the applicable regulatory limits. In reality, the expected dose to actual individuals is significantly lower.

Based on the very low concentrations of radionuclides actually present in the plant effluents, radioactivity levels measured in the environment as a result of plant operations are expected to be negligible. The results for the radiological environmental monitoring conducted for the SQN 2017 operations confirm this expectation

Results

As stated earlier in this report, the estimated increase in radiation dose equivalent to the general public resulting from the operation of SQN is negligible when compared to the dose from natural background radiation. The results from environmental samples are compared with the concentrations from the corresponding control stations as well as appropriate preoperational and background data to determine influences from the plant. Measurable levels of Cs-137 were detected in fish and soil. The Cs-137 concentrations are consistent with levels identified previously that are the result of fallout from past atmospheric nuclear weapons testing. The low levels of tritium measured in water samples from Chickamauga Reservoir and from the onsite well represented concentrations that were significantly lower than the EPA drinking water limit.

Conclusions

It is concluded from the above analysis of the environmental sampling results and from the trend plots presented that the exposure to members of the general public which may have been attributable to SQN plant operations is negligible. The radioactivity reported herein is primarily the result of fallout or natural background radiation. Any activity which may be present as a result of plant operations does not represent a significant contribution to the radiation exposure to members of the public.

REFERENCES

1. NCRP. (March 2009). *Report No. 160, Ionizing Radiation Exposure of the Population of the United States.* NCRP, Washington, D.C.
2. USNRC. (February 1996). *Instruction Concerning Risks from Occupational Exposure.* USNRC, Washington, D.C.

APPENDIX A RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM AND SAMPLING LOCATIONS

Table 3 - Sequoyah Nuclear Power Plant Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample[a]	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Particulates	4 samples from locations (in different sectors) at or near the site boundary (LM-2, 3, 4 and 5) 4 samples from communities approximately 6-10 miles from plant (PM-2, 3, 8 and 9) 4 samples from control locations > 10 miles from the plant (RM-1, 2, 3 and 4)	Continuous sampler operation with sample collection weekly (more frequently if required by dust loading)	Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample if gross beta > 10 times yearly mean of control sample. Composite at least once per 31 days (by location) for gamma spectroscopy.
b. Radioiodine	Samples from same locations as air particulates	Continuous sample operation with filter collection weekly.	I-131 by gamma spectroscopy on each sample.
c. Soil	Samples from same location as air particulates	Annually	Gamma spectroscopy, Sr-89, Sr-90 annually
2. DIRECT			
a. Dosimeters	2 or more dosimeters placed at or near the site boundary in each of the 16 sectors. 2 or more dosimeters placed at stations located approximately 4 to 5 miles from the plant in each of the 16 sectors. 2 or more dosimeters in other locations of special interest.	Quarterly (once per 92 days)	Gamma dose quarterly (at least once per 92 days)

Exposure Pathway and/or Sample[a]	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface Water	TRM 503.8 TRM 483.4	Collected by automatic sequential-type sampler[c] with composite samples collected over a period of approximately 31 days.	Gross beta and gamma spectroscopy on each sample. Composite for tritium analysis at least once per 92 days.
b. Ground water	1 sample adjacent to the plant (Well #6) 1 sample from ground water source up gradient (Farm HW).	Quarterly (Once per 92 days)	Gross beta, gamma spectroscopy, and tritium analysis of each sample.
c. Drinking Water	1 sample at the first potable surface water supplies, downstream from the plant (TRM 473.0). 1 sample at the next 2 downstream potable water systems (greater than 10 miles downstream) (TRM 469.9 and TRM 465.3) 1 sample at a control location (TRM 503.8)[d]	Monthly (once per 31 days)	Gross beta and gamma scan of each sample. Composite for tritium once per 92 days.
d. Shoreline Sediment	TRM 485 TRM 480 TRM 479	Semi-Annually (at least once per 184 days)	Gamma spectroscopy of each sample
4. INGESTION			
a. Milk	N/A. As of 2017, the milk pathway is not applicable to SQN.	Once per 15 days	I-131 and gamma spectroscopy on each sample. Sr-89 and Sr-90 quarterly.

Exposure Pathway and/or Sample[a]	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
b. Fish	One sample of commercially important species and one sample of recreationally important species. One sample of each species from Chickamauga and Watts Bar Reservoirs.	Semi-Annually (at least once per 184 days)	Gamma spectroscopy on edible portions
c. Vegetation[e] (Pasturage and grass)	Samples from farms producing milk but not providing a milk sample	Monthly (at least once per 31 days)	I-131 analysis and gamma spectroscopy of each sample
d. Food Products	1 sample of each principal food products grown at private gardens and/or farms in the immediate vicinity of the plant. 1 sample of each of the same foods grown at greater than 10 miles distance from the plant.	Annually at time of harvest. The types of foods available for sampling will vary. Typically available foods may include: • Cabbage • Corn • Green Beans • Potatoes • Tomatoes	Gamma spectroscopy on edible portions

[a] The sampling program outlined in this table is that which was in effect at the end of 2017.
[b] Sample locations are shown on Figure 4 through Figure 6.
[c] Samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours
[d] The samples collected at TRMs 503.8 are taken from the raw water supply, therefore, the upstream surface water sample will be considered the control sample for drinking water.
[e] Vegetation sampling is applicable only for farms that meet the criteria for milk sampling and when milk sampling cannot be performed

Table 4 - Sequoyah Nuclear Power Plant REMP Sampling Locations

Map Location Number[a]	Station	Sector	Distance (miles)	Indicator (I) or Control (C)	Samples Collected[b]
2	LM-2	N	0.7	I	AP,CF,S
3	LM-3	SSW	2.0	I	AP,CF,S
4	LM-4	NE	1.5	I	AP,CF,S
5	LM-5	NNE	1.8	I	AP,CF,S
7	PM-2	SW	3.8	I	AP,CF,S
8	PM-3	W	5.6	I	AP,CF,S
9	PM-8	SSW	8.7	I	AP,CF,S
10	PM-9	WSW	2.6	I	AP,CF,S
11	RM-1	SW	16.7	C	AP,CF,S
12	RM-2	NNE	17.8	C	AP,CF,S
13	RM-3	ESE	11.3	C	AP,CF,S
14	RM-4	NW	20.0	C	AP,CF,S
19	Farm HW	NW	1.2	I	W[c]
24	Well No. 6	NNE	0.15	I	W
31	TRM 473.0 (East Side Utilities)[c]	--	10.7[d]	I	PW
32	TRM 469.9 (E. I. DuPont)	--	13.8	I	PW
33	TRM 465.3 (Chattanooga)	--	18.4	I	PW
35	TRM 503.8 (Dayton)	--	20.1	C	PW,SW
37	TRM 485.0	--	1.3	C	SS
38	TRM 483.4	--	0.3	I	SW
40	TRM 479.0	--	4.7	I	SS
44	TRM 480.0	--	3.7	I	SS
46	Chickamauga Reservoir (TRM 471-530)	--	--	I	F
47	Watts Bar Reservoir (TRM 530-602)	--	--	C	F

[a] See Figure 4 through Figure 6

[b] Sample Codes:

AM =	Atmospheric moisture	PW =	Public water	SS =	Shoreline sediment
AP =	Air particulate filter	PS =	Pond sediment	SW =	Surface water
F =	Fish	S =	Soil	W =	Well water
M =	Milk				

