Tennessee Valley Authority, P.O. Box 2000, Spring City, Tennessee 37381-2000

May 12, 2016

10 CFR 50.4

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

Watts Bar Nuclear Plant, Units 1 and 2
Facility Operating License Nos. NPF-90 and NPF-96
NRC Docket Nos. 50-390 and 50-391

Subject: **Watts Bar Nuclear Plant – Annual Radiological Environmental Operating Report - 2015**

Enclosed is the subject report for the period of January 1, 2015, through December 31, 2015. This report is being submitted as required by Watts Bar Nuclear Plant (WBN) Units 1 and 2, Technical Specification (TS) 5.9.2, "Annual Radiological Environmental Operating Report," and the WBN Offsite Dose Calculation Manual (ODCM), Administrative Control Section 5.1. This report is required to be submitted to the Nuclear Regulatory Commission (NRC) by May 15 of each year.

There are no new regulatory commitments in this letter. If you have any questions concerning this matter, please contact Gordon Arent, WBN Licensing Director, at (423) 365-2004.

Respectfully,

Paul Simmons
Site Vice President
Watts Bar Nuclear Plant

Enclosure:

Annual Radiological Environmental Operating Report - Watts Bar Nuclear Plant 2015

cc: See Page 2

cc (Enclosure):

NRC Regional Administrator – Region II
NRC Project Manager – Watts Bar Nuclear Plant
NRC Senior Resident Inspector - Watts Bar Nuclear Plant

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT

Annual Radiological Environmental Operating Report
Watts Bar Nuclear Plant 2015

Annual Radiological Environmental Operating Report

Watts Bar Nuclear Plant 2015

ANNUAL ENVIRONMENTAL RADIOLOGICAL OPERATING REPORT
WATTS BAR NUCLEAR PLANT
2015

TENNESSEE VALLEY AUTHORITY

April 2016

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

EXECUTIVE SUMMARY

This report describes the Radiological Environmental Monitoring Program (REMP) conducted by TVA in the vicinity of the Watts Bar Nuclear Plant (WBN) during the monitoring period of 2015. The program is conducted in accordance with regulatory requirements to monitor the environment per 10 CFR 20 and 10 CFR 50, and in accordance with 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, milk, food crops, soil, fish, shoreline sediment, and the measurement of direct radiation levels. The radiation levels of these samples are measured and then compared with results at control stations located outside the plant's vicinity and data collected at WBN prior to operations (preoperational data). This report contains an evaluation of the potential impact of WBN operations on the environment and general public.

The vast majority of radioactivity measured in environmental samples from the WBN program can be contributed to naturally occurring radioactive materials. Low levels of Cesium (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 or operation of other nuclear facilities in the region. 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. Trace levels of tritium were detected in atmospheric moisture samples. Tritium at concentrations slightly above the analytical detection limit was also detected in water samples collected from Chickamauga Reservoir. These levels would not represent a significant contribution to the radiation exposure to members of the public.

Tritium was detected in onsite ground water monitoring wells. The tritium was the result of onsite ground water contamination from previously identified and repaired leaks in plant systems. In addition, cobalt (Co)-60 and Cs-137 were identified in sediment collected from the onsite ponds. The level of activity measured in these onsite locations would not present a risk of exposure to the general public.

INTRODUCTION

This report describes and summarizes the results of radioactivity measurements made in the vicinity of WBN 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 WBN Technical Specification 5.9.2 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 radioactivity. Potassium (K)-40, with a half-life of 1.3 billion years, is one of the major types of radioactive materials found naturally in our environment. Approximately 0.01 percent of all potassium is radioactive potassium-40. Other examples of naturally occurring radioactive materials are beryllium (Be)-7, bismuth (Bi)-212 and 214, lead (Pb)-212 and 214, thallium (Tl)-208, actinium (Ac)-228, uranium (U)-238 and 235, thorium (Th)-234, radium (Ra)-226, radon (Rn)-222 and 220, carbon (C) -14, and hydrogen (H)-3 (generally called tritium). 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 References 2 and 3.

U.S. GENERAL POPULATION AVERAGE DOSE EQUIVALENT ESTIMATES

Source	millirem (mrem)[1]/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 (approximately)

1. One-thousandth of a Roentgen equivalent man (rem)

As can be seen from the data presented above, natural background radiation dose equivalent to the U.S. population normally exceeds that from nuclear plants by several hundred times. This indicates that nuclear plant operations normally result in a population radiation dose equivalent which is insignificant as 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 and through the radiological environmental monitoring program which measures the environmental radiation in areas around the plant. 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 WBN 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 dose to a member of the general public from radioactive materials released to unrestricted areas, as given in Nuclear Regulatory Commission (NRC) guidelines and the ODCM, is limited as follows:

Liquid Effluents

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

Gaseous Effluents

Noble gases:

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

Particulates:

Any organ	≤15 mrem/Year

The EPA limits for the total dose to the public in the vicinity of a nuclear power plant, established in the Environmental Dose Standard of 40 CFR 190, are as follows:

Total body	$\leq$25 mrem/year
Thyroid	$\leq$75 mrem/year
Any other organ	$\leq$25 mrem/year

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. Table 1 of this report presents the annual average concentration limits for the 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 detection limits for measured radionculides. It should be noted that the levels of radioactive materials measured in the environment are typically below or only slightly above the lower limit of detection.

SITE/PLANT DESCRIPTION

The WBN site is located in Rhea county, Tennessee, on the west bank of the Tennessee River at Tennessee River Mile (TRM) 528. Figure 1 shows the site in relation to other TVA projects. The WBN site, containing approximately 1770 acres on Chickamauga Lake, is approximately 2 miles south of the Watts Bar Dam and approximately 31 miles north-northeast of TVA's Sequoyah Nuclear Plant (SQN) site. Also located within the reservation are the Watts Bar Dam and Hydro-Electric Plant, the Watts Bar Steam Plant (not in operation), the TVA Central Maintenance Facility, and the Watts Bar Resort Area.

Approximately 18,500 people live within 10 miles of the WBN site. More than 80 percent of these live between 5 and 10 miles from the site. Two small towns, Spring City and Decatur, are located in this area. Spring City, with a population of approximately 2,200, is northwest and north-northwest from the site, while Decatur, with about 1,500 people, is south and south-southwest from the plant. The remainder of the area within 10 miles of the site is sparsely populated, consisting primarily of small farms and individual residences.

The area between 10 and 50 miles from the site includes portions of the cities of Chattanooga and Knoxville. The largest urban concentration in this area is the city of Chattanooga, located to the southwest and south-southwest. The city of Chattanooga has a population of about 170,000, with approximately 80 percent located between 40 and 50 miles from the site and the remainder located beyond 50 miles. The city of Knoxville is located to the east-northeast, with not more than 10 percent of its 185,000 plus people living within 50 miles of the site. Three smaller urban areas of greater than 20,000 people are located between 30 and 40 miles from the site. Oak Ridge is approximately 40 miles to the northeast, the twin cities of Alcoa and Maryville are located 45 to 50 miles to the east-northeast, and Cleveland is located about 30 miles to the south.

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

WBN consists of two pressurized water reactors. WBN Unit 1 received a low power operating license (NPF-20) on November 9, 1995 and achieved initial criticality in January 1996. The full power operating license (NPF-90) was received on February 7, 1996. Commercial operation was achieved May 25, 1996. WBN Unit 2 was deferred October 24, 2000, in accordance with the guidance in Generic Letter 87-15, "Policy Statement on Deferred Plants." On August 3, 2007, TVA provided notice of its intent to reactivate and complete construction of WBN Unit 2. WBN Unit 2 resumed construction in late 2007. October 22, 2015 the operating license was issued.

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 WBN 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.

A number of 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 A-2 (Appendix A, Table 2: This notation system is used for all tables and figures given in the appendices.) lists the sampling stations and the types of samples collected from each. Modifications made to the WBN monitoring program in 2015 are reported in Appendix B. Deviations to the sampling program during 2015 are included in Appendix C.

To determine the amount of radioactivity in the environment prior to the operation of WBN, a preoperational radiological environmental monitoring program was initiated in December 1976 and operated through December 31, 1995. 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. During the 1950s, 1960s, and 1970s, atmospheric nuclear weapons testing released radioactive material to the environment causing fluctuations 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 WBN 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 WBN operation.

The sample analysis is performed by the 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 (Sr)-89, 90 analysis of soil samples which is performed by a contract laboratory. Analyses are conducted in accordance with written and approved procedures and are based on accepted methods. A summary of the analysis techniques and methodology is presented in Appendix D. Data tables summarizing the sample analysis results are presented in Appendix H.

The radiation detection devices and analysis methods used to determine the radionuclide content of samples collected in the environment are very sensitive to 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 is presented in Appendix E.

The ERM&I laboratory operates under a comprehensive quality assurance/quality control program to monitor laboratory performance throughout the year. The program is intended to detect any problems in the measurement process as soon as possible so they can be corrected. This program includes equipment checks to ensure that the radiation detection instruments are working properly and the analysis of quality control samples which are included alongside routine environmental samples. To provide for interlaboratory comparison program, the laboratory participates in an environmental cross-check program administered by Eckert and Ziegler Analytics. A complete description of the program is presented in Appendix F.

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 as a result of 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 15 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. WBN Technical Specification 5.9.2, Annual Radiological Environmental Operating Report, requires that the Annual Radiological Environmental Operating Report identify TLD results that represent collocated dosimeters in relation to the NRC TLD program and the exposure period associated with each result. The NRC collocated TLD program was terminated by the NRC at the end of 1997, therefore, there are no TLD results that represent collocated dosimeters included in this report.

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 gamma radiation levels determined from the dosimeters deployed around WBN in 2015 are summarized in Table H-1. The exposures are measured in milliroentgens (mR). For purposes of this report, one mR, one mrem and one mrad are assumed to be numerically equivalent.

The rounded average annual exposures, as measured in 2015, are shown below. For comparison purposes, the average direct radiation measurements made in the preoperational phase of the monitoring program are also shown.

Annual WBN Average
Direct Radiation Levels
mR/Year

	2015	Preoperational Average
Onsite Stations	61	65
Offsite Stations	55	57

The data in Table H-1 indicates that the average quarterly direct radiation levels at the WBN onsite stations are approximately 1.4 mR/quarter higher than levels at the offsite stations. This equates to 5.6 mR/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 preoperation and construction phases of TVA nuclear power plant sites where the average levels onsite were slightly higher than levels offsite. Figure H-1 compares plots of the data from the onsite stations with those from the offsite stations over the period from 1977 through 2015. The new Landauer InLight Optically Stimulated Luminescence (OSL) dosimeters were deployed since 2007 replacing the Panasonic UD-814 dosimeters used during the previous years.

The data in Table H-2 contains the results of the individual monitoring stations. The results reported in 2015 are consistent with direct radiation levels identified at locations which are not influenced by the operation of WBN. There is no indication that WBN 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 Tables H-3, H-4, and H-5. 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 as a result of WBN 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 pump, a magnehelic gauge for measuring the drop in pressure across the system, and a dry gas meter to measure the total volume of air sampled. This system is housed in a building approximately 2 feet by 3 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 located in the same sampling head as the air particulate filter and is downstream of the 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 analysis.

Atmospheric moisture sampling is conducted by pulling air at a constant flow rate through a column loaded with approximately 400 grams of silica gel. Every two weeks, the column is exchanged on the sampler. The atmospheric moisture is removed from silica gel by heating and analyzed for tritium.

Results

The results from the analysis of air particulate samples are summarized in Table H-3. Gross beta activity in 2015 was consistent with levels reported in previous years. The average gross beta activity measured for air particulate samples was 0.019 pCi/m^3. The annual averages of the gross beta activity in air particulate filters at these stations for the period 1977-2015 are presented in Figure H-2. 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. Comparison with the same data for the preoperational period of 1990-1995 indicates that the annual average gross beta activity for air particulates as measured in the 2015 monitoring program was consistent with the preoperational data.

Only natural radioactive materials were identified by the monthly gamma spectral analysis of the air particulate samples. As shown in Table H-4, I-131 was not detected in any charcoal cartridge samples collected in 2015.

The results for atmospheric moisture sampling are reported in Table H-5. Tritium was measured, above the nominal LLD value of 3.0 pCi/m^3, in atmospheric moisture samples from the indicator and control locations. The highest concentration from the indicator locations was 26.4 pCi/m3. The highest concentration from the control locations was 5.5 pCi/m3.

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 Tables H-6 through H-11.

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 a distance of 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 2015 land use survey are presented in Appendix G.

Sample Collection and Analysis

Milk samples are collected every two weeks from two indicator dairies and from at least one control dairy. Milk samples are placed on ice for transport to the radioanalytical laboratory. A radiochemical separation analysis for I-131 and a gamma spectral analysis are performed on each sample and Sr-89, 90 analysis is performed quarterly.

The monitoring program includes a provision for sampling of vegetation from locations where milk is being produced and when milk sampling cannot be conducted. There were no periods during this year when vegetation sampling was necessary.

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 as a result of changes in the local vegetable gardens. Samples of corn, green beans, tomatoes, and turnip greens 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 results from the analysis of milk samples are presented in Table H-6. No radioactivity attributable to WBN Plant operations was identified. All I-131 values were below the established nominal LLD of 0.4 pCi/liter. The gamma isotopic analysis detected only naturally occurring radionuclides. The results for the quarterly Sr-89 and Sr-90 analyses were below the established LLD's for these analyses.

Consistent with most of the environment, Cs-137 was detected in the majority of the soil samples collected in 2015. The maximum concentration of Cs-137 was 0.56 pCi/g. The concentrations were consistent with levels previously reported from fallout. All other radionuclides reported were naturally occurring isotopes. The results of the analysis of soil samples are summarized in Table H-7. A plot of the annual average Cs-137 concentrations in soil is presented in Figure H-3. Concentrations of Cs-137 in soil are steadily decreasing as a result of the cessation of weapons testing in the atmosphere, the 30 year half-life of Cs-137, and transport through the environment.

The radionuclides measured in food samples were naturally occurring. The results are reported in Tables H-8 through H-11.

LIQUID PATHWAY MONITORING

Potential exposures from the liquid pathway can occur from drinking water, ingestion of fish, or from direct radiation exposure from radioactive materials deposited in the shoreline sediment. The aquatic monitoring program includes the collection of samples of river (surface) water, ground water, drinking water supplies, fish, and shoreline sediment. Indicator samples were collected downstream of the plant and control samples collected within the reservoir upstream of the plant or in the next upstream reservoir (Watts Bar Lake).

Sample Collection and Analysis

Samples of surface water are collected from the Tennessee River using automatic sampling systems from two downstream stations and one upstream station. A timer turns on the system at least once every two hours. The line is flushed and a sample is collected into a composite container. A one-gallon sample is removed from the container at 4-week intervals and the remaining water is discarded. Each sample is analyzed for gamma-emitting radionculides, gross beta activity, and tritium.

Samples are also collected by an automatic sampling system at the first two downstream drinking water intakes. These samples are collected in the same manner as the surface water samples. These monthly samples are analyzed for gamma-emitting radionuclides, gross beta activity, and tritium. The samples collected by the automatic sampling device are taken directly from the river at the intake structure. Since these samples are untreated water collected at plant intake, the upstream surface water sample is used as a control sample for drinking water.

Ground water is sampled from one onsite well down gradient from the plant, one onsite well up gradient from the plant, and four additional onsite ground water monitoring wells located along underground discharge lines. The onsite wells are sampled with a continuous sampling system. A composite sample is collected from the onsite wells every four weeks and analyzed for gamma-emitting radionuclides, gross beta activity, and tritium content.

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. The ODCM specifies analysis of the edible portion of the fish. To comply with this requirement, filleted portions are taken from several fish of each species. The samples are analyzed by gamma spectroscopy.

Samples of shoreline sediment are collected from recreation areas in the vicinity of the plant. The samples are dried, ground, and analyzed by gamma spectroscopy.

Samples of sediment are also collected from the onsite ponds. A total of five samples were collected in 2015. The samples are dried, ground, and analyzed by gamma spectroscopy.

