



Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609

May 3, 2000

10 CFR 50, APPENDIX I,  
Section IV.B.2, IV.B.3, & IV.C

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

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

**BROWNS FERRY NUCLEAR PLANT (BFN) - UNITS 1, 2, AND 3 - ANNUAL  
RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR) REPORT -  
JANUARY THROUGH DECEMBER 1999**

In accordance with the BFN Technical Specifications (TS) Section 5.6.2 and 10 CFR 50, Appendix I, Section IV.B, TVA is submitting the AREOR report for BFN Units 1, 2, and 3. This report covers the period from January through December 1999.

TS Section 5.6.2 requires that the enclosed AREOR report contain summaries, interpretations, and analyses of trends of the results of the Radiological Environmental Monitoring Program for the reporting period. In addition, the BFN Offsite Dose Calculation Manual, Section 5.1, requires the AREOR to include the following information:

- Results of land use censuses
- Summarized and tabulated results of the radiological environmental samples taken during the reporting period, in the format of Regulatory Guide 4.8, December 1975, and NUREG 1302, April 1991
- Summary description of the radiological environmental monitoring program

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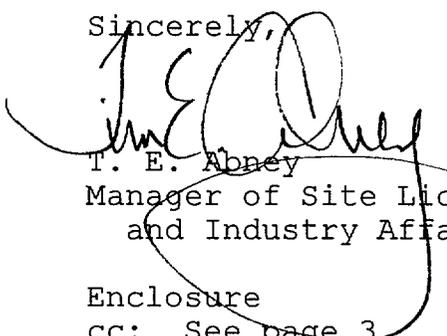
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- A map of sampling locations keyed to a table giving distances and directions from one reactor
- Results of TVA's participation in the Interlaboratory Comparison Program

The report concludes that based upon the analysis of the environmental sampling results and trend data, the exposure to members of the public which may have been attributable to BFN operation is negligible.

There are no commitments contained in this letter. If you have any questions, please contact me at (256) 729-2636.

Sincerely,



T. E. Abney  
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Enclosure  
cc: See page 3

U.S. Nuclear Regulatory Commission  
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Enclosure

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ENCLOSURE

TENNESSEE VALLEY AUTHORITY  
BROWNS FERRY NUCLEAR PLANT  
UNITS 1, 2, AND 3

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT  
JANUARY THROUGH DECEMBER 1999

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SEE ATTACHED:

# **Annual Radiological Environmental Operating Report**

**Browns Ferry  
Nuclear Plant  
1999**



ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

BROWNS FERRY NUCLEAR PLANT

1999

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION

April 2000

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## EXECUTIVE SUMMARY

This report describes the radiological environmental monitoring program conducted by TVA in the vicinity of the Browns Ferry Nuclear Plant (BFN) in 1999. The program includes the collection of samples from the environment and the determination of the concentrations of radioactive materials in the samples. Samples are taken from stations in the general area of the plant and from areas not influenced by plant operations. Monitoring includes the sampling of air, water, milk, foods, vegetation, soil, fish, sediment, and the measurement of direct radiation levels. Results from stations near the plant are compared with concentrations from control stations and with preoperational measurements to determine potential impacts of plant operations.

The vast majority of the exposures calculated from environmental samples were contributed by naturally occurring radioactive materials or from materials commonly found in the environment as a result of atmospheric nuclear weapons fallout.

Small amounts of Co-60, Cs-137, and Sr-90 were measured in a small number of samples collected during 1999. The level of activity measured in these samples would result in no measurable increase over background in the dose to the general public.

## INTRODUCTION

This report describes and summarizes results of radioactivity measurements made in the vicinity of BFN 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, Sections 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 BFN Technical Specification 5.6.2 and Offsite Dose Calculation Manual (ODCM) Administrative Control 5.1. In addition, estimates of the maximum potential doses to the surrounding population are made from radioactivity measured both in plant effluents and in environmental samples. The data presented in this report include results from the prescribed program and information 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. Approximately 0.01 percent of all potassium is radioactive potassium-40. Potassium-40 (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. An individual weighing 150 pounds contains about 140 grams of potassium (Reference 1). This is equivalent to approximately 100,000 pCi of K-40 which delivers a dose of 15 to 20 mrem per year to the bone and soft tissue of the body. Naturally occurring radioactive materials have always been in our environment. Other examples of naturally occurring radioactive materials are beryllium (Be)-7, bismuth (Bi)-212, 214, lead (Pb)-212, 214, thallium (Tl)-208, actinium (Ac)-228, uranium (U)-238, 235, thorium (Th)-234, radium (Ra)-226, radon (Rn)-222, 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 comes in the form of cosmic ray radiation from outer space. We are all exposed to this natural radiation 24 hours per day.

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 following information is primarily adapted from References 2 and 3.

#### U.S. GENERAL POPULATION AVERAGE DOSE EQUIVALENT ESTIMATES

Source	Millirem/Year Per Person
Natural background dose equivalent	
Cosmic	27
Cosmogenic	1
Terrestrial	28
In the body	39
Radon-222	200
Total	295
Release of radioactive material in natural gas, mining, ore processing, etc.	5
Medical (effective dose equivalent)	53
Nuclear weapons fallout	less than 1
Nuclear energy	0.28
Consumer products	0.03
<b>Total</b>	<b>355 (approximately)</b>

As can be seen from the table, the 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 compared to that which results 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 both types of 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 released to the environment.

The pathways through which radioactivity is 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 environmental monitoring program which measures the environmental radiation in outlying areas around the plant. In this way, not only is the release of radioactive materials from the plant tightly controlled, but measurements are made in surrounding areas to verify that the population is not being exposed to significant levels of radiation or radioactive materials.