[c] Also a control for well water

[d] Distance from plant discharge (TRM 483.7)

Table 5 - Sequoyah Nuclear Power Plant Environmental Dosimeter Locations

Map Location Number[a]	Station	Sector	Distance (miles)	Onsite or Offsite[b]
3	SSW-1C	SSW	2.0	off
4	NE-1A	NE	1.5	onsite
5	NNE-1	NNE	1.8	onsite
7	SW-2	SW	3.8	off
8	W-3	W	5.6	off
9	SSW-3	SSW	8.7	off
10	WSW-2A	WSW	2.6	off
11	SW-3	SW	16.7	off
12	NNE-4	NNE	17.8	off
13	ESE-3	ESE	11.3	off
14	NW-3	NW	20.0	off
49	N-1	N	0.6	onsite
50	N-2	N	2.1	off
51	N-3	N	5.2	off
52	N-4	N	10.0	off
53	NNE-2	NNE	5.3	off
55	NE-1	NE	2.4	off
56	NE-2	NE	4.1	off
57	ENE-1	ENE	0.2	onsite
58	ENE-2	ENE	5.1	off
59	E-1	E	1.2	onsite
60	E-2	E	5.2	off
62	ESE-1	ESE	1.2	onsite
63	ESE-2	ESE	4.9	off
66	SE-1	SE	1.4	onsite
67	SE-2	SE	1.9	onsite
68	SE-4	SE	5.2	off
69	SSE-1	SSE	1.6	onsite
70	SSE-2	SSE	4.6	off
71	S-1	S	1.5	onsite
72	S-2	S	4.7	off
73	SSW-1	SSW	0.6	onsite
74	SSW-2	SSW	4.0	off
75	SW-1	SW	0.7	onsite
76	WSW-1	WSW	0.9	onsite
77	WSW-2	WSW	2.5	off
78	WSW-3	WSW	5.7	off
79	WSW-4	WSW	7.8	off
81	W-1	W	0.6	onsite
82	W-2	W	4.3	off
83	WNW-1	WNW	0.4	onsite
84	WNW-2	WNW	5.3	off
85	NW-1	NW	0.4	onsite

Map Location Number[a]	Station	Sector	Distance (miles)	Onsite or Offsite[b]
86	NW-2	NW	5.2	off
87	NNW-1	NNW	0.6	onsite
88	NNW-2	NNW	1.7	onsite
89	NNW-3	NNW	5.3	off
90	SSW-1B	SSW	1.5	onsite

[a] See Figure 4 through Figure 6

[b] Dosimeters designated “onsite” are located 2 miles or less from the plant; “offsite” are located more than 2 miles from the plant

Figure 4 - Radiological Environmental Sampling Locations Within 1 Mile of the Plant

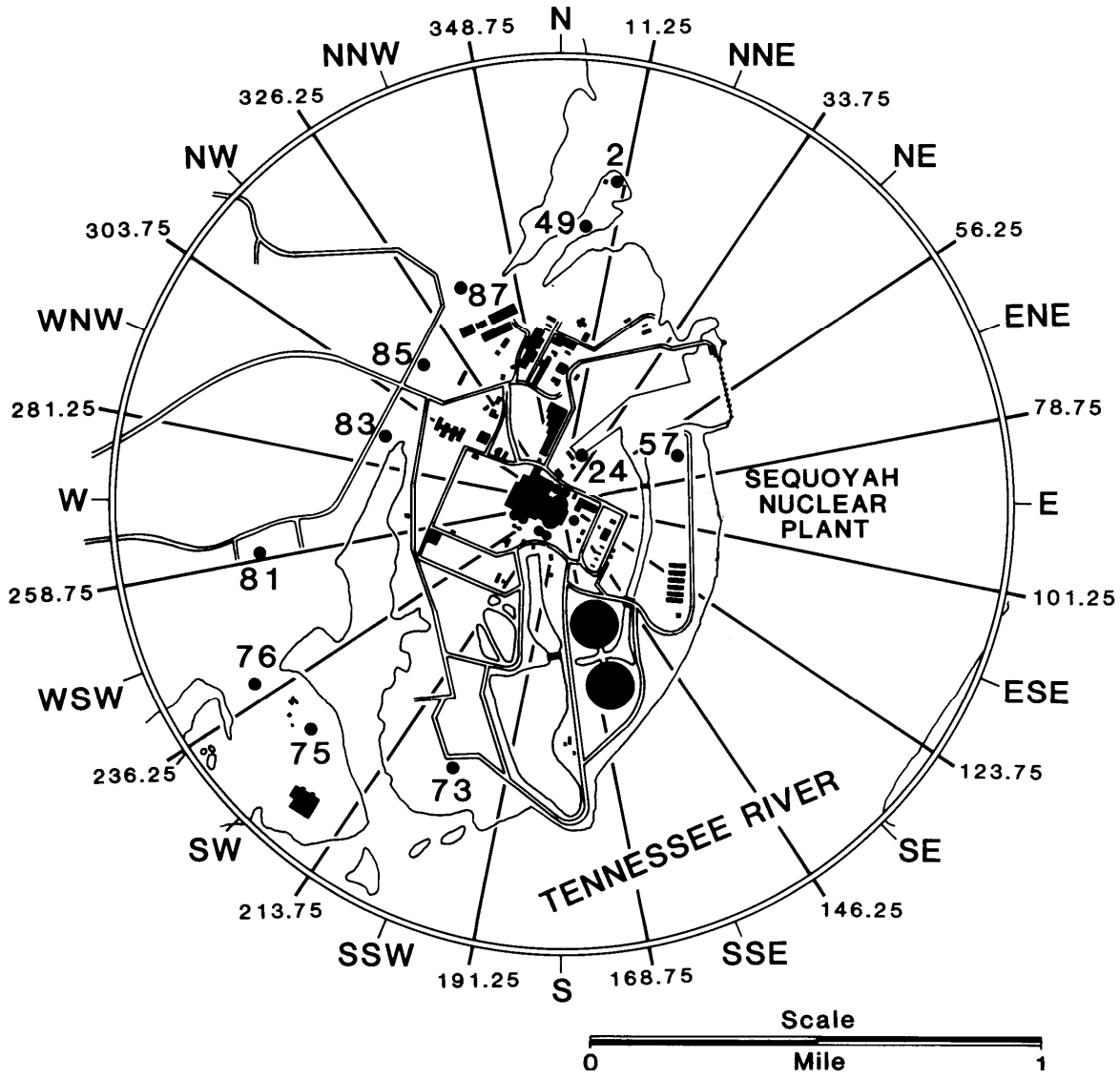


Figure 5 - Radiological Environmental Sampling Locations from 1 to 5 Miles from the Plant