Results

Gross beta activity was detectable above the nominal LLD in most of the surface water samples. The gross beta concentrations averaged 2.5 pCi/liter in downstream (indicator) samples and 2.4 pCi/L in upstream (control) samples. These levels were consistent with results found during the preoperational monitoring program. The gamma isotopic analysis of surface water samples identified only naturally occurring radionuclides. Low levels of tritium were detected in most surface water samples. The highest tritium concentration was 1,670 pCi/liter which is significantly below the EPA drinking water limit of 20,000 pCi/liter. A summary table of the results for surface water samples is shown in Table H-12. The annual average gross beta activity in surface water samples for the period 1977 through 2015 are presented in Figure H-4.

No fission or activation products were identified by the gamma analysis of drinking water samples from either of two downstream monitoring locations. Average gross beta activity at downstream (indicator) stations was 2.2 pCi/liter and the average for the upstream (control) station was 2.4 pCi/liter. Low levels of tritium were detected in most samples collected from the two downstream public water sampling locations. The highest tritium concentration was 1,070 pCi/liter. The tritium levels were significantly below the EPA drinking water limit of 20,000 pCi/liter. The results are shown in Table H-13. Trend plots of the gross beta activity in drinking water samples from 1977 through 2015 are presented in Figure H-5.

The gamma isotopic analysis of ground water samples identified only naturally occurring radionuclides. Gross beta concentrations in samples from the onsite indicator locations averaged 2.9 pCi/liter. The average gross beta activity for samples from the control locations was 2.8 pCi/liter. Tritium was detected in samples from the onsite monitoring wells located near plant discharge lines. The tritium in onsite ground water was the result of previously identified leaks from plant systems. Repairs were made to resolve the leaks but the plume of contaminated ground water continues to move slowly across the site toward the river. The highest tritium concentration in samples from these monitoring locations was 1,440 pCi/liter. There was no tritium detected in the onsite up gradient well or the offsite ground water monitoring location. The results are presented in Table H-14.

Cs-137 was identified in one fish sample. The Cs-137 concentration was 0.03 pCi/g measured in game fish collected at the upstream location. Other radioisotopes found in fish were naturally occurring, with the most notable being K-40. The results are summarized in Tables H-15 and H-16. Trend plots of the annual average Cs-137 concentrations measured in fish samples are presented in Figure H-6. The Cs-137 activities are consistent with preoperational results produced by fallout or effluents from other nuclear facilities.

No fission or activation products were detected, above the nominal LLD, by the gamma analyses performed on shoreline sediment samples. The results for the analysis of shoreline sediment are presented in Table H-17. Trend plots of the average concentration of Cs-137 in shoreline sediment are presented in Figure H-7.

Consistent with previous monitoring conducted for the onsite ponds, Cs-137 was detected in the sediment samples. The average of the Cs-137 levels measured in sediment from the onsite ponds was 0.10 pCi/gm. In addition, Co-60 was also detected in some of the samples collected from the onsite ponds. The average of the Co-60 levels measured in sediment from the onsite ponds was 0.08 pCi/gm. The results for the analysis of pond sediment samples are provided in Table H-18. Since these radionuclides were present in relatively low concentrations and confined to the ponds located in the owner controlled area not open to the general public, the presence of these radionuclides would not represent an increased risk of exposure to the general public.

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 guidance provided by the NRC in Regulatory Guide 1.109 for determining the potential dose to individuals and populations living in the vicinity of the plant. The results of the effluent dose calculations are reported in the Annual Radiological 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 the "hypothetical" person. The calculated maximum dose 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 result of plant operations, are expected to be negligible. The results for the radiological environmental monitoring conducted for WBN 2015 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 WBN is insignificant when compared to the dose from natural background radiation. The results from each environmental sample are compared with the concentrations from the corresponding control stations and appropriate preoperational and background data to determine influences from the plant. During this report period, Cs-137 was detected in soil and fish collected for the WBN program. The Cs-137 concentrations were consistent with levels measured during the preoperational monitoring program. The levels of tritium measured in water samples from Chickamauga Reservoir represented concentrations that were a small fraction of the EPA drinking water limit.

The levels of tritium detected in the onsite ground water monitoring wells and the radionuclides measured in samples of sediment from the onsite ponds do not represent an increased risk of exposure to the public. These radionuclides were limited to the owner controlled area and would not present an exposure pathway for the general public.

Conclusions

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

REFERENCES

1. Merril Eisenbud, Environmental Radioactivity, Academic Press, Inc., New York, NY, 1987.

2. National Council on Radiation Protection and Measurements, Report No. 160, "Ionizing Radiation Exposure of the Population of the United States," March 2009.

3. United States Nuclear Regulatory Commission, Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," February 1996.

Table 1

COMPARISON OF
PROGRAM LOWER LIMITS OF DETECTION WITH THE REGULATORY LIMITS FOR
MAXIMUM ANNUAL AVERAGE EFFLUENT CONCENTRATIONS
RELEASED TO UNRESTRICTED AREAS
AND REPORTING LEVELS

	Concentrations in Water, pCi/Liter			Concentrations in Air, pCi/Cubic Meter		
Analysis	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]
H-3	1,000,000	20,000	270	100,000	--	3.00
Cr-51	500,000	--	45	30,000	--	0.02
Mn-54	30,000	1,000	5	1,000	--	0.005
Co-58	20,000	1,000	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	--	5	1,000	--	0.0011
Sr-90	500	--	2	6	--	0.0004
Nb-95	30,000	400	5	2,000	--	0.005
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

Note: 1 pCi = 3.7 $\times 10^{-2}$ Bq.

Note: For those reporting levels that are blank, no value is given in the reference.

1. Source: Table 2 of Appendix B to 10 CFR 20.1001-20.2401

2. Source: WBN Offsite Dose Calculation Manual, Table 2.3-2.

3. Source: Table E-1 of this report.

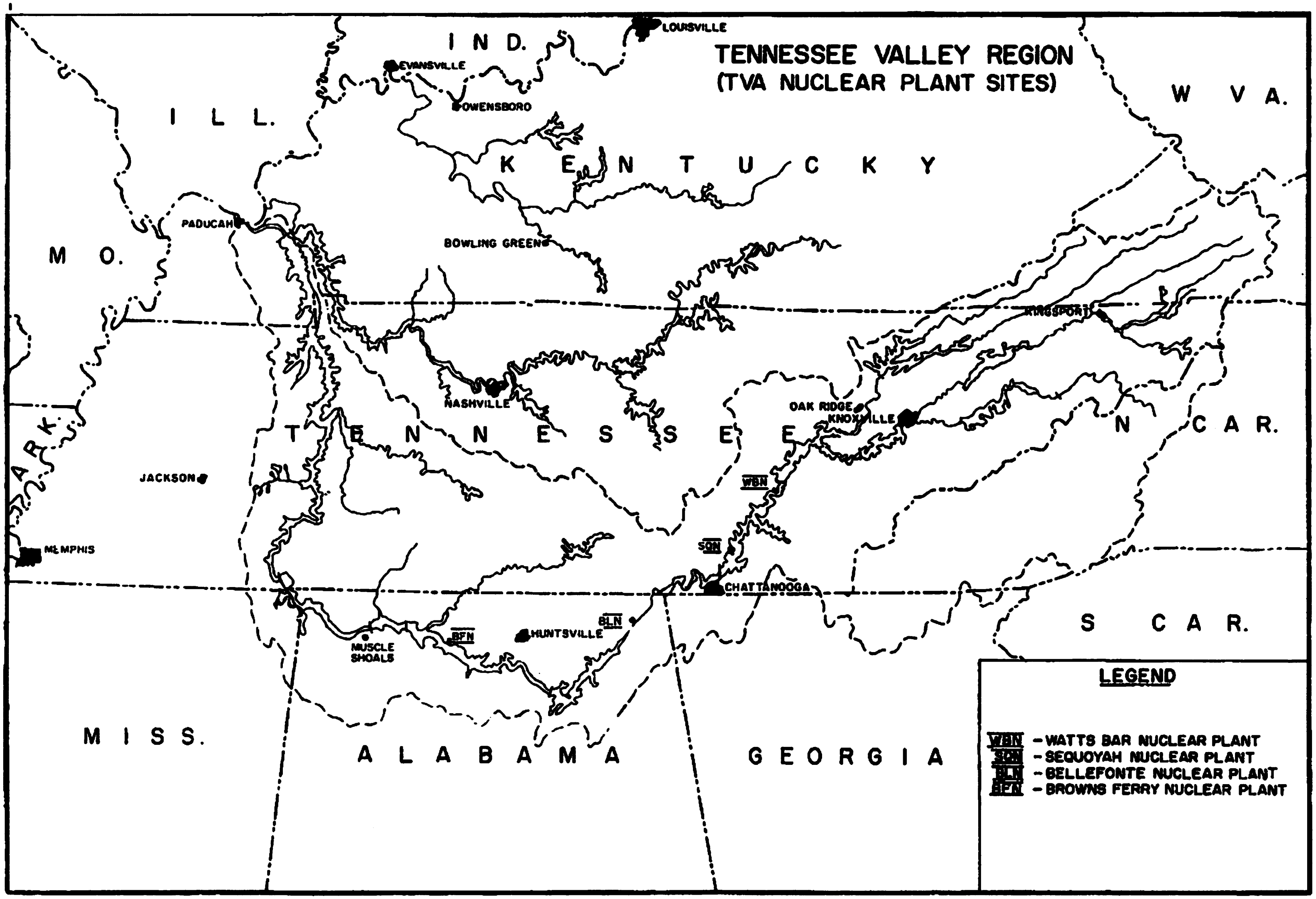
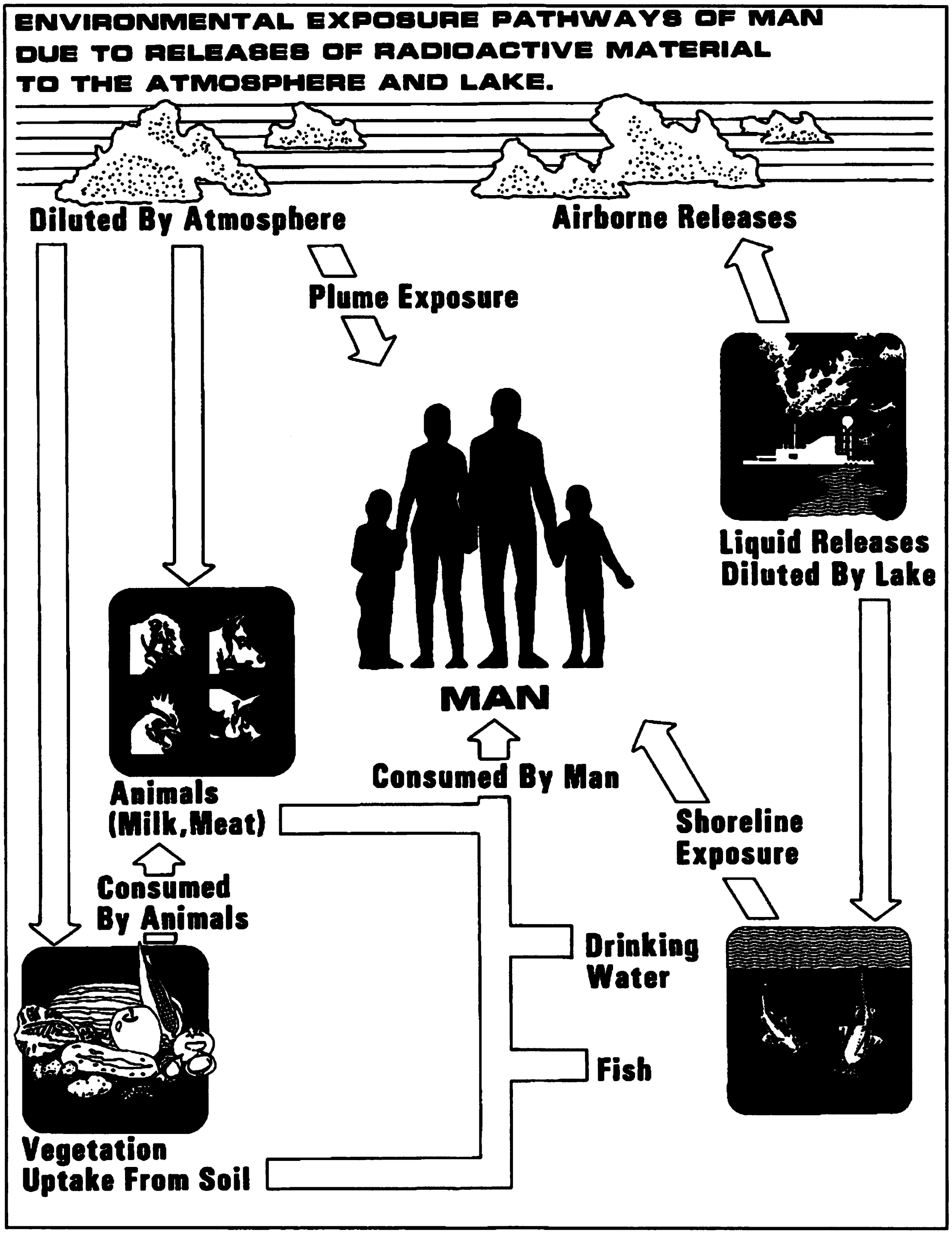

TENNESSEE VALLEY REGION
(TVA NUCLEAR PLANT SITES)
IND.
ILL.
MO.
ARK.
KENTUCKY
TENNESSEE
W VA.
N CAR.
S CAR.
MISS.
ALABAMA
GEORGIA
LOUISVILLE
EVANSVILLE
OWENSBORO
PADUCAH
BOWLING GREEN
NASHVILLE
KINGSPORT
OAK RIDGE
KNOXVILLE
JACKSON
MEMPHIS
WBN
SQN
CHATTANOOGA
BLN
BFN
HUNTSVILLE
MUSCLE SHOALS
LEGEND
WBN - WATTS BAR NUCLEAR PLANT
SQN - SEQUOYAH NUCLEAR PLANT
BLN - BELLEFONTE NUCLEAR PLANT
BFN - BROWNS FERRY NUCLEAR PLANT

Figure 1

Figure 2


ENVIRONMENTAL EXPOSURE PATHWAYS OF MAN
DUE TO RELEASES OF RADIOACTIVE MATERIAL
TO THE ATMOSPHERE AND LAKE.
Diluted By Atmosphere
Airborne Releases
Plume Exposure
Liquid Releases
Diluted By Lake
MAN
Consumed By Man
Animals
(Milk,Meat)
Shoreline
Exposure
Consumed
By Animals
Drinking
Water
Fish
Vegetation
Uptake From Soil

APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM AND SAMPLING LOCATIONS

Table A-1

WATTS BAR NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	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-1, 2, 3, and 4).	Continuous sampler operation with sample collection weekly (more (frequently if required by dust loading).	Analyze for gross beta radioactivity greater than or equal to 24 hours following filter change. Perform gamma isotopic analysis on each sample if gross beta is greater than 10 times yearly mean of control sample. Composite at least once per 31 days (by location) for gamma scan.
	4 samples from communities approximately 6-10 miles from the plant (PM-2, 3, 4, and 5).		
	2 samples from control locations greater than 10 miles from the plant (RM-2 and 3).		
b. Radioiodine	Samples from same locations as air particulates.	Continuous sampler operation with filter collection weekly.	I-131 at least once per 7 days. Analysis is performed by gamma spectroscopy.
c. Atmospheric Moisture	4 samples from locations (in different sectors) at or near the site boundary (LM-1, 2, 3, and 4)	Continuous sampler operation with sample collection biweekly.	Analyze each sample for tritium.
	2 samples from communities approximately 4-10 miles distance from the plant (PM-2, 5).		

Table A-1

WATTS BAR NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Atmospheric Moisture (Cont.)	2 samples from control location greater than 10 miles from the plant (RM-2 and RM-3).		
d. Soil	Samples from same location as air particulates.	Once per year.	Gamma scan, Sr-89, Sr-90 once per year.
2. DIRECT	2 or more dosimeters placed at or near the site boundary in each of the 16 sectors.	At least once per 92 days.	Gamma dose at least once per 92 days.
	2 or more dosimeters placed at stations located approximately 5 miles from the plant in each of the 16 sectors.		
	2 or more dosimeters in at least 8 additional locations of special interest, including at least 2 control stations.		

Table A-1

WATTS BAR NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface	2 samples downstream from plant discharge (TRM 517.9 and TRM 523.1).	Collected by automatic sequential-type sampler[c] with composite samples collected over a period of approximately 31 days.	Gross beta, gamma scan, and tritium analysis of each sample.
	1 sample at a control location upstream from the plant discharge (TRM 529.3).		
b. Ground	Five sampling locations from ground water monitoring wells adjacent to the plant (Wells No. 1, A, B, C, and F).	Collected by automatic sequential-type sampler with composite samples collected over a period of approximately 31 days.	Gross beta, gamma scan, and tritium analysis of each sample.
	1 sample from ground water source up gradient (Well No. 5).	Same as Well No. 1.	Gross beta, gamma scan, and tritium analysis of each sample.
c. Drinking	1 sample at the first two potable surface water supplies, downstream from the plant (TRM 503.8 and TRM 473.0).	Collected by automatic sequential-type sampler[c] with composite sample collected monthly.	Gross beta, gamma scan, and tritium analysis of each sample.
	1 sample at a control location TRM 529.3[d].		

Table A-1

WATTS BAR NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
d. Sediment from Shoreline	1 sample downstream from plant Discharge (TRM 513.0). 1 sample from a control location upstream from plant discharge (TRM 530.2).	At least once per 184 days.	Gamma scan of each sample.
e. Pond Sediment	1 sample from at least three locations in the Yard Holding Pond.	At least once per year.	Gamma scan of each sample.
5. INGESTION			
a. Milk	1 sample from milk producing animals in each of 1-3 areas indicated by the cow census were doses are calculated to be highest. 1 or more samples from control locations.	Every 2 weeks.	I-131 and gamma analysis on each sample. Sr-89 and Sr-90 once per quarter.
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.	At least once per 184 days.	Gamma scan on edible portions.

Table A-1

WATTS BAR NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Vegetation[e] (Pasturage and grass)	Samples from farms producing milk but not providing a milk sample.	At least once per 31 days.	I-131 analysis and gamma scan of each sample.
d. Food Products	1 sample each of principal food products grown at private gardens and/or farms in the immediate vicinity of the plant.	Annually at time of harvest. The types of foods available for sampling will vary. Following is a list of typical foods which may be available: Cabbage, Lettuce and/or Greens Corn Green Beans Potatoes Tomatoes	Gamma scan on edible portion.

a. The sampling program outlined in this table is that which was in effect at the end of 2015.
b. Sample locations are shown on Figures A-1, A-2, A-3.
c. Samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
d. The samples collected at TRMs 503.8 and 473.0 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 A-2
WATTS BAR NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

Map Location Number[a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected[b]
2	PM-2	NW	7.0	I	AP,CF,S,AM
3	PM-3	NNE	10.4	I	AP,CF,S
4	PM-4	NE/ENE[c]	7.6	I	AP,CF,S
5	PM-5	S	8.0	I	AP,CF,S,AM
6	RM-2	SW	15.0	C	AP,CF,S,AM
7	RM-3	NNW	15.0	C	AP,CF,S,AM
8	LM-1	SSW	0.5	I	AP,CF,S,AM
9	LM-2	NNE	0.4	I	AP,CF,S,AM
10	LM-3	NNE	1.9	I	AP,CF,S,AM
11	LM-4	SE	0.9	I	AP,CF,S,AM
15	Farm K	ENE	11.6	C	M
18	Well #1	S	0.6	I	W
20	Farm N	ESE	4.1	I	M
23	Well #5	N	0.5	C	W
25	TRM 517.9	--	9.9[d]	I	SW
26	TRM 523.1	--	4.7[d]	I	SW
27	TRM 529.3	--	1.5[d]	C	SW,PW[e]
31	TRM 473.0 (C. F. Industries)		54.8[d]	I	PW
32	TRM 513.0	--	14.8[d]	I	SS
33	TRM 530.2	--	2.4[d]	C	SS
35	TRM 503.8 (Dayton)	--	24.0[d]	I	PW
37	TRM 522.8-527.8 (downstream of WBN)	--	--	I	F
38	TRM 471-530 (Chickamauga Lake)	--	--	I	F
39	Watts Bar Reservoir			C	F
81	Yard Pond	SSE/S/SSW	Onsite	I	PS
82	Well A	SSE	0.6	I	W
83	Well B	SSE	0.5	I	W
84	Well C	ESE	0.3	I	W
85	Well F	SE	0.3	I	W
86	Farm HH	SSW	1.75	I	M
87	Farm BB	SW	18.6	C	M

a. See Figures A-1, A-2, and A-3
b. Sample codes:
AM = Atmospheric Moisture
AP = Air particulate filter
CF = Charcoal filter
F = Fish
M = Milk
PW = Public Water
PS = Pond Sediment
S = Soil
SS = Shoreline sediment
SW = Surface water
W = Well water

c. Station located on the boundary between these two sectors.
d. Distance from the plant discharge (TRM 527.8)
e. The surface water sample is also used as a control for public water.

Table A-3
WATTS BAR NUCLEAR PLANT
ENVIRONMENTAL DOSIMETERS LOCATIONS

Map[a] Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[b] or Offsite (Off)
2	NW-3	NW	7.0	Off
3	NNE-3	NNE	10.4	Off
4	ENE-3	NE/ENE	7.6	Off
5	S-3	S	7.8	Off
6	SW-3	SW	15.0	Off
7	NNW-4	NNW	15.0	Off
10	NNE-1A	NNE	1.9	On
11	SE-1A	SE	0.9	On
12	SSW-2	SSW	1.3	On
14	W-2	W	4.8	Off
40	N-1	N	1.2	On
41	N-2	N	4.7	Off
42	NNE-1	NNE	1.2	On
43	NNE-2	NNE	4.1	Off
44	NE-1	NE	0.9	On
45	NE-2	NE	2.9	Off
46	NE-3	NE	6.1	Off
47	ENE-1	ENE	0.7	On
48	ENE-2	ENE	5.8	Off
49	E-1	E	1.3	On
50	E-2	E	5.0	Off
51	ESE-1	ESE	1.2	On
52	ESE-2	ESE	4.4	Off
54	SE-2	SE	5.3	Off
55	SSE-1A	SSE	0.6	On
56	SSE-2	SSE	5.8	Off
57	S-1	S	0.7	On
58	S-2	S	4.8	Off
59	SSW-1	SSW	0.8	On
60	SSW-3	SSW	5.0	Off
62	SW-1	SW	0.8	On
63	SW-2	SW	5.3	Off
64	WSW-1	WSW	0.9	On
65	WSW-2	WSW	3.9	Off
66	W-1	W	0.9	On
67	WNW-1	WNW	0.9	On
68	WNW-2	WNW	4.9	Off
69	NW-1	NW	1.1	On
70	NW-2	NW	4.7	Off
71	NNW-1	NNW	1.0	On
72	NNW-2	NNW	4.5	Off
73	NNW-3	NNW	7.0	Off
74	ENE-2A	ENE	3.5	Off
75	SE-2A	SE	3.1	Off
76	S-2A	S	2.0	Off
77	W-2A	W	3.2	Off
78	NW-2A	NW	3.0	Off
79	SSE-1	SE	0.5	On

a. See Figures A-1, A-2, and A-3.
b. Dosimeters designated "onsite" are located 2 miles or less from the plant; "offsite" are located more than 2 miles from the plant.

Figure A-1

Radiological Environmental Sampling Locations

Within 1 Mile of the Plant

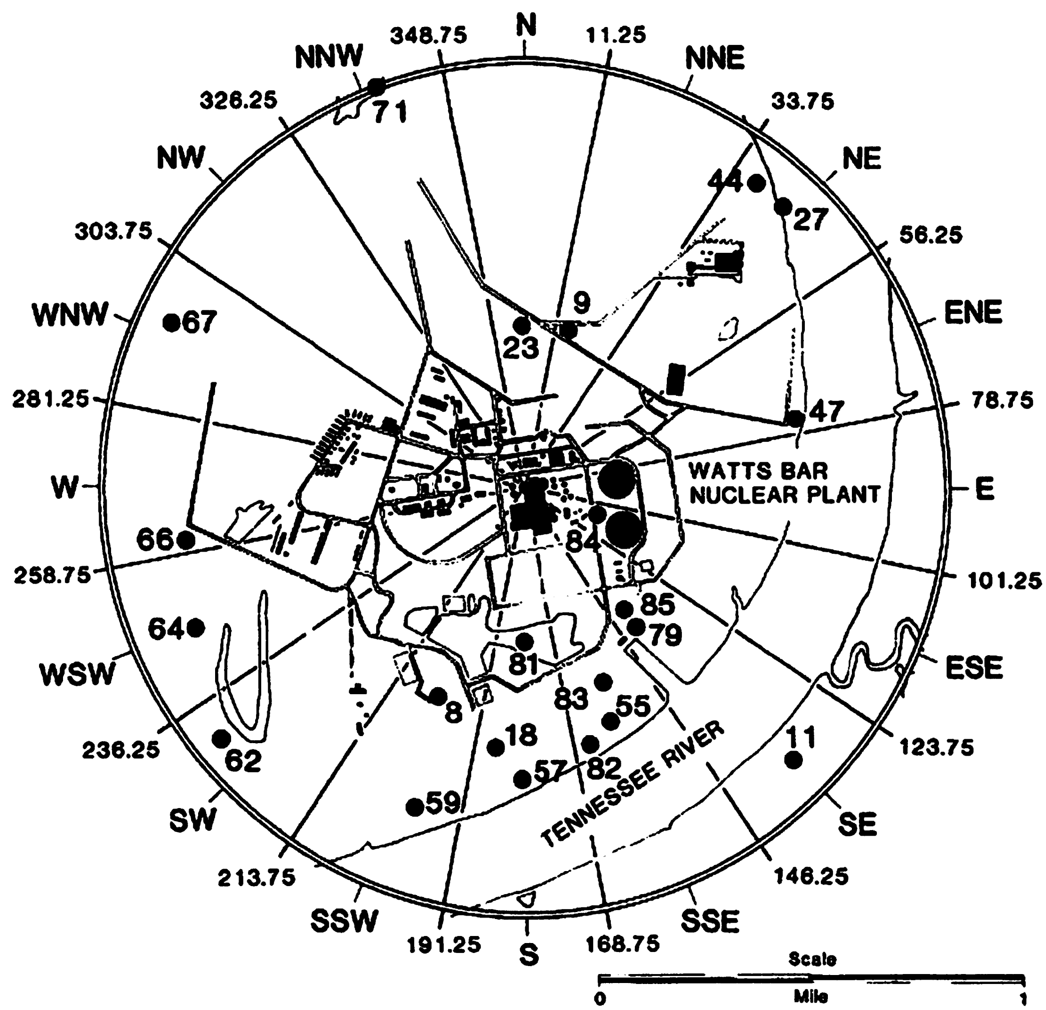


Figure A-2

Radiological Environmental Sampling Locations

From 1 to 5 Miles From The Plant

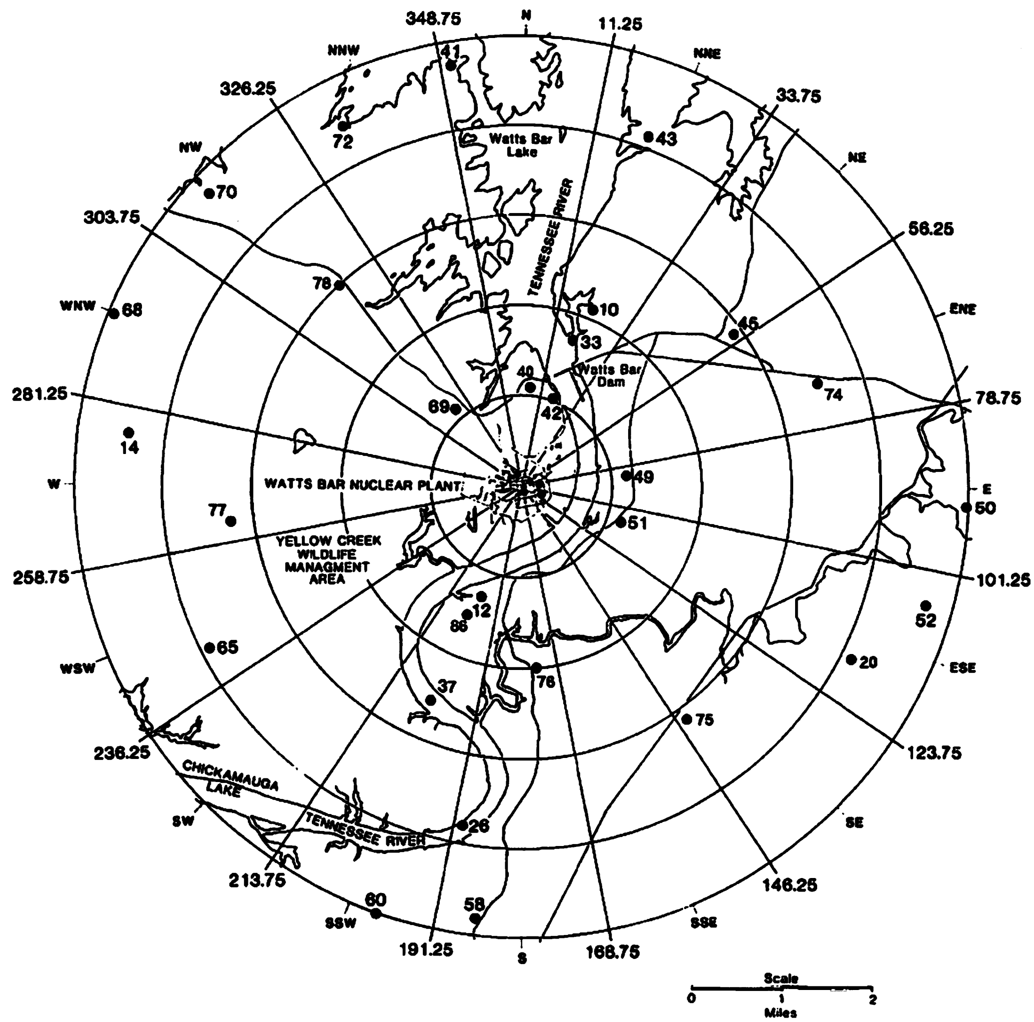
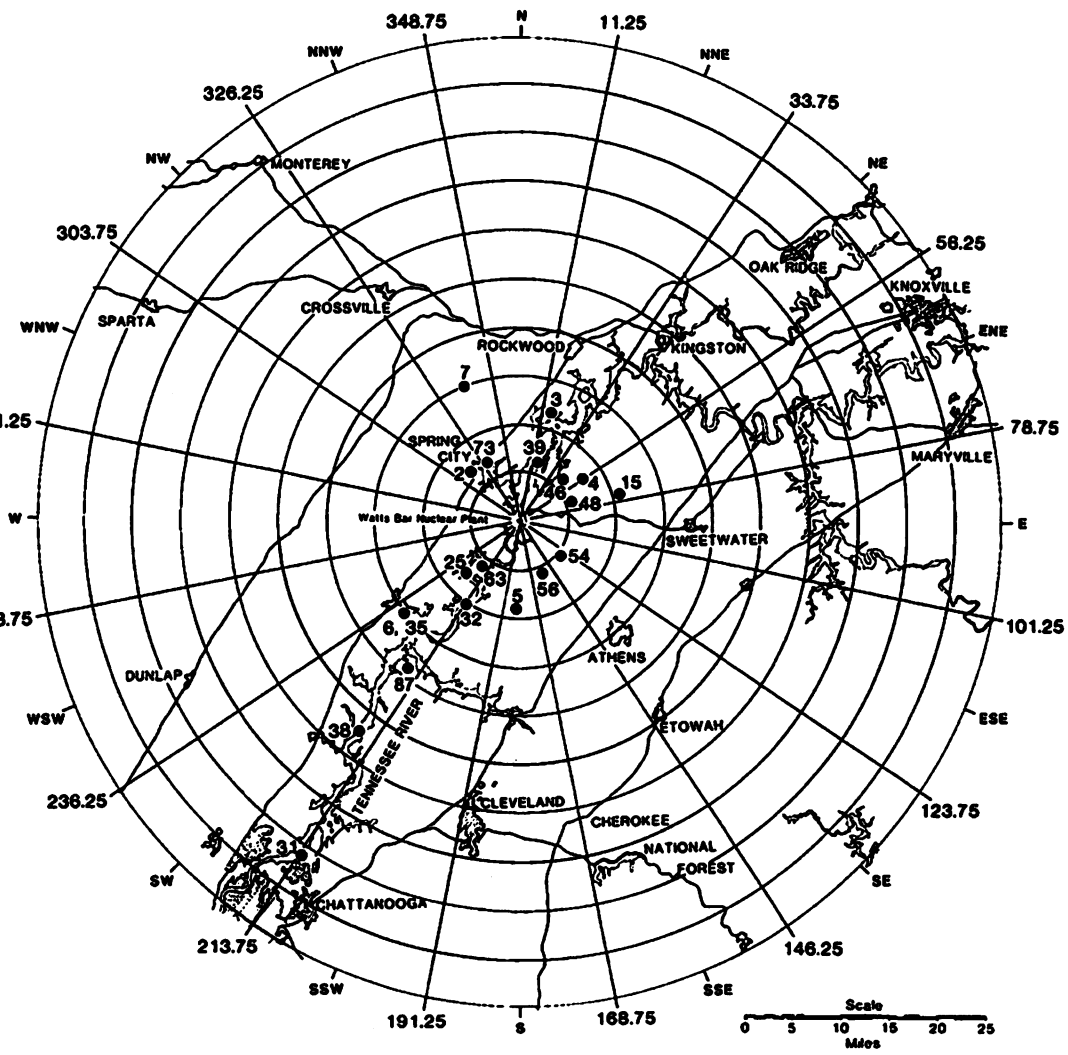


Figure A-3

Radiological Environmental Sampling Locations

Greater Than 5 Miles From the Plant



APPENDIX B

PROGRAM MODIFICATIONS

Appendix B

Radiological Environmental Monitoring Program Modification

Bacon Farm (Farm BB) was added to the REMP program during 2015 to replace the loss of the milk sampling location identified as Farm EH. (Farm EH closed operations during 2014.) The farm identified as Farm K closed its operation in March, 2015. However, it was officially removed from the REMP program at a later date. Both Farm EH and Farm K were control milk locations. The changes are reflected in the Tables and Figures of Appendix A of this report.