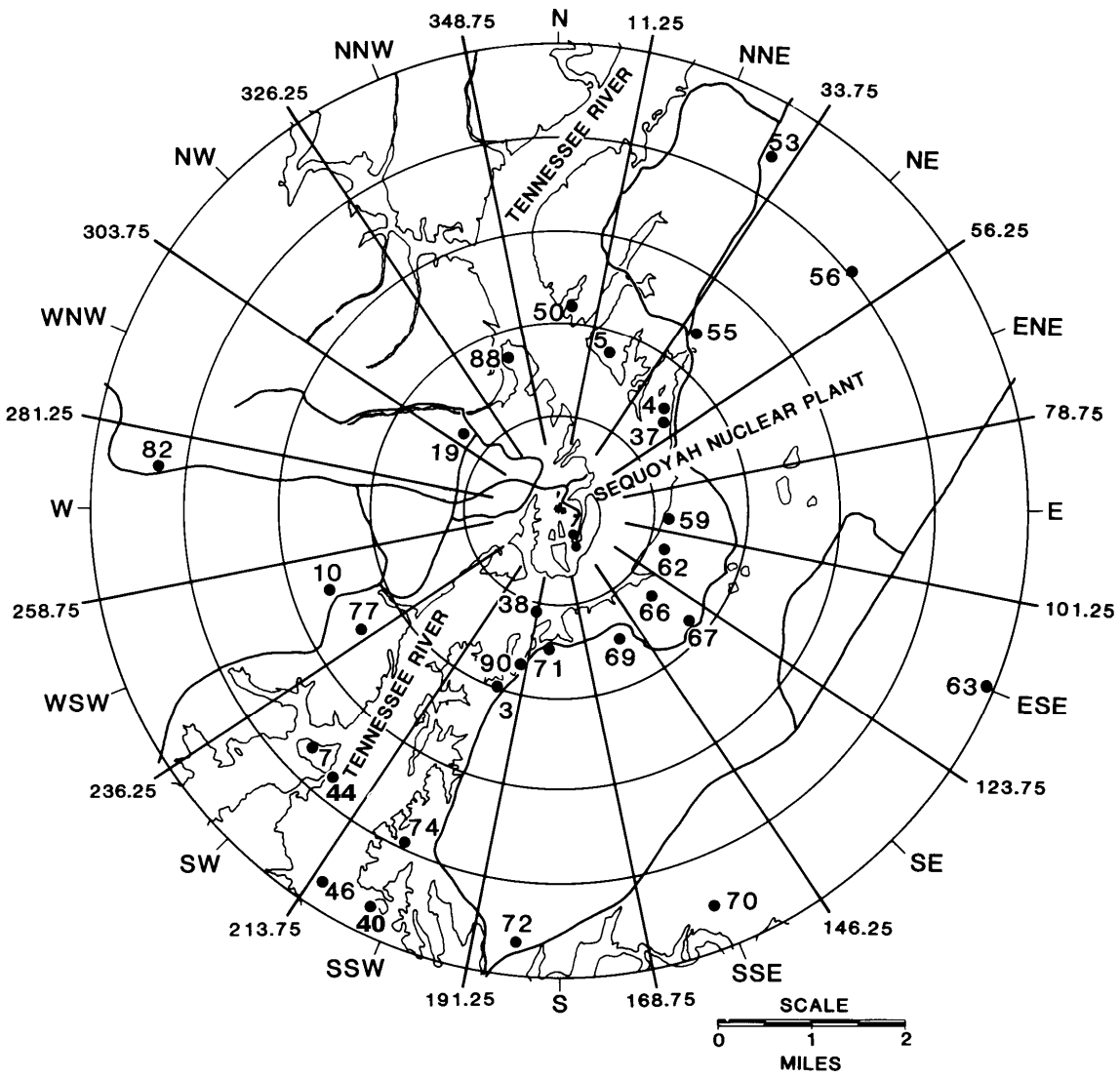
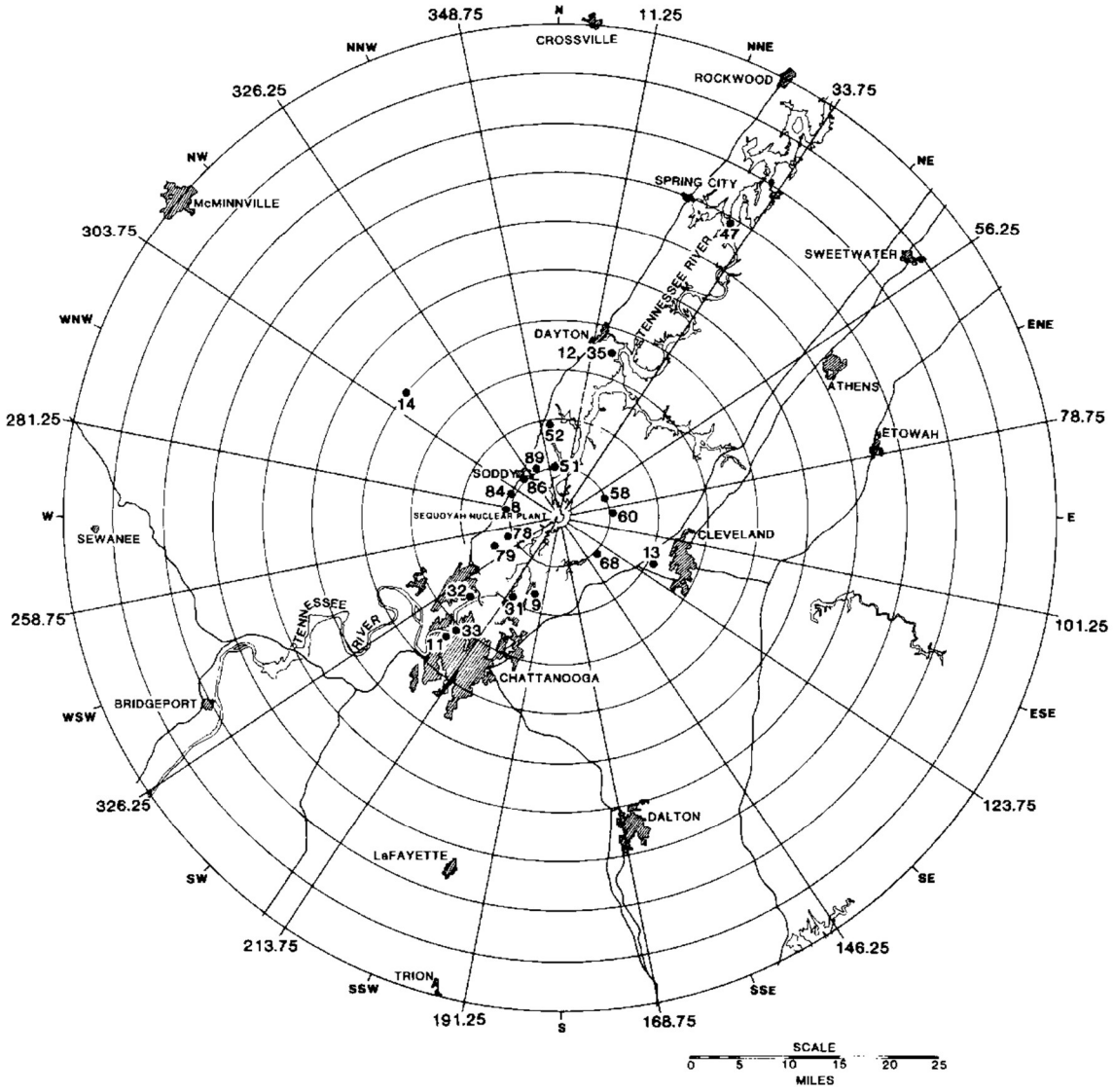


Figure 6 - Radiological Environmental Sampling Locations Greater Than 5 Miles from the Plant



APPENDIX B PROGRAM MODIFICATIONS

Radiological Environmental Monitoring Program Modifications

In 2017, the milk pathway was not applicable to Sequoyah. Previously, milk was sampled at the Walker Farm, but in 2017 the cow was sold and there was no human consumption of milk produced at the farm. The land use census did not identify any other locations where milk was consumed around SQN.