APPENDIX C

PROGRAM DEVIATIONS

Appendix C

Program Deviations

Problems with low moisture resulted in 5 missed atmospheric samples. The samples were collected but unable to be analyzed due to the low moisture content. In addition, 3 sets of dosimeters were missing at the time of change out during 2015.

Table C-1 provides additional information on the missed samples. A review of the details of the program deviations did not identify any adverse trend in equipment performance.

Table C-1
Radiological Environmental Monitoring Program Deviations

Date	Station	Location	Sample Type	Description
02/23/2015	3102 3106 3109 3205	1.3 miles SSW	Atmospheric Moisture	Five samples were unable to be analyzed due to low moisture content. The problem was identified in CR 1004980.
05/18/2015	3298	15 miles SW	Atmospheric Moisture	One sample was unable to be analyzed due to low moisture content. The problem was identified in CR 1035389.
3rd Qtr 2015	19 WB-NNW-3		Dosimeter	While performing quarterly dosimeter change out, it was discovered that the monitoring station 19 in the NNW sector had been disturbed. The OSLs had been knocked to the ground while Volunteer Electric was removing a pole about 2 feet away from the station. The OSLs where later mowed over by ground crews. One dosimeter was located but suffered damage and the other could not be found. This problem was identified in CR 1095655.
3rd Qtr 2015	42 WB-ESE-2		Dosimeter	Both dosimeters were found missing during the quarterly change out and could not be located after extensive search. It appears the fence that housed the dosimeters had been upgraded and the dosimeters may have been lost at this time. The issue was documented in CR 1095663.
4th Qtr 2015	38 WB-NNE-2		Dosimeter	Two dosimeters located at station 38 WB-NNE-2 were missing. A search of the area did not result in locating the dosimeters. The cage and protective sleeve that hold the dosimeters were found approximately 15 feet away from the station. The station was repaired and the new dosimeters were attached. This issue was identified in CR1129753.

APPENDIX D

ANALYTICAL PROCEDURES

Appendix D

Analytical Procedures

Analyses of environmental samples are performed by the radioanalytical laboratory located at the Western Area Radiological Laboratory facility in Muscle Shoals, Alabama, except for the Sr-89, 90 analysis of soil samples which was performed by a contract laboratory. 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 500 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 50 minutes. With the beta-gamma coincidence counting system, background counts are virtually eliminated and extremely low levels of activity can be detected.

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

NOMINAL LOWER LIMITS OF DETECTION

Appendix E

Nominal Lower Limits of Detection

A number of factors influence the Lower Limit of Detection (LLD), 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 in accordance with the methodology prescribed in the ODCM, are presented in Table E-1. The maximum LLD values for the lower limits of detection specified in the ODCM are shown in Table E-2.

The nominal LLD values are also presented in the data tables. For analyses for which nominal LLDs have not been established, an LLD of zero is assumed in determining if a measured activity is greater than the LLD. In these cases, the LLD value will appear as -1.00E+00 in the data tables in Appendix H.

TABLE E-1
Nominal LLD Values
A. Radiochemical Procedures

Analysis	Air Filters (pCi/m^3)	Water (pCi/L)	Milk (pCi/L)	Wet Vegetation (pCi/kg wet)	Sediment and Soil (pCi/g dry)
Gross Beta	0.002	1.9	--	--	--
Tritium	3.0	270	--	--	--
Iodine-131	--	0.4	0.4	6.0	--
Strontium-89	0.0011	5.0	3.5	31.0	1.6
Strontium-90	0.0004	2.0	2.0	12.0	0.4

Table E-1
Nominal LLD Values
B. Gamma Analyses

Analysis	Particulate Filter pCi/m^3	Charcoal Filter pCi/m^3	Water and Milk pCi/L	Vegetation and Grain pCi/g, dry	Wet Vegetation pCi/kg, wet	Soil and Sediment pCi/g, dry	Fish pCi/g, dry	Clam Flesh pCi/g, dry	Foods Tomatoes Potatoes, etc. pCi/kg, wet
Ce-141	.005	0.02	10	.07	35	.10	.07	.35	20
Ce-144	.01	0.07	30	.15	115	.20	.15	.85	60
Cr-51	.02	0.15	45	.30	200	.35	.30	2.40	95
I-131	.005	0.03	10	.20	60	.25	.20	1.70	20
Ru-103	.005	0.02	5	.03	25	.03	.03	.25	25
Ru-106	.02	0.12	40	.15	190	.20	.15	1.25	90
Cs-134	.005	0.02	5	.03	30	.03	.03	.14	10
Cs-137	.005	0.02	5	.03	25	.03	.03	.15	10
Zr-95	.005	0.03	10	.05	45	.05	.05	.45	45
Nb-95	.005	0.02	5	.25	30	.04	.25	.25	10
Co-58	.005	0.02	5	.03	20	.03	.03	.25	10
Mn-54	.005	0.02	5	.03	20	.03	.03	.20	10
Zn-65	.005	0.03	10	.05	45	.05	.05	.40	45
Co-60	.005	0.02	5	.03	20	.03	.03	.20	10
K-40	.04	0.30	100	.40	400	.75	.40	3.50	250
Ba-140	.015	0.07	25	.30	130	.30	.30	2.40	50
La-140	.01	0.04	10	.20	50	.20	.20	1.40	25
Fe-59	.005	0.04	10	.08	40	.05	.08	.45	25
Be-7	.02	0.15	45	.25	200	.25	.25	1.90	90
Pb-212	.005	0.03	15	.04	40	.10	.04	.30	40
Pb-214	.005	0.07	20	.50	80	.15	.50	.10	80
Bi-214	.005	0.05	20	.10	55	.15	.10	.50	40
Bi-212	.02	0.20	50	.25	250	.45	.25	2.00	130
Tl-208	.002	0.02	10	.03	30	.06	.03	.25	30
Ra-224	--	--	--	--	--	.75	--	--	--
Ra-226	--	--	--	--	--	.15	--	--	--
Ac-228	.01	0.07	20	.10	70	.25	.10	.75	50
Pa-234m	--	--	800	--	--	4.0	--	--	--

Table E-2

Maximum LLD Values Specified by the
WBN ODCM

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	1×10^{-2}	N.A.	N.A.	N.A.	N.A.
H-3	2000[a]	N.A.	N.A.	N.A.	N.A.	N.A.
Mn-54	15	N.A.	130	N.A.	N.A.	N.A.
Fe-59	30	N.A.	260	N.A.	N.A.	N.A.
Co-58,60	15	N.A.	130	N.A.	N.A.	N.A.
Zn-65	30	N.A.	260	N.A.	N.A.	N.A.
Zr-95	30	N.A.	N.A.	N.A.	N.A.	N.A.
Nb-95	15	N.A.	N.A.	N.A.	N.A.	N.A.
I-131	1[b]	7×10^{-2}	N.A.	1	60	N.A.
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-140	60	N.A.	N.A.	60	N.A.	N.A.
La-140	15	N.A.	N.A.	15	N.A.	N.A.

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

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

APPENDIX F

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

Appendix F

Quality Assurance/Quality Control Program

A quality assurance program is employed by the laboratory 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 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, replicate samples, analytical knowns, blind samples, and cross-checks.

Blanks are samples which contain no measurable radioactivity or no activity of the type being measured. Such samples are analyzed to determine whether there is any contamination of equipment or commercial laboratory chemicals, cross-contamination in the chemical process, or interference from isotopes other than the one being measured.

Duplicate 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 it into two portions. Such a sample provides information about the variability of the analytical process since two identical portions of material are analyzed side by side.

Analytical knowns are another category of quality control sample. A known amount of radioactivity is added to a sample medium. The lab staff knows the radioactive content of the sample. Whenever possible, the analytical knowns contain the same amount of radioactivity each time they are run. In this way, analytical knowns provide immediate data on the quality of the measurement process.

Blind spikes are samples containing radioactivity which are introduced into the analysis process disguised as ordinary environmental samples. The lab staff does not know the sample contains radioactivity. Since the bulk of the ordinary workload of the environmental laboratory contains no measurable activity or only naturally occurring radioisotopes, blind spikes can be used to test the detection capability of the laboratory or can be used to test the data review process. If an analysis routinely generates numerous zeroes for a particular isotope, the presence of the isotope is brought to the attention of the laboratory supervisor in the daily review process. Blind spikes test this process since the blind spikes contain radioactivity at levels high enough to be detected. Furthermore, the activity can be put into such samples at the extreme limit of detection (near the LLD) to verify that the laboratory can detect very low levels of activity.

Another category of quality control samples is the internal cross-checks. These samples have a known amount of radioactivity added and are presented to the lab staff labeled as cross-check samples. This means that the quality control staff knows the radioactive content or "right answer" but the lab personnel performing the analysis do not. Such samples test the best - performance of the laboratory by determining if the lab 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 blind spikes or analytical knowns, 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 2015.

To provide for an independent verification of the laboratory's ability to make accurate measurements, the laboratory participated in an environmental level cross-check program available through Eckert and Ziegler Analytics during 2015. The results of TVA's participation in this cross-check program are presented in Table F-1. The results for these cross-check samples were all within the program agreement limits with the exception of the Sr-90 in Milk result for the first quarter cross-checks. The disagreement was documented in CR 1106899. All other Sr-90 results were in agreement.

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.

Table F-1

Results For 2015 External Cross Checks

Test Period	Sample Type / Analysis	Results Known	Results TVA	Agreement
First Quarter	Water (pCi/L)			
	Gross Beta	2.80E+02	2.83E+02	Yes
First Quarter	Water (pCi/L)			
	^{3}H	1.26E+04	1.36E+04	Yes
First Quarter	Water (pCi/L)			
	^{131}I	9.67E+01	9.83E+01	Yes
	^{51}Cr	3.66E+02	3.76E+02	Yes
	^{134}Cs	1.26E+02	1.23E+02	Yes
	^{137}Cs	1.67E+02	1.69E+02	Yes
	^{58}Co	1.80E+02	1.81E+02	Yes
	^{54}Mn	1.59E+02	1.67E+02	Yes
	^{59}Fe	1.95E+02	1.92E+02	Yes
	^{65}Zn	2.99E+02	3.09E+02	Yes
	^{60}Co	3.28E+02	3.25E+02	Yes
	^{141}Ce	1.39E+02	1.49E+02	Yes
First Quarter	Synthetic Urine (pCi/L)			
	^{3}H	1.43E+04	1.46E+04	Yes
First Quarter	Milk (pCi/L)			
	^{131}I	9.90E+01	9.08E+01	Yes
	^{89}Sr	9.68E+01	8.61E+01	Yes
	^{90}Sr	1.32E+01	8.90E+00	No
First Quarter	Air Filter (pCi/Filter)			
	Gross Beta	1.00E+02	9.46E+01	Yes
Third Quarter	Water (pCi/L)			
	^{3}H	1.32E+04	1.36E+04	Yes
Third Quarter	Sand (pCi/gram)			
	^{141}Ce	3.38E-01	3.10E-01	Yes
	^{51}Cr	8.54E-01	8.20E-01	Yes
	^{134}Cs	3.36E-01	2.82E-01	Yes
	^{137}Cs	4.05E-01	3.78E-01	Yes
	^{58}Co	4.18E-01	4.01E-01	Yes
	^{54}Mn	4.61E-01	4.70E-01	Yes
	^{59}Fe	3.58E-01	3.39E-01	Yes
	^{65}Zn	5.61E-01	5.75E-01	Yes
	^{60}Co	5.24E-01	5.13E-01	Yes
Third Quarter	Air Filter (pCi/Filter)			
	Gross Beta	9.21E+01	7.70E+01	Yes
Third Quarter	Air Filter (pCi/Filter)			
	^{141}Ce	8.34E+01	8.36E+01	Yes
	^{51}Cr	2.11E+02	2.01E+02	Yes
	^{134}Cs	8.29E+01	6.60E+01	Yes
	^{137}Cs	9.98E+01	9.55E+01	Yes
	^{58}Co	1.03E+02	9.96E+01	Yes
	^{54}Mn	1.14E+02	1.19E+02	Yes
	^{59}Fe	8.84E+01	9.05E+01	Yes
	^{65}Zn	1.38E+02	1.50E+02	Yes
	^{60}Co	1.29E+02	1.32E+02	Yes
Third Quarter	Synthetic Urine (pCi/L)			
	^{3}H	1.39E+04	1.40E+04	Yes
Fourth Quarter	Milk (pCi/L)			
	^{131}I	8.97E+01	9.38E+01	Yes
	^{89}Sr	9.00E+01	8.28E+01	Yes
	^{90}Sr	1.57E+01	1.27E+01	Yes

APPENDIX G

LAND USE SURVEY

Appendix G

Land Use Survey

A land use survey was conducted in accordance with the provisions of ODCM Control 1.3.2 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 a distance of 5 miles (8 km) from the plant.

The land use survey was conducted between April 1, 2015, and October 1, 2015, 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 the survey data, relative radiation doses were projected for individuals near the plant. Doses from air submersion were calculated for the nearest resident in each sector. Doses from milk ingestion or vegetable ingestion were calculated for the areas with milk producing animals and gardens, respectively. These doses were calculated using historical meteorological data. They also assume that the effluent 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 WBN.

The location of nearest resident changed in one sector during 2015. In addition, the location of the nearest garden changed in a total of five sectors. The survey of milk producing locations performed in 2015 did not identify any new locations.

Tables G-1, G-2, and G-3 compare results of the relative projected annual dose calculations for 2014 and 2015.

Table G-1

Watts Bar Nuclear Plant
Relative Projected Annual Air Submersion Dose to the Nearest Residence
Within 8 km (5 Miles) of Plant[a]

mrem/year

	2014		2015	
Sector	Approximate Distance (Meters)	Annual Dose	Approximate Distance (Meters)	Annual Dose
N	4,474	0.07	4,474	0.07
NNE	3,750	0.21	3,750	0.21
NE	3,399	0.27	3,399	0.27
ENE	3,072	0.29	3,072	0.29
E	4,388	0.15	4,388	0.15
ESE	4,654	0.14	4,654	0.14
SE	1,409	0.72	1,409	0.72
SSE	1,646	0.34	1,646	0.34
S	1,550	0.40	1,550	0.40
SSW	1,832	0.31	1,832	0.31
SW	4,141	0.09	3,784	0.10
WSW	2,422	0.19	2,422	0.19
W	2,901	0.05	2,901	0.05
WNW	1,448	0.19	1,448	0.19
NW	2,065	0.08	2,065	0.08
NNW	4,376	0.02	4,376	0.02

a. Assumes the effluent releases are equivalent to design basis source terms.