Future land use census' will identify if the milk pathway becomes applicable again, at which time milk sampling will be returned to the REMP.

After June 2017, GEL Laboratories LLC began performing all radioanalytical services in support of the Sequoyah REMP, replacing TVA's Western Areal Radiological Laboratory (WARL) based in Muscle Shoals, AL.

APPENDIX C PROGRAM DEVIATIONS

Program Deviations

Media	Location	Date	CR	Issue
Air Filter	PM-3 2107	3/14/17	1270140	Both the normal REMP charcoal/particulate sample and the QC particulate sample from station 2107 (PM-3) were less than 250 m^3 volume and are considered a missed sample. It was noted that the monitor was turned off for maintenance to prevent pump from burning up.
Charcoal Filter	PM-3 2107	3/14/17	1270140	Both the normal REMP charcoal/particulate sample and the QC particulate sample from station 2107 (PM-3) were less than 250 CU. M. volume and are considered a missed sample. It was noted that the monitor was turned off for maintenance to prevent pump from burning up.
Public Drinking Water	TRM 473, East Side Utilities 2140	1/16/2017	1252083	Sampler was not working on mid cycle check. Station was not repaired by sample collection date so sample was missed. Sampler was repaired by the time of the next sample.
		July – Nov. 2017	1383005	Five drinking water samples were collected from July to November 2017 from TRM 473. These samples were not promptly analyzed via gamma scan. The samples were retained by the laboratory, so upon identification, they were analyzed in January 2018. No plant-related radioactivity was identified in the samples. However, I-131 could not be properly evaluated, due to its short half-life and the delay between sample collection and analysis. The issue was caused by an error in the lab analysis scheduling system, which has been corrected.

APPENDIX D ANALYTICAL PROCEDURES

Analytical Procedures

Analyses of environmental samples are performed by GEL Laboratories, LLC in Charleston, SC. Analysis procedures are based on accepted methods. A summary of the analysis techniques and methodology follows.

The gross beta measurements are made with an automatic low background counting system. Normal counting times are 50 minutes. Water samples are prepared by evaporating 400 milliliter (mL) of samples to near dryness, transferring to a stainless steel planchet, and completing the evaporation process. Air particulate filters are counted directly in a shallow planchet.

The specific analysis of I-131 in milk is performed by first isolating and purifying the iodine by radiochemical separation and then counting the final precipitate on a beta-gamma coincidence counting system. The normal count time is 480 minutes. When the I-131 counted in a gamma spectroscopy utilizing high resolution Hp-Ge detectors.

After a radiochemical separation, milk samples analyzed for Sr-89, 90 are counted on a low background beta counting system. The sample is counted a second time after a minimum ingrowth period of six days. From the two counts, the Sr-89 and Sr-90 concentrations can be determined.

Water samples are analyzed for tritium content by first distilling a portion of the sample and then counting by liquid scintillation. A commercially available scintillation cocktail is used.

Gamma analyses are performed in various counting geometries depending on the sample type and volume. All gamma counts are obtained with germanium type detectors interfaced with a high resolution gamma spectroscopy system.

The charcoal cartridges used to sample gaseous radioiodine are analyzed by gamma spectroscopy using a high resolution gamma spectroscopy system with germanium detectors.

Atmospheric moisture samples are collected on silica gel from a metered air flow. The moisture is released from the silica gel by heating and a portion of the distillate is counted by liquid scintillation for tritium using commercially available scintillation cocktail.

The necessary efficiency values, weight-efficiency curves, and geometry tables are established and maintained on each detector and counting system. A series of daily and periodic quality control checks are performed to monitor counting instrumentation. System logbooks and control charts are used to document the results of the quality control checks.

APPENDIX E LOWER LIMITS OF DETECTION

Lower Limits of Detection

A number of factors influence the Lower Limit of Detection (LLD) for a specific analysis method, including sample size, count time, counting efficiency, chemical processes, radioactive decay factors, and interfering isotopes encountered in the sample. The most probable values for these factors have been evaluated for the various analyses performed in the environmental monitoring program. The nominal LLDs are calculated from these values, in accordance with the methodology prescribed in the ODCM. The current nominal LLD values achieved by the radioanalytical lab are listed in Table 7 and Table 8. For comparison, the maximum values for the lower limits of detection specified in the ODCM are given in Table 9.

Table 6 - Comparison of Program Lower Limits of Detection with the Regulatory Limits for Maximum Annual Average Effluent Concentration Released to Unrestricted Areas and Reporting Levels

	Concentrations in Water (pCi[1]/Liter)			Concentrations in Air (pCi/m^3)		
Analysis	Effluent Concentration[2]	Reporting Level[3] [4]	Lower Limit of Detection[5]	Effluent Concentration	Reporting Level	Lower Limit of Detection
H-3	1,000,000	20,000	270	100,000	--	--
Cr-51	500,000	--	45	30,000	--	0.02
Mn-54	30,000	1000	5	1,000	--	0.005
Fe-59	10,000	400	10	500	--	0.005
Co-58	20,000	1000	5	1,000	--	0.005
Co-60	3,000	300	5	50	--	0.005
Zn-65	5,000	300	10	400	--	0.005
Sr-89	8,000	--	--	1,000	--	--
Sr-90	500	--	--	6	--	--
Nb-95	30,000	400	5	2,000	--	0.0005
Zr-95	20,000	400	10	400	--	0.005
Ru-103	30,000	--	5	900	--	0.005
Ru-106	3,000	--	40	20	--	0.02
I-131	1,000	2	0.4	200	0.9	0.03
Cs-134	900	30	5	200	10	0.005
Cs-137	1,000	50	5	200	20	0.005
Ce-144	3,000	--	30	40	--	0.01
Ba-140	8,000	200	25	2,000	--	0.015
La-140	9,000	200	10	2,000	--	0.01

[1] 1 pCi = 3.7 x10^{-2} Bq

[2] Source: Table 2 of Appendix B to 10 CFR 20.1001-20.2401

[3] For those reporting levels and lower limits of detection that are blank, no value is given in the reference

[4] Source: SQN Offsite Dose Calculation Manual, Table 2.3-2

[5] Source: Table 7 and Table 8 of this report

Table 7 – Nominal LLD Values - Radiochemical

Analysis	Airborne Particulate or Gases (pCi/m^3)	Water (pCi/L)	Milk (pCi/L)	Wet Vegetation (pCi/kg, wet)	Sediment and Soil (pCi/kg, dry)
Gross beta	0.002	1.9	--	--	--
H-3	3.0	270	--	--	--
I-131	--	0.4	0.4	6.0	--
Sr-89	--	--	3.5	--	1.6
Sr-90	--	--	2.0	--	0.4