Table G-2

Watts Bar Nuclear Plant
Relative Projected Annual Ingestion Dose to Child's Bone
Organ from Ingestion of Home-Grown Foods
Nearest Garden Within 8 km (5 Miles) of Plant[a]

mrem/year

	2014		2015	
Sector	Approximate Distance (Meters)	Annual Dose	Approximate Distance (Meters)	Annual Dose
N	7,188	0.55	6,295	0.74
NNE	5,030	2.79	5,030	2.79
NE	3,793	4.90	3,793	4.90
ENE	3,072	6.20	5,281	2.27
E	4,656	3.09	4,656	3.09
ESE	7,059	1.66	7,297	1.59
SE	1,409	14.20	1,409	14.20
SSE	1,711	6.76	1,711	6.76
S	2,349	5.29	3,535	2.79
SSW	7,736	0.61	7,736	0.61
SW	4,566	1.70	3,784	2.39
WSW	3,080	2.77	3,080	2.77
W	3,138	0.99	3,138	0.99
WNW	2,963	1.13	2,956	1.13
NW	2,065	1.64	2,065	1.64
NNW	4,742	0.48	4,742	0.48

a. Assumes the effluent releases are equivalent to design basis source terms.

Table G-3

Watts Bar Nuclear Plant
Relative Projected Annual Dose to Receptor Thyroid from Ingestion of Milk[a]
(Nearest Milk-Producing Animal Within 8km (5 Miles) of Plant)

mrem/year

Location	Sector	Approximate Distance Meters	Annual Dose 2014	Annual Dose 2015	X/Q s/m^3
Cows					
Farm N[b]	ESE	6,706	0.06	0.06	1.35 E-6
Farm HH[b,c]	SSW	2,826	0.19	0.19	1.73 E-6

a. Assumes the plant is operating and effluent releases are equivalent to design basis source terms.
b. Milk being sampled at these locations.
c. The identification for this location was revised in 2013 from Farm Ho to Farm HH.

APPENDIX H

DATA TABLES AND FIGURES

Table H-1

DIRECT RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from Watts Bar Nuclear Plant for Each Quarter - 2015
mR / Quarter [a]

Average External Gamma Radiation Levels [b]

	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	mR / Yr [c]
Average 0 - 2 miles (onsite)	14.2	15.3	16.6	14.7	61
Average > 2 miles (offsite)	13.3	13.4	15.1	13.6	55

(a) Field periods normalized to one standard quarter (2190 hours)
(b) Average of the individual measurements in the set
(c) The 5.6 mR/yr for onsite locations falls below the 25 mrem total body limit in 10 CFR 190.

Table H-2 (1 of 2)

DIRECT RADIATION LEVELS

Individual Stations at Watts Bar Nuclear Plant

Map Location Number	Dosimeter Station Number	Direction, degrees	Approx Distance, miles	Environmental Radiation Levels mR /Quarter 1st Qtr Jan-Mar 2015	2nd Qtr Apr-Jun 2015	3rd Qtr Jul-Sep 2015	4th Qtr Oct-Dec 2015	Annual(1) Exposure mR/Year
40	N-1	10	1.2	15.5	17.4	18.5	16.4	67.8
41	N-2	350	4.7	16.0	17.3	19.5	13.2	66.0
42	NNE-1	21	1.2	18.7	19.3	18.0	15.5	71.5
10	NNE-1A	22	1.9	12.3	14.0	16.0	15.7	58.0
43	NNE-2	20	4.1	11.7	11.3	14.1	(1)	49.5
3	NNE-3	17	10.4	12.2	12.6	15.0	13.5	53.3
44	NE-1	39	0.9	11.7	15.5	16.1	15.5	58.8
45	NE-2	54	2.9	15.2	12.7	16.5	14.4	58.8
46	NE-3	47	6.1	8.8	11.4	12.1	9.5	41.8
47	ENE-1	74	0.7	17.1	13.6	16.3	13.7	60.7
48	ENE-2	69	5.8	12.9	13.3	14.0	13.1	53.3
74	ENE-2A	69	3.5	11.1	9.9	12.1	10.2	43.3
4	ENE-3	56	7.6	8.8	10.4	11.7	11.7	42.6
49	E-1	85	1.3	14.5	16.0	16.5	16.6	63.6
50	E-2	92	5.0	15.2	15.0	17.3	14.0	61.5
51	ESE-1	109	1.2	9.9	10.8	10.2	10.2	41.1
52	ESE-2	106	4.4	18.8	17.3	(1)	14.7	67.7
11	SE-1A	138	0.9	12.8	13.2	17.4	13.6	57.0
54	SE-2	128	5.3	10.0	12.2	13.0	12.5	47.7
75	SE-2A	144	3.1	12.3	14.5	16.6	14.0	57.4
79	SSE-1	146	0.5	16.0	14.5	17.2	15.0	62.7
55	SSE-1A	161	0.6	12.3	11.7	20.0	10.0	54.0
56	SSE-2	156	5.8	13.5	15.9	17.3	16.0	62.7

(1) Sum of available quarterly data normalized to 1 year for the annual exposure value.

Table H-2 (2 of 2)

DIRECT RADIATION LEVELS

Individual Stations at Watts Bar Nuclear Plant

Map Location Number	Dosimeter Station Number	Direction, degrees	Approx Distance, miles	Environmental Radiation Levels mR /Quarter 1st Qtr Jan-Mar 2015	2nd Qtr Apr-Jun 2015	3rd Qtr Jul-Sep 2015	4th Qtr Oct-Dec 2015	Annual[(1)] Exposure mR/Year
57	S-1	182	0.7	12.3	13.1	15.8	12.8	54.0
58	S-2	185	4.8	12.3	9.4	10.8	12.3	45.0
76	S-2A	177	2.0	14.0	16.4	16.6	16.3	63.3
5	S-3	185	7.8	10.4	10.8	15.6	12.8	49.6
59	SSW-1	199	0.8	17.6	20.5	19.1	15.3	72.5
12	SSW-2	200	1.3	12.2	12.2	16.6	13.6	54.6
60	SSW-3	199	5.0	11.7	10.3	12.2	11.0	45.2
62	SW-1	226	0.8	16.0	19.2	19.1	16.2	70.5
63	SW-2	220	5.3	15.8	15.4	20.0	19.2	70.4
6	SW-3	225	15.0	11.0	11.3	11.1	11.3	44.7
64	WSW-1	255	0.9	13.4	13.1	12.9	13.2	52.6
65	WSW-2	247	3.9	16.9	17.4	18.6	15.5	68.4
66	W-1	270	0.9	13.9	16.4	15.3	14.1	59.7
14	W-2	277	4.8	11.1	11.8	13.4	11.4	47.7
77	W-2A	268	3.2	12.2	16.0	14.4	14.2	56.8
67	WNW-1	294	0.9	21.4	21.2	21.7	22.8	87.1
68	WNW-2	292	4.9	15.8	17.8	18.9	17.8	70.3
69	NW-1	320	1.1	12.8	14.1	14.7	13.2	54.8
70	NW-2	313	4.7	18.3	16.8	17.6	16.4	69.1
78	NW-2A	321	3.0	16.6	11.2	13.8	11.8	53.4
2	NW-3	317	7.0	18.0	16.8	18.4	16.0	69.2
71	NNW-1	340	1.0	10.1	13.6	14.4	13.9	52.0
72	NNW-2	333	4.5	13.6	13.1	16.7	15.0	58.4
73	NNW-3	329	7.0	9.4	11.2	(1)	12.2	43.7
7	NNW-4	337	15.0	11.7	12.6	11.2	13.5	49.0

(1) Sum of available quarterly data normalized to 1 year for the annual exposure value.

Table H-3

Tennessee Valley Authority

RADIOACTIVITY IN AIR FILTER

pCi/m^3 = 0.037 Bq/m^3

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GROSS BETA - 520						
	2.00E-03	1.92E-02 (416 / 416) 2.57E-03 - 4.23E-02	PM5 DECATUR 6.2 MILES S	1.96E-02 (52 / 52) 4.54E-03 - 3.23E-02	1.89E-02 (104 / 104) 3.03E-03 - 4.25E-02	
GAMMA SCAN (GELI) - 130						
AC-228	1.00E-02	104 VALUES < LLD	LM3 1.9 MILES NNE	13 VALUES < LLD	26 VALUES < LLD	
BE-7	2.00E-02	1.01E-01 (104 / 104) 6.13E-02 - 1.42E-01	PM3 10.4 MILES NNE	1.07E-01 (13 / 13) 7.94E-02 - 1.42E-01	9.86E-02 (26 / 26) 5.49E-02 - 1.34E-01	
BI-214	5.00E-03	1.99E-02 (102 / 104) 5.40E-03 - 7.16E-02	LM-4 WB 0.9 MILES SE	2.53E-02 (13 / 13) 6.40E-03 - 7.16E-02	2.16E-02 (26 / 26) 5.20E-03 - 5.66E-02	
K-40	4.00E-02	104 VALUES < LLD	PM4 7.6 MILES NE/ENE	13 VALUES < LLD	26 VALUES < LLD	
PB-212	5.00E-03	104 VALUES < LLD	PM4 7.6 MILES NE/ENE	13 VALUES < LLD	26 VALUES < LLD	
PB-214	5.00E-03	1.90E-02 (100 / 104) 5.00E-03 - 7.50E-02	LM-4 WB 0.9 MILES SE	2.40E-02 (12 / 13) 5.30E-03 - 7.50E-02	2.13E-02 (26 / 26) 5.00E-03 - 5.94E-02	
TL-208	2.00E-03	2.20E-03 (1 / 104) 2.20E-03 - 2.20E-03	PM5 DECATUR 6.2 MILES S	2.20E-03 (1 / 13) 2.20E-03 - 2.20E-03	26 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-4

Tennessee Valley Authority

RADIOACTIVITY IN CHARCOAL FILTER

pCi/m^3 = 0.037 Bq/m^3

Name of Facility: WATTS BAR NUCLEAR PLANT

Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391

Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 520						
BI-214	5.00E-02	1.14E-01 (206 / 416) 5.01E-02 - 6.81E-01	LM2 0.5 MILES N	1.40E-01 (28 / 52) 5.03E-02 - 6.81E-01	1.35E-01 (43 / 104) 5.21E-02 - 7.50E-01	
I-131	3.00E-02	SEE NOTE 4				
K-40	3.00E-01	3.49E-01 (79 / 416) 3.02E-01 - 7.33E-01	PM5 DECATUR 6.2 MILES S	3.60E-01 (17 / 52) 3.02E-01 - 7.33E-01	3.78E-01 (19 / 104) 3.02E-01 - 6.13E-01	
PB-212	3.00E-02	416 VALUES < LLD	PM2 SPRING CITY 7.0 MILES NW	52 VALUES < LLD	104 VALUES < LLD	
PB-214	7.00E-02	1.44E-01 (119 / 416) 7.00E-02 - 6.92E-01	LM2 0.5 MILES N	2.10E-01 (13 / 52) 7.89E-02 - 6.92E-01	1.78E-01 (25 / 104) 7.15E-02 - 7.40E-01	
TL-208	2.00E-02	416 VALUES < LLD	LM3 1.9 MILES NNE	52 VALUES < LLD	104 VALUES < LLD	

Notes:
1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements
4. The analysis of Charcoal Filters was performed by Gamma Spectroscopy. No I-131 was detected. The LLD for I-131 by Gamma Spectroscopy was 0.03 pCi/cubic meter.

Tennessee Valley Authority

RADIOACTIVITY IN ATMOSPHERIC MOISTURE
pCi/m^3 = 0.037 Bq/m^3

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
TRITIUM - 203						
	3.00E+00	4.90E+00 (75 / 153) 3.06E+00 - 2.64E+01	LM1 0.5 MILES SSW	5.54E+00 (18 / 26) 3.26E+00 - 2.64E+01	4.00E+00 (18 / 50) 3.04E+00 - 5.54E+00	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-5

Table H-6

Tennessee Valley Authority

RADIOACTIVITY IN MILK

pCi/L = 0.037 Bq/L

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
IODINE-131 - 78						
	4.00E-01	52 VALUES < LLD			26 VALUES < LLD	
GAMMA SCAN (GELI) - 78						
AC-228	2.00E+01	52 VALUES < LLD	1.75 MILES SSW	26 VALUES < LLD	2.59E+01 (1 / 26) 2.59E+01 - 2.59E+01	
BI-212	5.00E+01	1.84E+02 (1 / 52) 1.84E+02 - 1.84E+02	1.75 MILES SSW	1.84E+02 (1 / 26) 1.84E+02 - 1.84E+02	26 VALUES < LLD	
BI-214	2.00E+01	3.23E+01 (31 / 52) 2.00E+01 - 6.48E+01	1.75 MILES SSW	3.33E+01 (17 / 26) 2.00E+01 - 6.48E+01	3.28E+01 (15 / 26) 2.12E+01 - 6.13E+01	
K-40	1.00E+02	1.31E+03 (50 / 52) 1.15E+03 - 1.44E+03	NORTON FARM 4.1 MILES ESE	1.31E+03 (25 / 26) 1.15E+03 - 1.42E+03	1.32E+03 (26 / 26) 1.18E+03 - 1.44E+03	
PA-234M	8.00E+02	52 VALUES < LLD	1.75 MILES SSW	26 VALUES < LLD	26 VALUES < LLD	
PB-212	1.50E+01	52 VALUES < LLD	1.75 MILES SSW	26 VALUES < LLD	26 VALUES < LLD	
PB-214	2.00E+01	2.93E+01 (21 / 52) 2.01E+01 - 4.99E+01	1.75 MILES SSW	3.07E+01 (8 / 26) 2.14E+01 - 4.99E+01	2.94E+01 (14 / 26) 2.04E+01 - 4.90E+01	
TL-208	1.00E+01	52 VALUES < LLD	NORTON FARM 4.1 MILES ESE	26 VALUES < LLD	26 VALUES < LLD	
SR 89 - 12						
	3.50E+00	8 VALUES < LLD			4 VALUES < LLD	
SR 90 - 12						
	2.00E+00	8 VALUES < LLD			4 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-7

Tennessee Valley Authority

RADIOACTIVITY IN SOIL
pCi/g = 0.037 Bq/g (DRY WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 10						
AC-228	2.50E-01	1.18E+00 (8 / 8) 8.32E-01 - 1.34E+00	LM1 0.5 MILES SSW	1.34E+00 (1 / 1) 1.34E+00 - 1.34E+00	6.25E-01 (2 / 2) 6.08E-01 - 6.42E-01	
BE-7	2.50E-01	3.15E-01 (3 / 8) 2.62E-01 - 3.84E-01	PM5 DECATUR 6.2 MILES S	3.84E-01 (1 / 1) 3.84E-01 - 3.84E-01	2 VALUES < LLD	
BI-212	4.50E-01	1.23E+00 (8 / 8) 9.08E-01 - 1.48E+00	PM3 10.4 MILES NNE	1.48E+00 (1 / 1) 1.48E+00 - 1.48E+00	6.62E-01 (2 / 2) 6.62E-01 - 6.62E-01	
BI-214	1.50E-01	7.64E-01 (8 / 8) 5.38E-01 - 8.87E-01	LM3 1.9 MILES NNE	8.87E-01 (1 / 1) 8.87E-01 - 8.87E-01	6.07E-01 (2 / 2) 5.68E-01 - 6.45E-01	
CS-137	3.00E-02	1.68E-01 (7 / 8) 3.07E-02 - 5.64E-01	PM2 SPRING CITY 7.0 MILES NW	5.64E-01 (1 / 1) 5.64E-01 - 5.64E-01	3.15E-01 (2 / 2) 1.84E-01 - 4.46E-01	
K-40	7.50E-01	1.16E+01 (8 / 8) 3.39E+00 - 2.58E+01	LM-4 WB 0.9 MILES SE	2.58E+01 (1 / 1) 2.58E+01 - 2.58E+01	3.65E+00 (2 / 2) 3.08E+00 - 4.23E+00	
PA-234M	4.00E+00	8 VALUES < LLD	PM2 SPRING CITY 7.0 MILES NW	1 VALUES < LLD	2 VALUES < LLD	
PB-212	1.00E-01	1.17E+00 (8 / 8) 8.52E-01 - 1.42E+00	PM3 10.4 MILES NNE	1.42E+00 (1 / 1) 1.42E+00 - 1.42E+00	6.07E-01 (2 / 2) 6.06E-01 - 6.08E-01	
PB-214	1.50E-01	8.39E-01 (8 / 8) 6.00E-01 - 9.70E-01	LM3 1.9 MILES NNE	9.70E-01 (1 / 1) 9.70E-01 - 9.70E-01	6.76E-01 (2 / 2) 6.23E-01 - 7.29E-01	
RA-226	1.50E-01	7.64E-01 (8 / 8) 5.38E-01 - 8.87E-01	LM3 1.9 MILES NNE	8.87E-01 (1 / 1) 8.87E-01 - 8.87E-01	6.07E-01 (2 / 2) 5.68E-01 - 6.45E-01	
TL-208	6.00E-02	3.93E-01 (8 / 8) 2.78E-01 - 4.61E-01	PM3 10.4 MILES NNE	4.61E-01 (1 / 1) 4.61E-01 - 4.61E-01	1.96E-01 (2 / 2) 1.87E-01 - 2.05E-01	
SR 89 - 10	1.60E+00	8 VALUES < LLD			2 VALUES < LLD	
SR 90 - 10	4.00E-01	8 VALUES < LLD			2 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Tennessee Valley Authority

RADIOACTIVITY IN CORN

pCi/Kg = 0.037 Bq/Kg (WET WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 2						
BI-214	4.00E+01	1 VALUES < LLD	NORTON FARM 4.1 MILES ESE	1 VALUES < LLD	1.72E+02 (1 / 1) 1.72E+02 - 1.72E+02	
K-40	2.50E+02	2.03E+03 (1 / 1) 2.03E+03 - 2.03E+03	NORTON FARM 4.1 MILES ESE	2.03E+03 (1 / 1) 2.03E+03 - 2.03E+03	2.21E+03 (1 / 1) 2.21E+03 - 2.21E+03	
PB-214	8.00E+01	1 VALUES < LLD	NORTON FARM 4.1 MILES ESE	1 VALUES < LLD	1 VALUES < LLD	

Table H-8

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Tennessee Valley Authority

RADIOACTIVITY IN GREEN BEANS
pCi/Kg = 0.037 Bq/Kg (WET WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 2						
BI-214	4.00E+01	4.17E+01 (1 / 1) 4.17E+01 - 4.17E+01	3.0 MILES NE	4.17E+01 (1 / 1) 4.17E+01 - 4.17E+01	1 VALUES < LLD	
K-40	2.50E+02	1.90E+03 (1 / 1) 1.90E+03 - 1.90E+03	3.0 MILES NE	1.90E+03 (1 / 1) 1.90E+03 - 1.90E+03	2.40E+03 (1 / 1) 2.40E+03 - 2.40E+03	
PB-214	8.00E+01	1 VALUES < LLD	3.0 MILES NE	1 VALUES < LLD	1 VALUES < LLD	

Table H-9

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Tennessee Valley Authority

RADIOACTIVITY IN TOMATOES
pCi/Kg = 0.037 Bq/Kg (WET WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 2						
BI-214	4.00E+01	4.09E+01 (1 / 1) 4.09E+01 - 4.09E+01	2.5 MILES NE	4.09E+01 (1 / 1) 4.09E+01 - 4.09E+01	4.72E+01 (1 / 1) 4.72E+01 - 4.72E+01	
K-40	2.50E+02	2.11E+03 (1 / 1) 2.11E+03 - 2.11E+03	2.5 MILES NE	2.11E+03 (1 / 1) 2.11E+03 - 2.11E+03	1.98E+03 (1 / 1) 1.98E+03 - 1.98E+03	
PB-214	8.00E+01	1 VALUES < LLD	2.5 MILES NE	1 VALUES < LLD	1 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-10

Table H-11

Tennessee Valley Authority

RADIOACTIVITY IN TURNIP GREENS

pCi/Kg = 0.037 Bq/Kg (WET WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 2						
BI-214	4.00E+01	6.84E+01 (1 / 1) 6.84E+01 - 6.84E+01	3.0 MILES SE	6.84E+01 (1 / 1) 6.84E+01 - 6.84E+01	7.34E+01 (1 / 1) 7.34E+01 - 7.34E+01	
K-40	2.50E+02	2.55E+03 (1 / 1) 2.55E+03 - 2.55E+03	3.0 MILES SE	2.55E+03 (1 / 1) 2.55E+03 - 2.55E+03	2.14E+03 (1 / 1) 2.14E+03 - 2.14E+03	
PB-214	8.00E+01	1 VALUES < LLD	3.0 MILES SE	1 VALUES < LLD	1 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Tennessee Valley Authority

RADIOACTIVITY IN SURFACE WATER (Total)
pCi/L = 0.037 Bq/L

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GROSS BETA - 39						
	1.90E+00	2.50E+00 (14 / 26) 1.96E+00 - 3.10E+00	TRM 517.9	2.57E+00 (7 / 13) 2.05E+00 - 3.10E+00	2.41E+00 (8 / 13) 2.02E+00 - 2.98E+00	
GAMMA SCAN (GELI) - 39						
AC-228	2.00E+01	26 VALUES < LLD	TRM 523.1	13 VALUES < LLD	13 VALUES < LLD	
BI-214	2.00E+01	3.17E+01 (15 / 26) 2.03E+01 - 5.30E+01	TRM 523.1	3.25E+01 (7 / 13) 2.07E+01 - 5.30E+01	4.30E+01 (7 / 13) 2.20E+01 - 1.11E+02	
K-40	1.00E+02	26 VALUES < LLD	TRM 523.1	13 VALUES < LLD	13 VALUES < LLD	
PB-212	1.50E+01	26 VALUES < LLD	TRM 523.1	13 VALUES < LLD	13 VALUES < LLD	
PB-214	2.00E+01	3.25E+01 (9 / 26) 2.17E+01 - 4.72E+01	TRM 523.1	3.48E+01 (4 / 13) 2.31E+01 - 4.72E+01	5.44E+01 (4 / 13) 3.39E+01 - 1.02E+02	
TL-208	1.00E+01	26 VALUES < LLD	TRM 517.9	13 VALUES < LLD	13 VALUES < LLD	
TRITIUM - 39						
	2.70E+02	6.85E+02 (14 / 26) 2.98E+02 - 1.67E+03	TRM 523.1	7.31E+02 (8 / 13) 3.12E+02 - 1.67E+03	13 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-12

Tennessee Valley Authority

RADIOACTIVITY IN PUBLIC (DRINKING) WATER (Total)
pCi/L = 0.037 Bq/L

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GROSS BETA - 39						
	1.90E+00	2.18E+00 (13 / 26) 1.91E+00 - 2.69E+00	RM-2 DAYTON TN 17.8 MILES NNE	2.27E+00 (5 / 13) 2.06E+00 - 2.69E+00	2.41E+00 (8 / 13) 2.02E+00 - 2.98E+00	
GAMMA SCAN (GELI) - 39						
AC-228	2.00E+01	2.25E+01 (1 / 26) 2.25E+01 - 2.25E+01	CF INDUSTRIES TRM 473.0	2.25E+01 (1 / 13) 2.25E+01 - 2.25E+01	13 VALUES < LLD	
BI-214	2.00E+01	4.33E+01 (14 / 26) 2.16E+01 - 9.21E+01	RM-2 DAYTON TN 17.8 MILES NNE	5.06E+01 (5 / 13) 2.69E+01 - 9.21E+01	4.30E+01 (7 / 13) 2.20E+01 - 1.11E+02	
K-40	1.00E+02	26 VALUES < LLD	RM-2 DAYTON TN 17.8 MILES NNE	13 VALUES < LLD	13 VALUES < LLD	
PB-212	1.50E+01	26 VALUES < LLD	RM-2 DAYTON TN 17.8 MILES NNE	13 VALUES < LLD	13 VALUES < LLD	
PB-214	2.00E+01	3.84E+01 (12 / 26) 2.04E+01 - 8.68E+01	RM-2 DAYTON TN 17.8 MILES NNE	4.60E+01 (4 / 13) 2.48E+01 - 8.68E+01	5.44E+01 (4 / 13) 3.39E+01 - 1.02E+02	
TL-208	1.00E+01	26 VALUES < LLD	RM-2 DAYTON TN 17.8 MILES NNE	13 VALUES < LLD	13 VALUES < LLD	
TRITIUM - 47						
	2.70E+02	4.74E+02 (21 / 34) 2.84E+02 - 1.07E+03	CF INDUSTRIES TRM 473.0	4.83E+02 (10 / 17) 2.84E+02 - 9.16E+02	13 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-14

Tennessee Valley Authority

RADIOACTIVITY IN WELL (GROUND) WATER (Total)

pCi/L = 0.037 Bq/L

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GROSS BETA - 78						
	1.90E+00	2.86E+00 (35 / 65) 1.91E+00 - 5.60E+00	WBN WELL #1 0.6 MILES S	3.13E+00 (3 / 13) 2.47E+00 - 3.62E+00	2.76E+00 (6 / 13) 1.97E+00 - 4.99E+00	
GAMMA SCAN (GELI) - 78						
AC-228	2.00E+01	65 VALUES < LLD	WBN MW-B 0.45 MILES SSE)	13 VALUES < LLD	13 VALUES < LLD	
BI-214	2.00E+01	3.35E+01 (43 / 65) 2.05E+01 - 6.69E+01	WBN MW-A 0.58 MILES SSE)	3.95E+01 (11 / 13) 2.32E+01 - 5.82E+01	2.95E+01 (7 / 13) 2.19E+01 - 4.15E+01	
K-40	1.00E+02	65 VALUES < LLD	WBN MW-A 0.58 MILES SSE)	13 VALUES < LLD	13 VALUES < LLD	
PB-212	1.50E+01	65 VALUES < LLD	WBN MW-A 0.58 MILES SSE)	13 VALUES < LLD	13 VALUES < LLD	
PB-214	2.00E+01	3.22E+01 (34 / 65) 2.01E+01 - 6.21E+01	WBN MW-A 0.58 MILES SSE)	3.88E+01 (11 / 13) 2.27E+01 - 6.21E+01	2.72E+01 (6 / 13) 2.03E+01 - 3.51E+01	
TL-208	1.00E+01	65 VALUES < LLD	WBN MW-F O.30 MILES SE)	13 VALUES < LLD	13 VALUES < LLD	
TRITIUM - 78						
	2.70E+02	7.78E+02 (34 / 65) 2.74E+02 - 1.44E+03	WBN MW-B 0.45 MILES SSE)	1.09E+03 (13 / 13) 8.25E+02 - 1.44E+03	13 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Tennessee Valley Authority

RADIOACTIVITY IN COMMERCIAL FISH
pCi/g = 0.037 Bq/g (DRY WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 6						
BI-214	1.00E-01	1.82E-01 (3 / 4) 1.47E-01 - 2.17E-01	CHICKAMAUGA RES TRM 471-530	1.82E-01 (2 / 2) 1.47E-01 - 2.17E-01	1.66E-01 (2 / 2) 1.57E-01 - 1.75E-01	
K-40	4.00E-01	1.05E+01 (4 / 4) 9.41E+00 - 1.15E+01	DOWNSTREAM STATION 1 DOWNSTREAM	1.06E+01 (2 / 2) 1.02E+01 - 1.10E+01	1.06E+01 (2 / 2) 1.01E+01 - 1.11E+01	
PB-212	4.00E-02	4 VALUES < LLD	CHICKAMAUGA RES TRM 471-530	2 VALUES < LLD	2 VALUES < LLD	
PB-214	5.00E-01	4 VALUES < LLD	DOWNSTREAM STATION 1 DOWNSTREAM	2 VALUES < LLD	2 VALUES < LLD	
TL-208	3.00E-02	4 VALUES < LLD	CHICKAMAUGA RES TRM 471-530	2 VALUES < LLD	2 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-15

Tennessee Valley Authority

RADIOACTIVITY IN GAME FISH
pCi/g = 0.037 Bq/g (DRY WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 6						
BI-214	1.00E-01	1.93E-01 (4 / 4) 1.32E-01 - 2.58E-01	CHICKAMAUGA RES TRM 471-530	2.11E-01 (2 / 2) 1.63E-01 - 2.58E-01	1.23E-01 (2 / 2) 1.07E-01 - 1.39E-01	
CS-137	3.00E-02	4 VALUES < LLD	CHICKAMAUGA RES TRM 471-530	2 VALUES < LLD	3.24E-02 (1 / 2) 3.24E-02 - 3.24E-02	
K-40	4.00E-01	1.23E+01 (4 / 4) 1.18E+01 - 1.25E+01	DOWNSTREAM STATION 1 DOWNSTREAM	1.25E+01 (2 / 2) 1.24E+01 - 1.25E+01	1.33E+01 (2 / 2) 1.31E+01 - 1.35E+01	
PB-212	4.00E-02	4 VALUES < LLD	CHICKAMAUGA RES TRM 471-530	2 VALUES < LLD	2 VALUES < LLD	
PB-214	5.00E-01	4 VALUES < LLD	CHICKAMAUGA RES TRM 471-530	2 VALUES < LLD	2 VALUES < LLD	
TL-208	3.00E-02	4 VALUES < LLD	DOWNSTREAM STATION 1 DOWNSTREAM	2 VALUES < LLD	2 VALUES < LLD	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-16

Table H-17

Tennessee Valley Authority

RADIOACTIVITY IN SHORELINE SEDIMENT
pCi/g = 0.037 Bq/g (DRY WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 4						
AC-228	2.50E-01	1.19E+00 (2 / 2) 1.16E+00 - 1.23E+00	COTTON PORT MARINA TRM 513	1.19E+00 (2 / 2) 1.16E+00 - 1.23E+00	1.15E+00 (2 / 2) 5.27E-01 - 1.77E+00	
BE-7	2.50E-01	3.40E-01 (1 / 2) 3.40E-01 - 3.40E-01	COTTON PORT MARINA TRM 513	3.40E-01 (1 / 2) 3.40E-01 - 3.40E-01	2 VALUES < LLD	
BI-212	4.50E-01	1.29E+00 (2 / 2) 1.28E+00 - 1.30E+00	COTTON PORT MARINA TRM 513	1.29E+00 (2 / 2) 1.28E+00 - 1.30E+00	1.27E+00 (2 / 2) 5.20E-01 - 2.01E+00	
BI-214	1.50E-01	5.56E-01 (2 / 2) 5.23E-01 - 5.89E-01	COTTON PORT MARINA TRM 513	5.56E-01 (2 / 2) 5.23E-01 - 5.89E-01	7.67E-01 (2 / 2) 4.47E-01 - 1.09E+00	
CS-137	3.00E-02	2 VALUES < LLD	COTTON PORT MARINA TRM 513	2 VALUES < LLD	2 VALUES < LLD	
K-40	7.50E-01	2.70E+01 (2 / 2) 2.46E+01 - 2.94E+01	COTTON PORT MARINA TRM 513	2.70E+01 (2 / 2) 2.46E+01 - 2.94E+01	7.31E+00 (2 / 2) 2.36E+00 - 1.23E+01	
PB-212	1.00E-01	1.16E+00 (2 / 2) 1.08E+00 - 1.24E+00	COTTON PORT MARINA TRM 513	1.16E+00 (2 / 2) 1.08E+00 - 1.24E+00	1.13E+00 (2 / 2) 5.13E-01 - 1.74E+00	
PB-214	1.50E-01	6.14E-01 (2 / 2) 5.82E-01 - 6.45E-01	COTTON PORT MARINA TRM 513	6.14E-01 (2 / 2) 5.82E-01 - 6.45E-01	8.01E-01 (2 / 2) 4.74E-01 - 1.13E+00	
RA-224	7.50E-01	1.34E+00 (1 / 2) 1.34E+00 - 1.34E+00	COTTON PORT MARINA TRM 513	1.34E+00 (1 / 2) 1.34E+00 - 1.34E+00	1.76E+00 (1 / 2) 1.76E+00 - 1.76E+00	
RA-226	1.50E-01	5.56E-01 (2 / 2) 5.23E-01 - 5.89E-01	COTTON PORT MARINA TRM 513	5.56E-01 (2 / 2) 5.23E-01 - 5.89E-01	7.67E-01 (2 / 2) 4.47E-01 - 1.09E+00	
TL-208	6.00E-02	3.90E-01 (2 / 2) 3.86E-01 - 3.94E-01	COTTON PORT MARINA TRM 513	3.90E-01 (2 / 2) 3.86E-01 - 3.94E-01	3.72E-01 (2 / 2) 1.66E-01 - 5.79E-01	