Table 8 – Nominal LLD Values – Gamma Analysis

Analysis	Airborne Particulate (pCi/m^3)	Charcoal Filter (pCi/m^3)	Water and Milk (pCi/L)	Wet Vegetation (pCi/kg, wet)	Sediment and Soil (pCi/kg, dry)	Fish (pCi/kg, wet)	Food Products (pCi/kg, wet)
Ce-141	0.005	0.02	10	35	0.10	0.07	20
Ce-144	0.01	0.07	30	115	0.20	0.15	60
Cr-51	0.02	0.15	45	200	0.35	0.30	95
I-131	0.005	0.03	10	60	0.25	0.20	20
Ru-103	0.005	0.02	5	25	0.03	0.03	25
Ru-106	0.02	0.12	40	190	0.20	0.15	90
Cs-134	0.005	0.02	5	30	0.03	0.03	10
Cs-137	0.005	0.02	5	25	0.03	0.03	10
Zr-95	0.005	0.03	10	45	0.05	0.05	45
Nb-95	0.005	0.02	5	30	0.04	0.25	10
Co-58	0.005	0.02	5	20	0.03	0.03	10
Mn-54	0.005	0.02	5	20	0.03	0.03	10
Zn-65	0.005	0.03	10	45	0.05	0.05	45
Co-60	0.005	0.02	5	20	0.03	0.03	10
K-40	0.04	0.30	100	400	0.75	0.40	250
Ba-140	0.015	0.07	25	130	0.30	0.30	50
La-140	0.01	0.04	10	50	0.20	0.20	25
Fe-59	0.005	0.04	10	40	0.05	0.08	25
Be-7	0.02	0.15	45	200	0.25	0.25	90
Pb-212	0.005	0.03	15	40	0.10	0.04	40
Pb-214	0.005	0.07	20	80	0.15	0.10	80
Bi-214	0.005	0.05	20	55	0.15	0.10	40
Bi-212	0.02	0.20	50	250	0.45	0.25	130
Tl-208	0.002	0.02	10	30	0.06	0.03	30
Ra-224	--	--	--	--	0.75	--	--

Analysis	Airborne Particulate (pCi/m^3)	Charcoal Filter (pCi/m^3)	Water and Milk (pCi/L)	Wet Vegetation (pCi/kg, wet)	Sediment and Soil (pCi/kg, dry)	Fish (pCi/kg, wet)	Food Products (pCi/kg, wet)
Ra-226	--	--	--	--	0.15	--	--
Ac-228	0.01	0.07	20	70	0.25	0.10	50
Pa-234m	--	--	800	--	4.0	--	--

Table 9 - Maximum Values for Lower Limits of Detection (LLD)

Analysis	Water (pCi/L)	Airborne Particulate or Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/L)	Food Products (pCi/kg, wet)	Sediment (pCi/kg, dry)
Gross beta	4	0.01	--	--	--	--
H-3	2000[a]	--	--	--	--	--
Mn-54	15	--	130	--	--	--
Fe-59	30	--	260	--	--	--
Co-58, 60	15	--	130	--	--	--
Zn-65	30	--	260	--	--	--
Zr-95	30	--	--	--	--	--
Nb-95	15	--	--	--	--	--
I-131	1[b]	0.07	--	1	60	--
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-140	60	--	--	60	--	--
La-140	15	--	--	15	--	--

Notes

a. If no drinking water pathway exists, a value of 3000 pCi/L may be used
b. If no drinking water pathway exists, a value of 15 pCi/L may be used.

APPENDIX F QUALITY ASSURANCE / QUALITY CONTROL PROGRAM

Quality Assurance / Quality Control Program

A quality assurance program is employed by both laboratories to ensure that the environmental monitoring data are reliable. This program includes the use of written, approved procedures in performing the work, provisions for staff training and certification, internal self-assessments of program performance, audits by various external organizations, and a laboratory quality control program

The quality control program employed by the radioanalytical laboratory is designed to ensure that the sampling and analysis process is working as intended. The program includes equipment checks and the analysis of quality control samples, along with routine field samples. Instrument quality control checks include background count rate and counts reproducibility. In addition to these two general checks, other quality control checks are performed on the variety of detectors used in the laboratory. The exact nature of these checks depends on the type of device and the method it uses to detect radiation or store the information obtained.

Quality control samples of a variety of types are used by the laboratory to verify the performance of different portions of the analytical process. These quality control samples include blanks, field duplicates, process duplicates, matrix spikes, laboratory control samples, and independent cross-checks.

Blanks are samples which contain no measurable radioactivity of the type being measured. Such samples are analyzed to determine whether there is any contamination or cross-contamination of equipment, reagents, processed samples, or interferences from isotopes other than the ones being measured.

Duplicate field samples are generated at random by the sample computer program which schedules the collection of the routine samples. For example, if the routine program calls for four milk samples every week, on a random basis each farm might provide an additional sample several times a year. These duplicate samples are analyzed along with other routine samples. They provide information about the variability of radioactive content in the various sample media. If enough sample is available for a particular analysis, the laboratory staff can split the sample taking two individual aliquots, known as process duplicates. Duplicate samples provide information about the variability of the entire sampling and analytical process.

Matrix spikes are field samples that have been spiked with known low levels of specific target isotopes. Recovery of the known amount allow the analyst to determine if any interferences are exhibited from the field sample's matrix.

Laboratory control samples are another type of quality control sample. A known amount of radioactivity is added to a sample medium are processed along with the other QC and field samples in the analytical batch. Laboratory control samples provide the assurance that all aspects of the process have been successfully completed within the criteria established by Standard Operating Procedure.

Another category of quality control samples are cross-checks. The laboratory procures single-blind performance evaluation samples from Eckert & Ziegler Analytics to verify the analysis of sample matrices processed at the laboratory. Samples are received on a quarterly basis. The laboratory's Third-Party Cross-Check Program provides environmental matrices encountered in a typical nuclear utility REMP. Once performance evaluation samples have been prepared in accordance with the instructions from the performance evaluator provider, samples are managed and analyzed in the same manner as environmental samples. These samples have a known amount of radioactivity added and are presented

to the lab staff labeled as cross-check samples. The laboratory does not know the amount of radioactivity added to the sample. Such samples test the best performance of the laboratory by determining if the laboratory can find the "right answer." These samples provide information about the accuracy of the measurement process. Further information is available about the variability of the process if multiple analyses are requested on the same sample. Like matrix spikes or laboratory control samples, these samples can also be spiked with low levels of activity to test detection limits. The analysis results for internal cross-check samples met program performance goals for 2017.

The quality control data are routinely collected, examined and reported to laboratory supervisory personnel. They are checked for trends, problem areas, or other indications that a portion of the analytical process needs correction or improvement. The end result is a measurement process that provides reliable and verifiable data and is sensitive enough to measure the presence of radioactivity far below the levels which could be harmful to humans.

APPENDIX G LAND USE SURVEY

Land Use Survey

A land use survey is conducted annually to identify the location of the nearest milk producing animal, the nearest residence, and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of 16 meteorological sectors within a distance of 5 miles (8,047 meters) from the plant.

The land use survey is conducted between April 1 and October 1 using appropriate techniques such as door-to-door survey, mail survey, telephone survey, aerial survey, or information from local agricultural authorities or other reliable sources.

Using survey data, relative radiation doses are projected for individuals living near the plant. These projections use the data obtained in the survey and historical meteorological data. They also assume that releases are equivalent to the design basis source terms. The calculated doses are relative in nature and do not reflect actual exposures received by individuals living near SQN. Calculated doses to individuals based on measured effluents from the plant are well below applicable dose limits.

Using the locations identified in the 2017 SQN land use survey, annual dose projections were calculated for air submersion and vegetable ingestion. External doses due to radioactivity in air (air submersion) are calculated for the nearest resident in each sector.