Notes: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

RADIOACTIVITY IN POND SEDIMENT

pCi/g = 0.037 Bq/g (DRY WEIGHT)

Name of Facility: WATTS BAR NUCLEAR PLANT
Location of Facility: RHEA, TENNESSEE

Docket Number: 50-390,391
Reporting Period: 2015

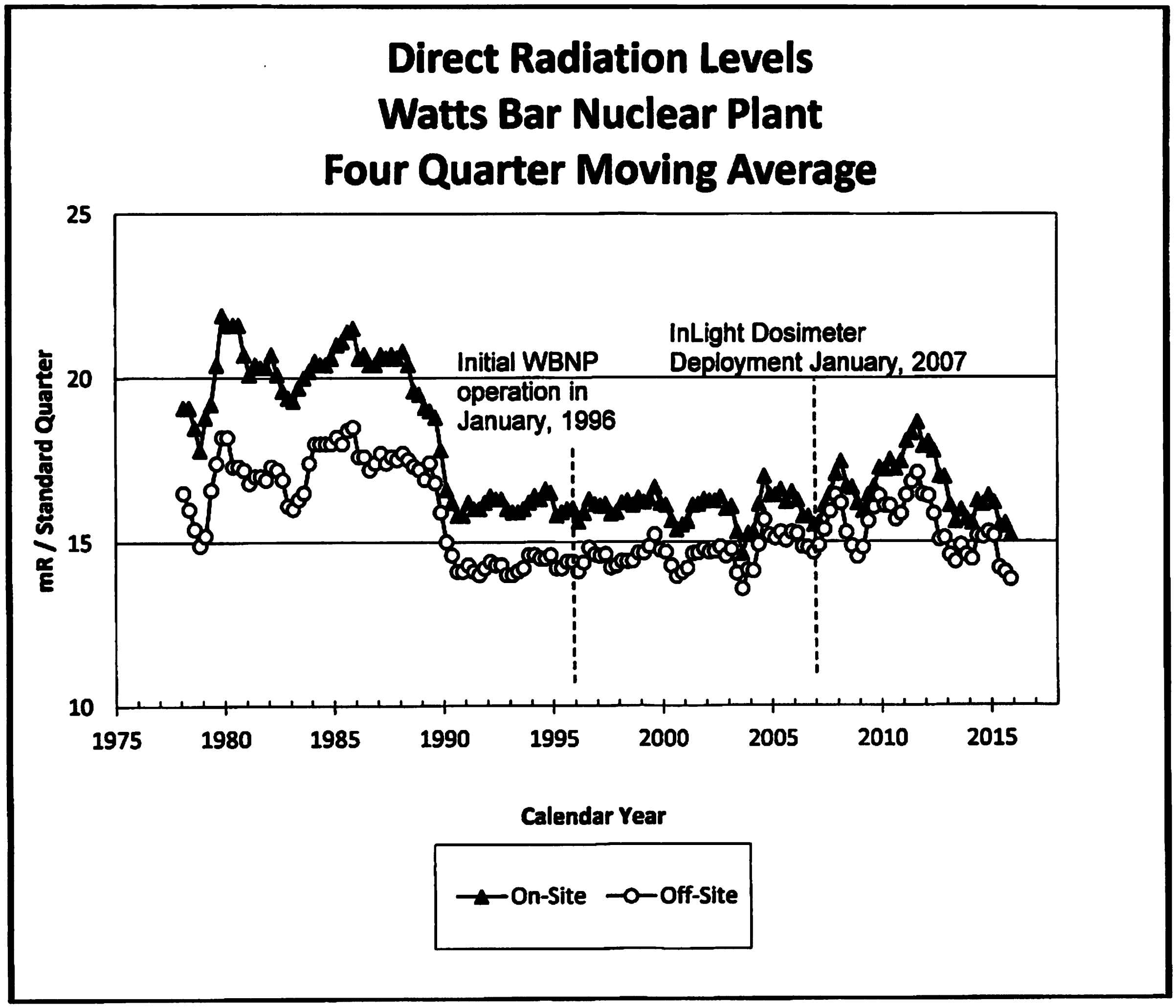
Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Annual Mean: Location Description with Distance and Direction	Location with Highest Annual Mean: Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements See Note 3
GAMMA SCAN (GELI) - 5						
AC-228	2.50E-01	8.42E-01 (5 / 5) 4.88E-01 - 1.01E+00	YP-13 YARD POND	1.01E+00 (1 / 1) 1.01E+00 - 1.01E+00	VALUES < LLD	
BE-7	2.50E-01	2.79E-01 (1 / 5) 2.79E-01 - 2.79E-01	YP-13 YARD POND	2.79E-01 (1 / 1) 2.79E-01 - 2.79E-01	VALUES < LLD	
BI-212	4.50E-01	9.18E-01 (5 / 5) 5.79E-01 - 1.13E+00	YP-5 YARD POND	1.13E+00 (1 / 1) 1.13E+00 - 1.13E+00	VALUES < LLD	
BI-214	1.50E-01	6.42E-01 (5 / 5) 4.20E-01 - 8.13E-01	YP-5 YARD POND	8.13E-01 (1 / 1) 8.13E-01 - 8.13E-01	VALUES < LLD	
CO-60	3.00E-02	7.63E-02 (3 / 5) 4.30E-02 - 1.29E-01	YP-5 YARD POND	1.29E-01 (1 / 1) 1.29E-01 - 1.29E-01	VALUES < LLD	
CS-137	3.00E-02	9.84E-02 (4 / 5) 3.10E-02 - 1.43E-01	LV-3 LOW VOL WASTE POND	1.43E-01 (1 / 1) 1.43E-01 - 1.43E-01	VALUES < LLD	
K-40	7.50E-01	1.07E+01 (5 / 5) 5.95E+00 - 1.54E+01	YP-13 YARD POND	1.54E+01 (1 / 1) 1.54E+01 - 1.54E+01	VALUES < LLD	
PA-234M	4.00E+00	5 VALUES < LLD	YP-5 YARD POND	1 VALUES < LLD	VALUES < LLD	
PB-212	1.00E-01	8.25E-01 (5 / 5) 5.22E-01 - 1.05E+00	YP-13 YARD POND	1.05E+00 (1 / 1) 1.05E+00 - 1.05E+00	VALUES < LLD	
PB-214	1.50E-01	7.08E-01 (5 / 5) 4.76E-01 - 8.73E-01	YP-13 YARD POND	8.73E-01 (1 / 1) 8.73E-01 - 8.73E-01	VALUES < LLD	
RA-224	7.50E-01	8.91E-01 (3 / 5) 8.01E-01 - 9.76E-01	YP-5 YARD POND	9.76E-01 (1 / 1) 9.76E-01 - 9.76E-01	VALUES < LLD	
TL-208	6.00E-02	2.80E-01 (5 / 5) 1.66E-01 - 3.52E-01	YP-13 YARD POND	3.52E-01 (1 / 1) 3.52E-01 - 3.52E-01	VALUES < LLD	

Notes:
1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
3. Blanks in this column indicate no nonrountine measurements

Table H-18

Figure H-1

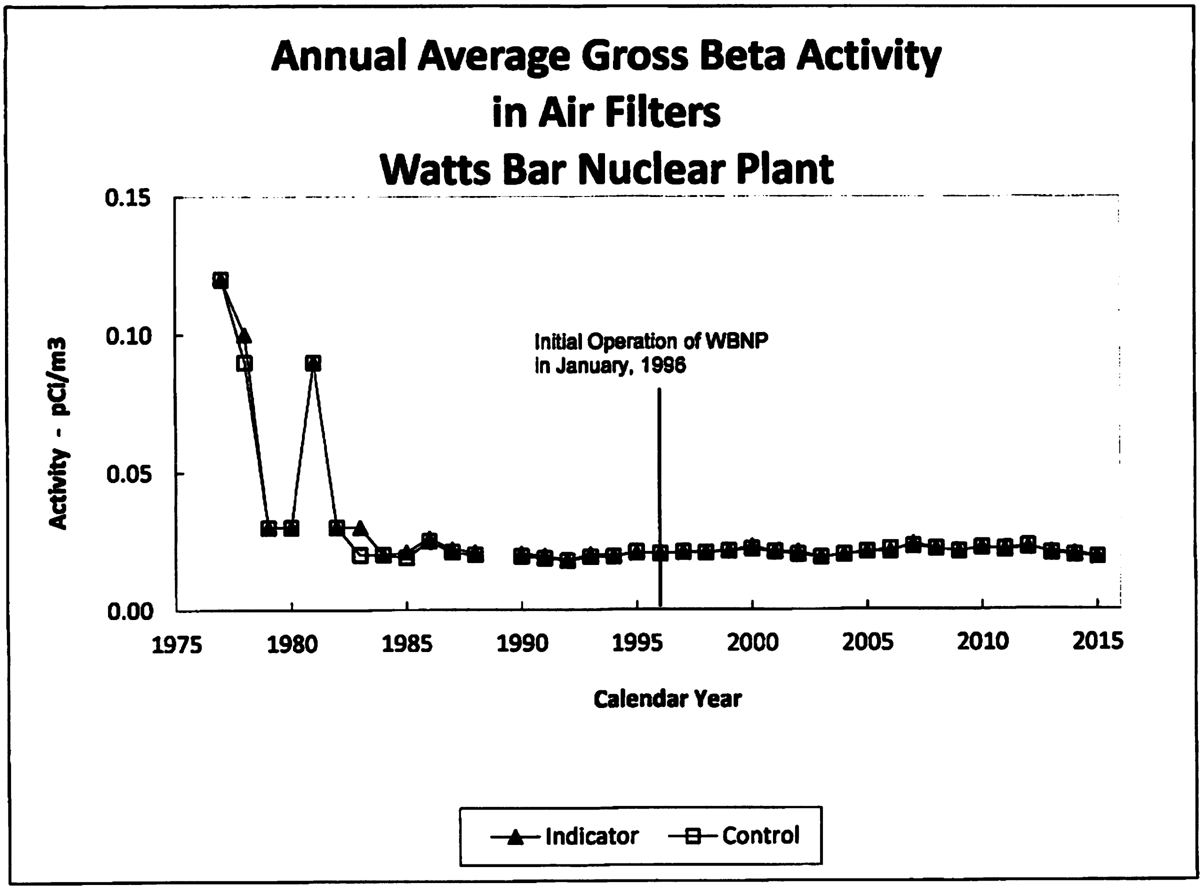
Direct Radiation



Dosimeters are processed quarterly. This chart shows trends in the average measurement for all dosimeters grouped as "on-site" or "off-site". The data from preoperational phase, prior to 1996, show the same trend of "on-site" measurements higher than "off-site" measurements that is observed in current data indicating that the slightly higher "on-site" direct radiation levels are not related to plant operations.

Figure H-2

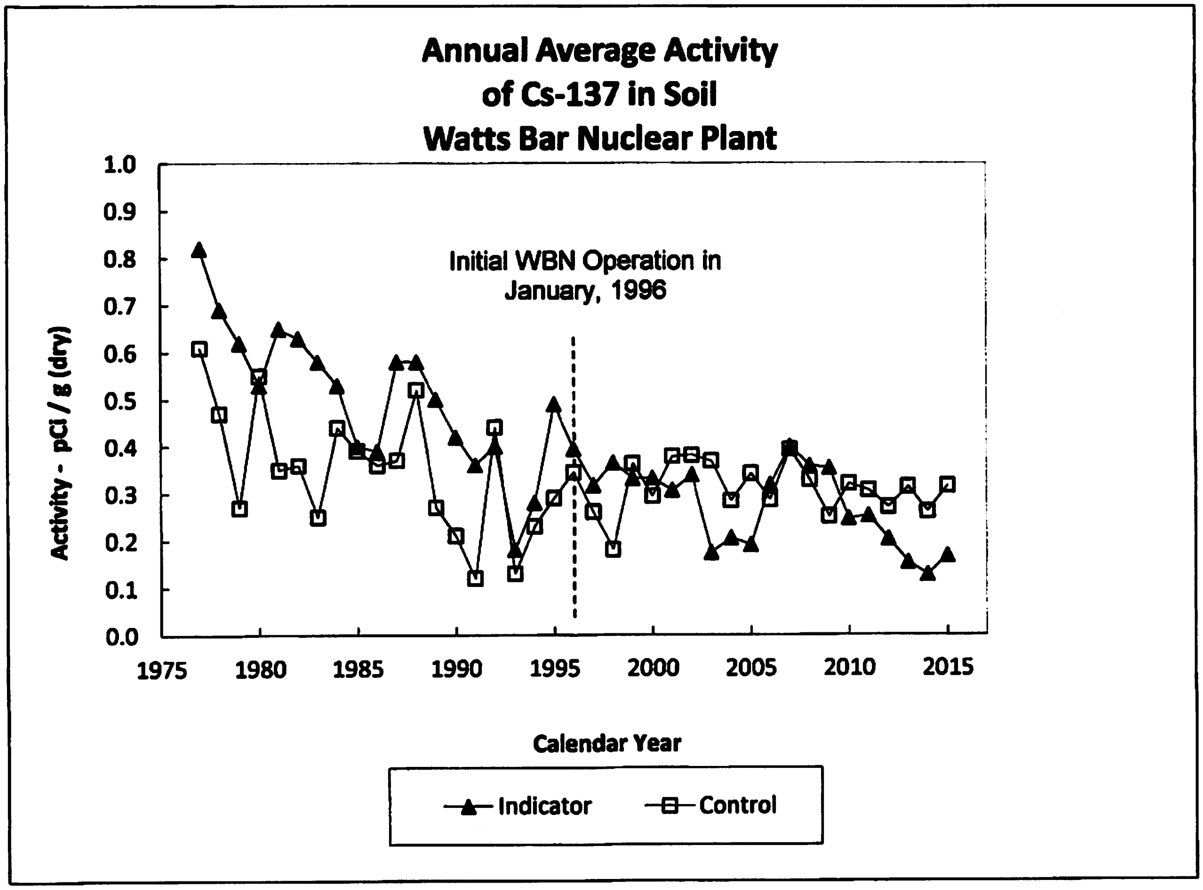
Radioactivity in Air Filters



As can be seen in the trend plot of gross beta activity, the gross beta levels in air particulates have remained relatively constant with the exception of years when the beta activity was elevated due to fallout from nuclear weapons testing. The data also shows that there is no difference in the levels for sampling conducted at the indicator stations as compared to the control stations. The Watts Bar monitoring program was suspended for one year in 1989. The preoperational monitoring was restarted in 1990.