There were no changes in the location of the nearest resident as identified in 2017 compared to 2016, in any of the 16 sectors. The location of the nearest garden changed in a total of five sectors. The distance to the closest garden increased in the NE, SW, W and NNW sectors. The distance decreased in the SSE sector. The land use survey verified that there are no milk locations in any sector.

Table 10 and Table 11 show the comparative relative calculated doses for 2016 and 2017.

Table 10 - Relative Projected Annual Air Submersion Dose to the Nearest Residence

	2016		2017	
Sector	Distance (meters)	Dose	Distance (meters)	Dose
N	1,389	0.13	1,389	0.13
NNE	2,456	0.07	2,456	0.07
NE	2,361	0.06	2,361	0.06
ENE	2,127	0.02	2,127	0.02
E	1,685	0.02	1,685	0.02
ESE	1,693	0.02	1,693	0.02
SE	1,721	0.03	1,721	0.03
SSE	2,073	0.04	2,073	0.04
S	1,764	0.13	1,764	0.13
SSW	2,129	0.14	2,129	0.14
SW	2,502	0.04	2,502	0.04
WSW	1,036	0.06	1,036	0.06
W	982	0.05	982	0.05
WNW	1,331	0.03	1,331	0.03
NW	1,316	0.05	1,316	0.05
NNW	864	0.13	864	0.13

Table 11 - Relative Projected Annual Ingestion Dose to Child's Bone from Home-Grown Foods

	2016		2017	
Sector	Distance (meters)	Dose	Distance (meters)	Dose
N	4,329	0.74	4,329	0.74
NNE	3,770	1.24	3,770	1.24
NE	1,400	3.87	6,230	0.43
ENE	5,220	0.21	5,220	0.21
E	5,933	0.1	5,370	0.12
ESE	1,861	0.51	1,861	0.51
SE	3,406	0.3	3,406	0.3
SSE	6,969	0.2	6,190	0.24
S	4,137	1.14	4,137	1.14
SSW	4,532	1.55	4,532	1.55
SW	4,440	0.64	4,920	0.56
WSW	1,152	1.69	1,152	1.69
W	1,393	0.92	3,050	0.3
WNW	5,363	0.14	5,363	0.14
NW	1,316	1.48	1,316	1.48
NNW	635	6.56	1,975	1.19

APPENDIX H DATA TABLES AND FIGURES

Table 12 - Individual Stations at Sequoyah Nuclear Plant

Map Loc. No.	Station Number	Dir. (degrees)	Distance (miles)	Q1 2017	Q2 2017	Q3 2017	Q4 2017	Annual Exposure (mrem/yr)
				(mrem/qtr)				
3	SSW-1C	198	2.0	13.5	17.5	13.3	12.9	57.2
4	NE-1A	50	1.5	16.1	19.1	15.4	13.9	64.5
5	NNE-1	13	1.8	19.3	20.0	19.1	15.9	74.3
7	SW-2	227	3.8	10.9	15.4	15.0	9.9	51.1
8	W-3	280	5.6	12.5	14.6	10.8	10.4	48.2
9	SSW-3	203	8.7	13.5	15.2	16.6	13.9	59.1
10	WSW-2A	250	2.6	11.4	14.1	10.8	9.4	45.6
11	SW-3	228	16.7	16.6	19.4	20.6	15.4	72.0
12	NNE-4	32	17.8	10.7	14.8	12.1	8.4	45.9
13	ESE-3	117	11.3	12.3	15.4	15.7	11.9	55.3
14	NW-3	320	20.0	12.4	15.9	10.2	8.4	46.8
49	N-1	3	0.6	16.2	17.9	13.3	14.9	62.3
50	N-2	4	2.1	14.5	17.4	14.5	13.9	60.2
51	N-3	358	5.2	13.1	15.9	14.1	9.9	52.9
52	N-4	355	10.0	11.4	14.9	14.8	13.4	54.5
53	NNE-2	31	5.3	10.7	14.8	12.1	8.4	45.9
55	NE-1	38	2.4	16.1	18.3	13.3	11.9	59.5
56	NE-2	51	4.1	8.0	11.8	12.1	7.9	39.7
57	ENE-1	73	0.2	12.0	16.2	11.9	14.6	54.6
58	ENE-2	66	5.1	12.9	17.4	12.1	12.4	54.7
59	E-1	96	1.2	14.6	13.4	12.7	11.4	52.1
60	E-2	87	5.2	11.3	17.0	16.3	11.9	56.4
62	ESE-1	110	1.2	12.4	16.0	13.9	11.9	54.2
63	ESE-2	112	4.9	13.4	17.8	18.7	13.9	63.9
66	SE-1	131	1.4	9.2	12.7	12.5	8.4	42.7
67	SE-2	129	1.9	14.0	15.6	15.1	11.4	56.1
68	SE-4	136	5.2	15.0	18.9	18.4	15.4	67.7
69	SSE-1	154	1.6	11.9	16.6	11.9	9.4	49.8
70	SSE-2	158	4.6	13.9	20.3	18.4	15.4	68.0
71	S-1	183	1.5	15.7	19.3	21.4	12.9	69.2
72	S-2	185	4.7	13.0	11.4	14.2	14.4	53.0
73	SSW-1	203	0.6	15.8	18.4	16.6	16.1	66.9
74	SSW-2	204	4.0	18.9	21.9	22.0	16.9	79.6
75	SW-1	228	0.7	19.7	20.7	19.4	13.9	73.6
76	WSW-1	241	0.9	15.8	18.5	20.6	14.9	69.8
77	WSW-2	238	2.5	10.3	12.8	11.2	7.4	41.7
78	WSW-3	248	5.7	13.1	19.0	19.4	9.4	60.8
79	WSW-4	244	7.8	12.0	13.0	13.9	10.9	49.7
81	W-1	260	0.6	18.0	22.0	20.6	16.4	77.0
82	W-2	275	4.3	9.8	12.4	9.5	7.4	38.9
83	WNW-1	292	0.4	13.1	17.6	14.1	13.4	58.2
84	WNW-2	295	5.3	11.4	14.1	10.0	10.4	45.9
85	NW-1	315	0.4	15.8	18.1	17.1	14.4	65.3
86	NW-2	318	5.2	14.2	14.6	14.7	8.9	52.3
87	NNW-1	344	0.6	17.3	20.3	18.2	14.6	70.4
88	NNW-2	342	1.7	12.5	15.4	13.0	10.9	51.8
89	NNW-3	334	5.3	12.5	16.3	11.8	11.9	52.5
90	SSW-1B	192	1.5	10.8	14.0	11.3	9.4	45.5

Table 13 - Weekly Airborne Particulate Gross Beta

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)[b]	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Air Filter Inhalation (pCi/m³)	Gross Beta 624	0.01	0.027 (467/468) (0.009 – 0.071)	RM-3, 11.3 Mi. ESE[a]	0.029 (52/52) (0.011 – 0.073)	0.028 (156/156) (0.009 – 0.073)	0

NOTES

a. The location with the highest annual mean is a control location.
b. LLD is the a priori limit as prescribed by the ODCM.

Figure 7 - Average Gross Beta in Air Filters

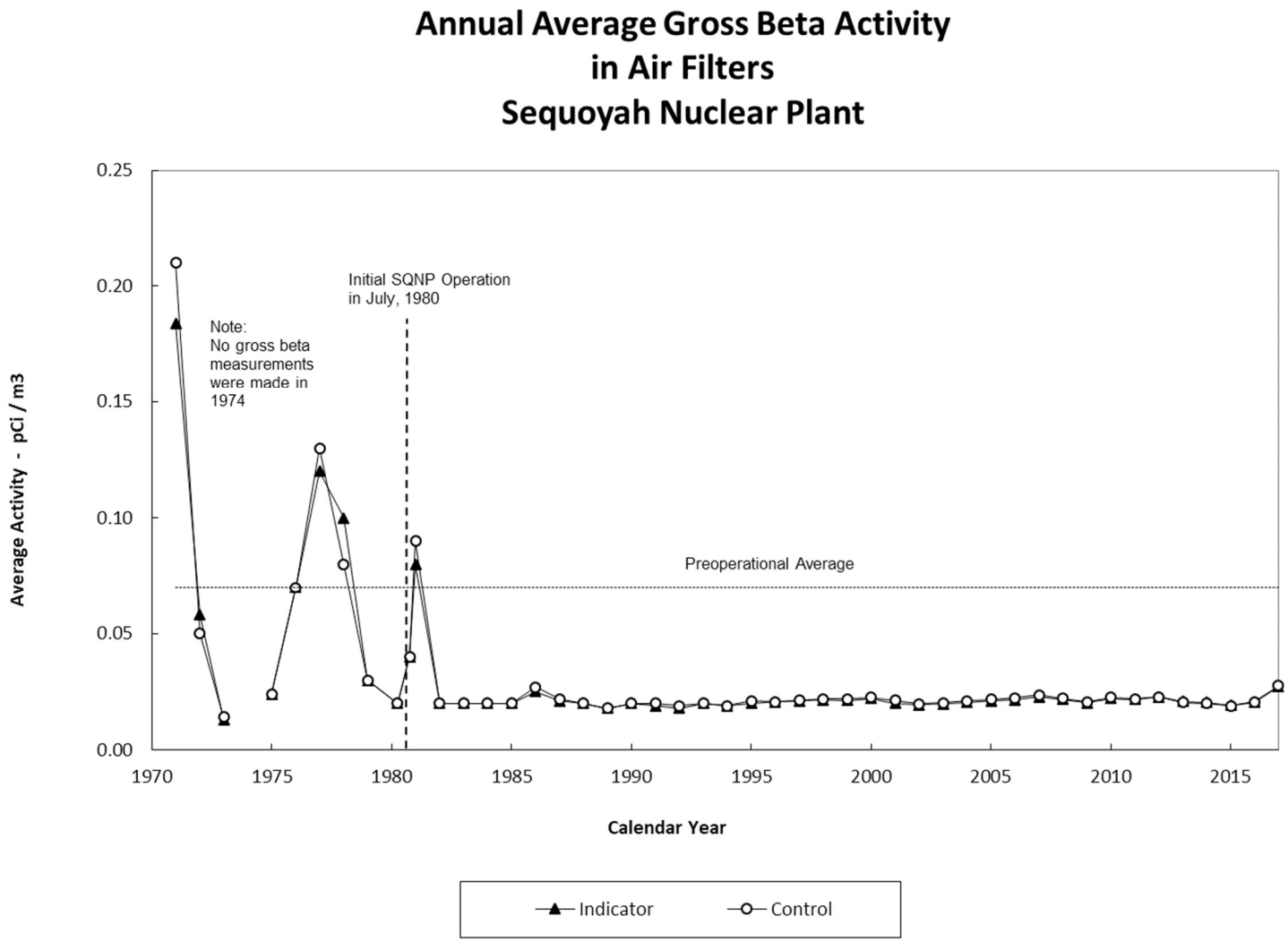


Table 14 - Weekly Radioiodine I-131 Activity

Pathway [a] (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Activated Charcoal Inhalation (pCi/m^3)	I-131 624	0.07	< LLD[a] (0/468)	< LLD	< LLD	< LLD (0/156)	0

NOTES

a. The Term < LLD as used means that results had no detectable activity above the minimum detectable.

Table 15 – Quarterly Composite Airborne Particulate Gamma Activity

Pathway (Measurement Unit)	Type and Number of Analysis Performed	Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
				Name, Distance and Direction	Mean (Range)		
Air Filter Inhalation (pCi/m^3)	Gamma Isotopic 156	Various	< LLD[a] (0/117)	< LLD	< LLD	< LLD (0/39)	0

NOTES

a. Natural occurring radionuclides (Be-7, Pb-212, Bi-214 and others) were observed in quarterly composite air samples in 2017.

Table 16 – Annual Soil Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Soil Direct Radiation (pCi/g)	Gamma Isotopic	15	Various	< LLD[a] (0/10)	< LLD	< LLD	< LLD (0/5)	0
	Cs-137	15	180	300 (7/10) 158 - 467	RM-1, 16.7 Mi., SW	468 (1/1) 468 - 468	257 (4/5) 135 - 468	0
	Sr-89	15	1.6	< LLD (0/10)	< LLD	< LLD	< LLD (0/5)	0
	Sr-90	15	0.4	< LLD (0/10)	< LLD	< LLD	< LLD (0/5)	0

NOTES

a. Natural occurring radionuclides (Pb-212, Bi-214 and others) were observed in soil samples in 2017.