Figure H-3

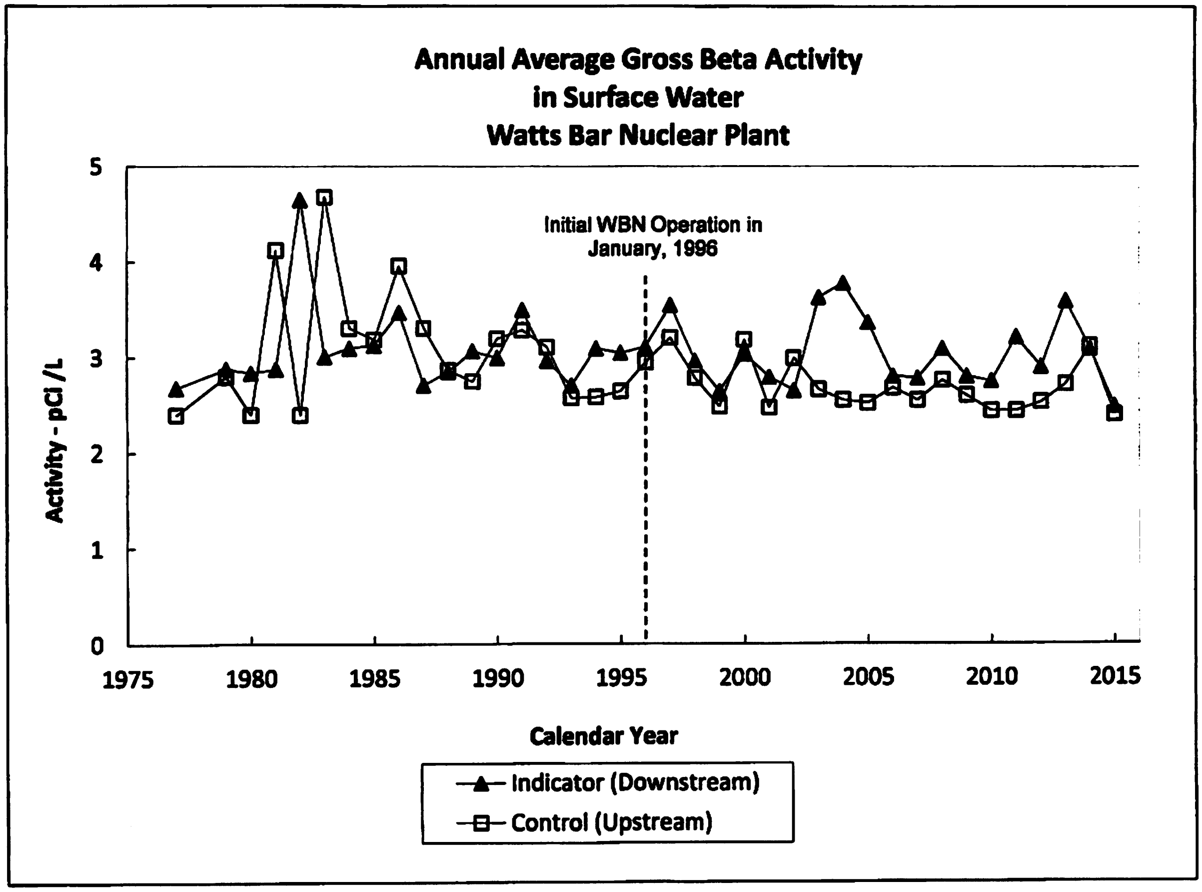
Cs-137 in Soil



Cesium-137 was produced by past nuclear weapons testing and is present in almost every environmental soil sample exposed to the atmosphere. The "control" and "indicator" locations have generally trended downward with year-to-year variation, since the beginning of the Watts Bar monitoring program.

Figure H-4

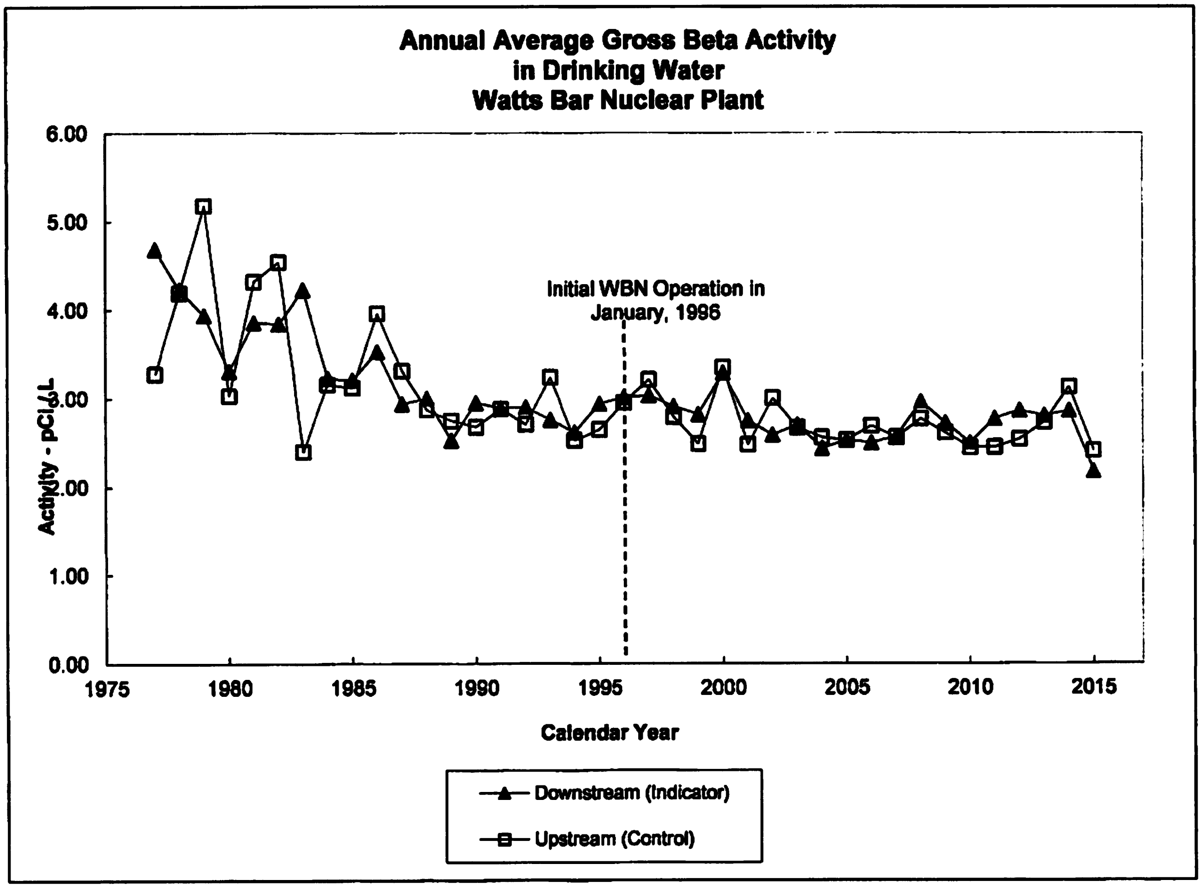
Gross Beta Activity in Surface Water



As shown in the graph, the gross beta activity has been essentially the same in samples from the downstream and upstream locations. The average gross beta activity in these samples has been representative of the levels measured during preoperational monitoring.

Figure H-5

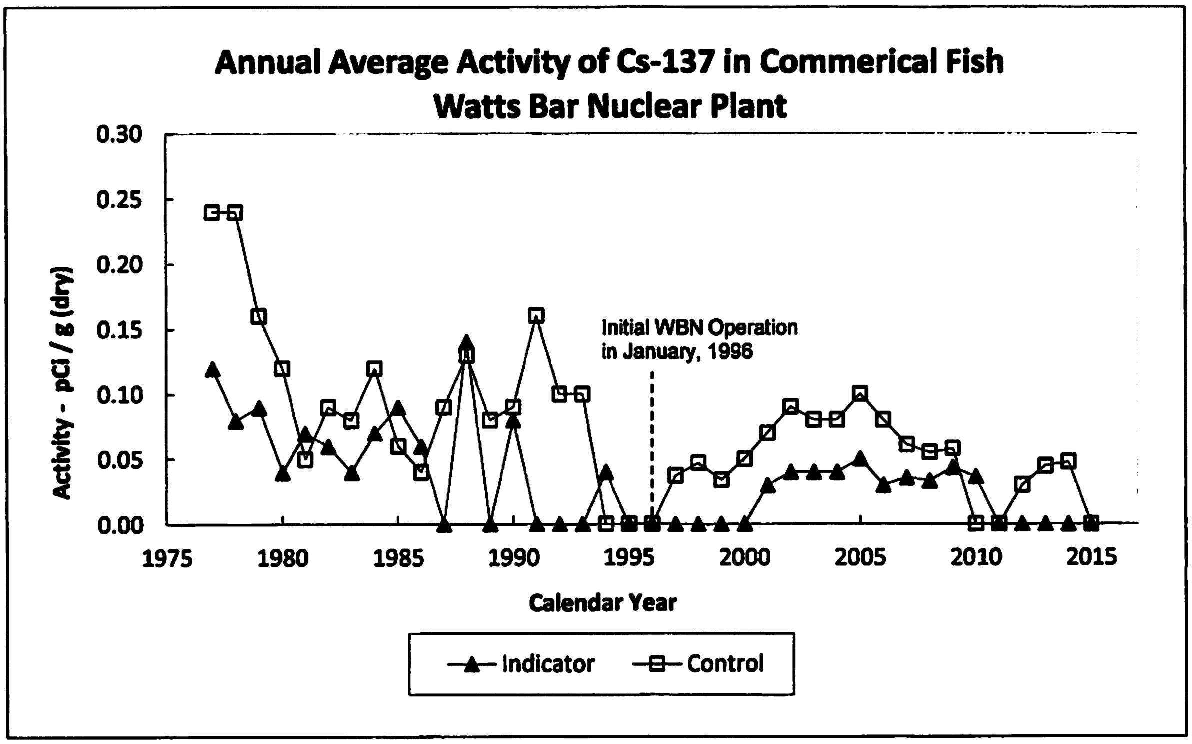
Gross Beta Activity in Drinking Water

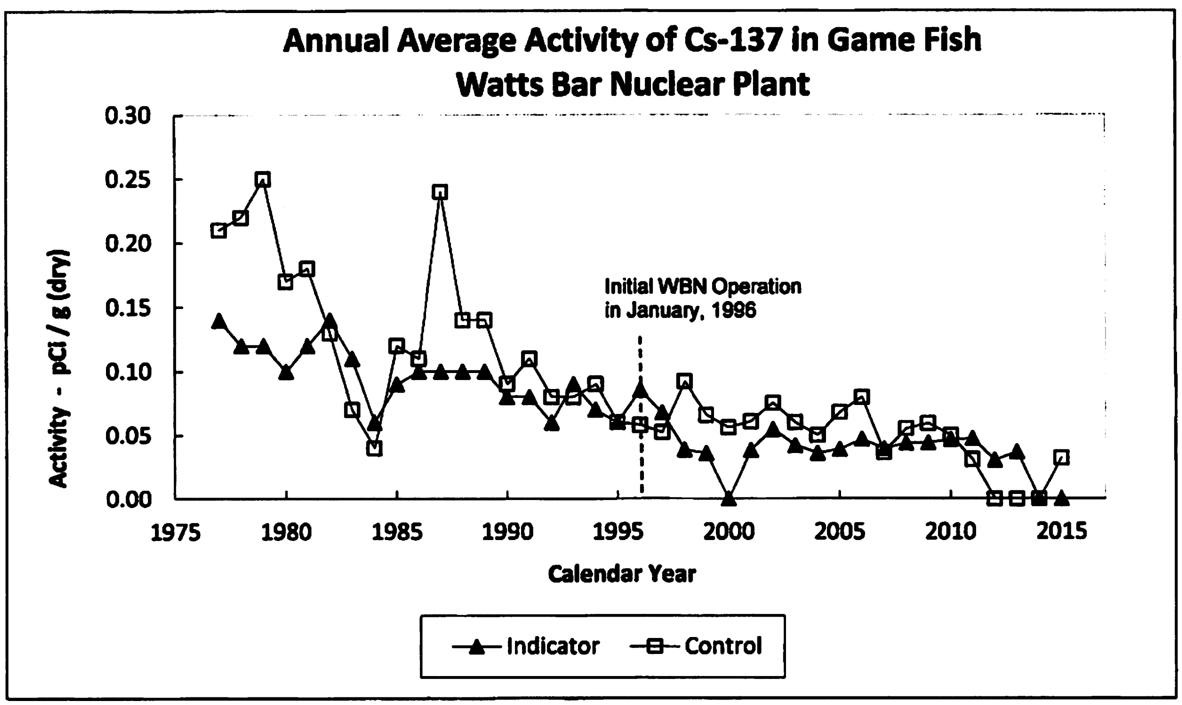


The average gross beta activity in drinking water samples from the upstream control locations has been essentially the same as the activity level measured in samples from the downstream indicator locations. The annual average gross beta activity has been relatively constant since the start of plant operations in 1996 and is slightly lower than preoperational levels.

Figure H-6

Radioactivity in Fish

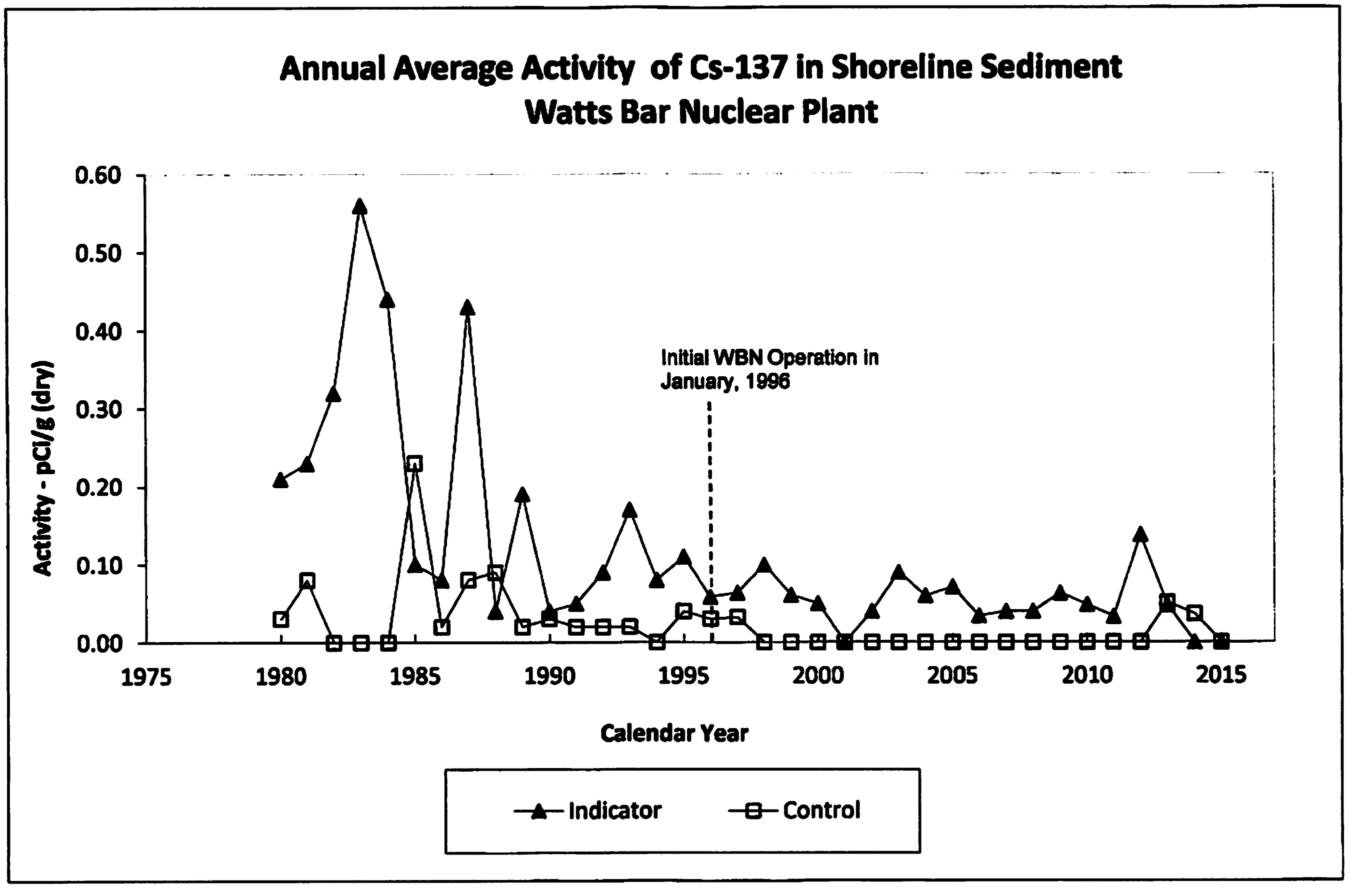




The concentrations of Cs-137 found in fish are consistent with levels present in the Tennessee River due to past atmospheric nuclear weapons testing and operation of other nuclear facilities in the upper reaches of the Tennessee River Watershed.

Figure H-7

Radioactivity in Shoreline Sediment



The Cs-137 present in the shoreline sediments of the Tennessee River system was produced both by testing of nuclear weapons and operation of other nuclear facilities in the upper reaches of the Tennessee River Watershed. The amounts of Cs-137 have declined significantly during the course of monitoring for the Watts Bar site, so much so that not all samples contain detectable levels.