Figure 8 – Average Soil Radioactivity

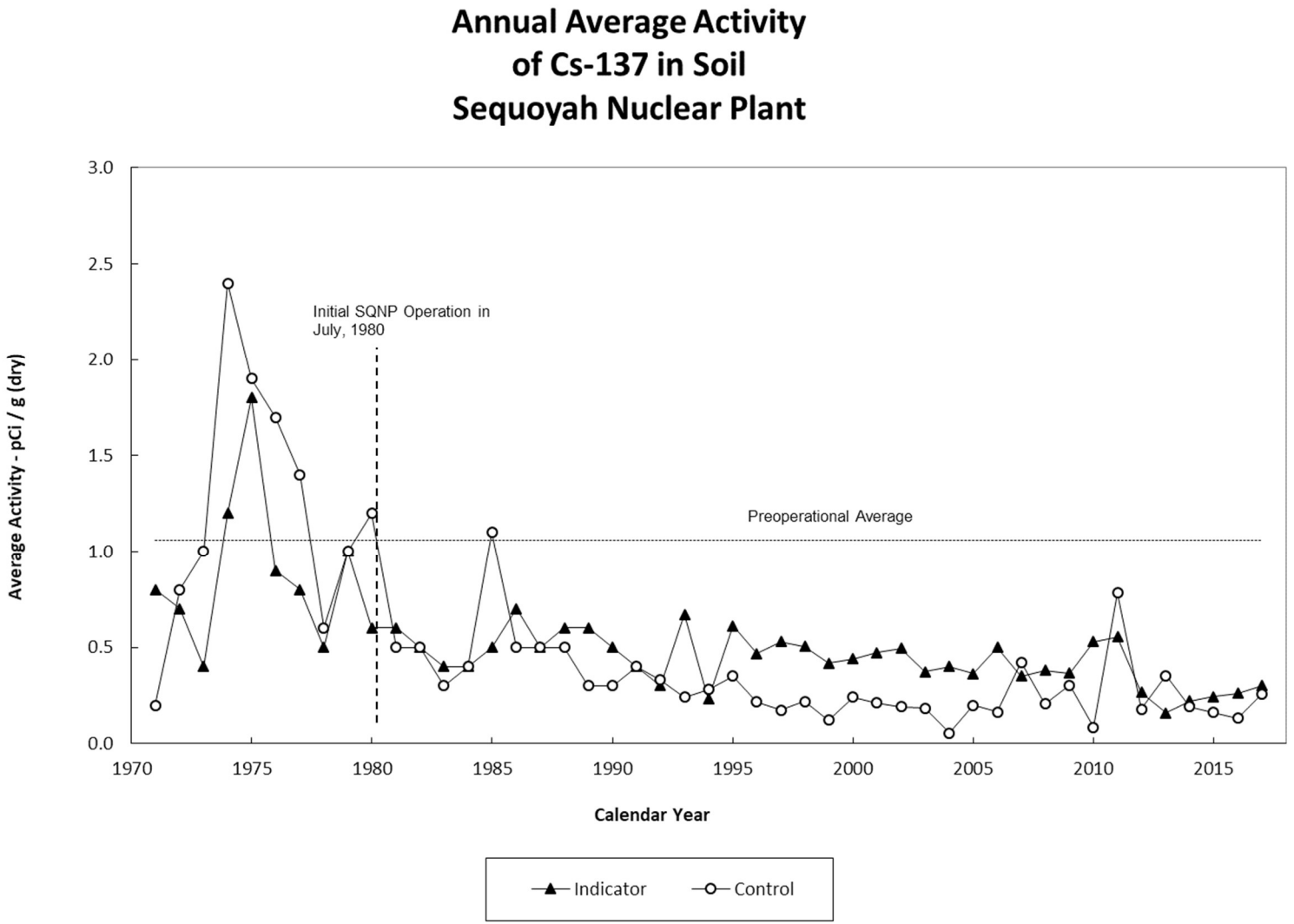


Table 17 – Annual Local Crops Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Cabbage Ingestion (pCi/g)	Gamma Isotopic	2	Various	< LLD (0/1)	< LLD	< LLD	< LLD (0/1)	0
Corn Ingestion (pCi/g)	Gamma Isotopic	1	Various	< LLD (0/1)	< LLD	< LLD	N/A	0
Pears Ingestion (pCi/g)	Gamma Isotopic	2	Various	< LLD (0/1)	< LLD	< LLD	< LLD (0/1)	0
Potatoes Ingestion (pCi/g)	Gamma Isotopic	2	Various	< LLD (0/1)	< LLD	< LLD	< LLD (0/1)	0
Green Beans Ingestion (pCi/g)	Gamma Isotopic	1	Various	< LLD (0/1)	< LLD	< LLD	N/A	0
Tomatoes Ingestion (pCi/g)	Gamma Isotopic	1	Various	< LLD (0/1)	< LLD	< LLD	N/A	0

Table 18 – Monthly Surface Water Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Surface Water Direct Exposure (pCi/L)	Gross Beta[b]	26	4.0	2.20 (2/13) 2.06 – 2.35	TRM 503.8[d]	4.05 (2/13) 2.10 -6.01	4.05 (2/13) 2.10 – 6.01	0
Surface Water Direct Exposure (pCi/L)	Gamma Isotopic	26	Various	< LLD[a] (0/13)	< LLD	< LLD	< LLD (0/13)	0
Surface Water Direct Exposure (pCi/L)	Tritium[c]	19	2000	576 (2/4) 523 - 629	TRM 483.4	576 (2/4) 523 - 629	432 (4/15) 271 - 589	0

NOTES

a. Natural occurring radionuclides (Pb-212, Bi-214 and others) were observed in surface water samples in 2017.
b. Gross beta samples are not required by ODCM.
c. SQN ODCM only requires quarterly tritium samples on surface water samples
d. The location with the highest annual mean is a control location.

Table 19 – Monthly Public Drinking Water Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Drinking Water Ingestion (pCi/L)	Gross Beta	55	4.0	2.61 (7/42)	TRM 503.8 [b]	4.05 (2/13) 2.10 – 6.01	4.05 (2/13) 2.10 – 6.01	0
Drinking Water Ingestion (pCi/L)	Gamma Isotopic	55	Various	< LLD[a] (0/41)	< LLD	< LLD	< LLD (0/14)	0
Drinking Water Ingestion (pCi/L)	Tritium	53	2000	533 (9/40) 314 - 1030	TRM 473	571 (7/18) 362 - 1030	432 (4/15) 271 - 589	0

NOTES

a. Natural occurring radionuclides (Pb-212, Bi-214 and others) were observed in drinking water samples in 2017.
b. The location with the highest annual mean is a control location.

Table 20 – Quarterly Well (Ground) Water Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Ground Water Ingestion (pCi/L)	Gross Beta	16	4.0	< LLD (0/9)	Farm HW, 1.2 Mi., NW[b]	7.8 (6/7) 5.8 – 10.0	7.8 (6/7) 5.8 – 10.0	0
Ground Water Ingestion (pCi/L)	Gamma Isotopic	19	Various	< LLD[a] (0/13)	< LLD	< LLD	< LLD (0/6)	0
Ground Water Ingestion (pCi/L)	Tritium	19	2000	293 (6/13) 254 – 364	Well #6, 0.15 Mi NNE	293 (6/13) 254 – 364	< LLD (0/6)	0

NOTES

a. Natural occurring radionuclides (Pb-212, Bi-214 and others) were observed in ground water samples in 2017.
b. The location with the highest annual mean is a control location

Table 21 – Semi-Annual Fish Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Game Fish Ingestion (pCi/g)	Gamma Isotopic	4	Various	< LLD[a] (0/2)	< LLD	< LLD	< LLD (0/2)	0
	Cs-137	4	150	.019 (1/2) 0.019 – 0.019	Chickimauga Reservoir	.019 (1/2) 0.019 – 0.019	.018 (1/2) 0.018 – 0.018	0
Commercial Fish Ingestion (pCi/g)	Gamma Isotopic	5	Various	< LLD (0/3)	< LLD	< LLD	< LLD (0/2)	0

NOTES

a. Natural occurring radionuclides (Pb-212, Bi-214 and others) were observed in fish samples in 2017.

Table 22 – Semi-Annual Shoreline Sediment Radioactivity

Pathway (Measurement Unit)	Type and Number of Analysis Performed		Lower Limit of Detection (LLD)	All Indicator Locations Mean (Range)	Location with Highest Annual Mean		Control Locations Mean (Range)	Non-routine Reported Measurements
					Name, Distance and Direction	Mean (Range)		
Shoreline Sediment Direct Radiation (pCi/kg)	Gamma Isotopic	6	Various	< LLD[a] (0/4)	< LLD	< LLD	< LLD (0/2)	0

NOTES

a. Natural occurring radionuclides (Pb-212, Bi-214 and others) were observed in shoreline sediment samples in 2017.

APPENDIX I ERRATA TO PREVIOUS ANNUAL ENVIRONMENTAL OPERATING REPORTS

Errata to Previous AREORs

The 2015 and 2016 Annual Radiological Environmental Operating Reports submitted to the NRC contained errors. Specifically, Table A-2 and Figure A-3 are not aligned with SQN ODCM revisions in effect during 2015, and 2016, or with EMSTD-01 Revision 26. One example includes the addition of location 91, Farm BB which is designated as location 23, Farm Bacon in the SQN ODCM. These reports are prepared by offsite groups but are reviewed onsite by Chemistry and Licensing prior to submittal to the NRC. This deficiency was identified during QA Chemistry and Environmental Audit SSA1707 at SQN and documented in CR 1311501.