The BFN ODCM, which is 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 NRC guidelines and in the ODCM, is limited as follows:

### Liquid Effluents

Total body	$\leq 3$ mrem/year
Any organ	$\leq 10$ mrem/year

### Gaseous Effluents

#### Noble gases:

Gamma radiation	$\leq 10$ mrad/year
Beta radiation	$\leq 20$ mrad/year

#### Particulates:

Any organ	$\leq 15$ mrem/year
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The Environmental Protection Agency (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 the regulatory limits for the annual average concentrations of radioactive materials released in gaseous and liquid effluents at the boundary of the unrestricted area. Table 1 of this report compares the nominal lower limits of detection for the BFN monitoring program with the regulatory limits for maximum annual average effluent concentrations released to unrestricted areas and levels requiring special reports to the NRC. The data presented in this report indicate compliance with the regulations.

## SITE/PLANT DESCRIPTION

Browns Ferry Nuclear Plant (BFN) is located on the north shore of Wheeler Reservoir at Tennessee River Mile 294 in Limestone County in north Alabama (Figure 1). Wheeler Reservoir averages 1 to 1-1/2 miles in width in the vicinity of the plant. The site, containing approximately 840 acres, is approximately 10 miles southwest of Athens, Alabama, and 10 miles northwest of Decatur, Alabama. The dominant character of land use is small, scattered villages and homes in an agricultural area. A number of relatively large farming operations occupy much of the land on the north side of the river immediately surrounding the plant. The principal crop grown in the area is cotton. Only one dairy farm is located within a 10-mile radius of the plant.

Approximately 2500 people live within a 5-mile radius of the plant. The town of Athens has a population of about 17,000, while approximately 49,000 people live in the city of Decatur. The largest city in the area with approximately 160,000 people is Huntsville, Alabama, located about 24 miles east of the site.

Area recreation facilities are developed along the Tennessee River. The nearest facilities are public use areas located 2 to 3 miles from the site. The city of Decatur has developed a large municipal recreation area, Point Mallard Park, approximately 15 miles upstream of the site. The Tennessee River is also a popular sport fishing area.

BFN consists of three boiling water reactors. Unit 1 achieved criticality on August 17, 1973, and began commercial operation on August 1, 1974. Unit 2 began commercial operation on March 1, 1975. However, a fire in the cable trays on March 22, 1975, forced the shutdown of both reactors. Units 1 and 2 resumed operation and Unit 3 began testing in August 1976. Unit 3 began commercial operation in March 1977.

All three units were out of service from March 1985 to May 1991. Unit 2 was restarted May 24, 1991 and Unit 3 restarted on November 19, 1995. Unit 1 remains in a non operating status.

## RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Most of the radiation and radioactivity generated in a nuclear power reactor is contained within the reactor itself or one of the other plant systems. Plant effluent monitors are designed to detect the small amounts released to the environment. Environmental monitoring is a final verification that the systems are performing as planned. The monitoring program is designed to check the pathways between the plant and the people in the immediate vicinity and to most efficiently monitor these pathways. Sample types are chosen so that the potential for detection of radioactivity in the environment will be maximized. The radiological environmental monitoring program is 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 be 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 method of notation 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 program in 1999 are described in Appendix B and exceptions to the sampling and analysis schedule are presented in Appendix C.

To determine the amount of radioactivity in the environment prior to the operation of BFN, a preoperational radiological environmental monitoring program was initiated in 1968 and operated until the plant began operation in 1973. Measurements of the same types of radioactive materials that are measured currently were assessed during the preoperational phase to establish normal background levels for various radionuclides in the environment.

The preoperational monitoring program is a very important part of the overall program. During the 1950s, 60s, and 70s, atmospheric nuclear weapons testing released radioactive material to the environment causing fluctuations in background radiation levels. This radioactive material is the same type as that produced in the BFN reactors. Preoperational knowledge of pre-existing radionuclide patterns in the environment permits a determination, through comparison and trending analyses, of whether the operation of BFN is impacting the environment and thus the surrounding population.

The evaluation of the impact of plant operations also utilizes data from control stations that have been established in the monitoring program. Results of environmental samples taken at control stations (far from the plant) are compared with those from indicator stations (near the plant) to establish the extent of BFN influence.

All samples are analyzed by the Radioanalytical Laboratory of TVA's Environmental Radiological Monitoring and Instrumentation group located at the Western Area Radiological Laboratory (WARL) in Muscle Shoals, Alabama. All 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 Radioanalytical Laboratory is presented in Appendix E.

The Radioanalytical Laboratory employs 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. In 1999, the laboratory participated in a blind cross-check program administered by a vendor. This cross-check program was used to replace the discontinued EPA Interlaboratory Comparison Program. In addition, samples split with the EPA National Air and Radiation Environmental Laboratory and the State of Alabama provide an independent verification of the overall performance of the laboratory. A complete description of the quality control program is presented in Appendix F.

## DIRECT RADIATION MONITORING

Direct radiation levels are measured at a number of stations 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 radioactivity that may be present as a result of plant operations. Because of the relative large variations in background radiation as compared to the small levels from the plant, contributions from the plant may be difficult to distinguish.

Radiation levels measured in the area around the BFN site in 1999 were consistent with levels from previous years and with levels measured at other locations in the region.

### Measurement Techniques

Direct radiation measurements are made with thermoluminescent dosimeters (TLDs). When certain materials are exposed to ionizing radiation, many of the electrons which become displaced are trapped in the crystalline structure of the material. They remain trapped for long periods of time as long as the material is not heated. When heated (thermo-), the electrons are released, producing a pulse of light (-luminescence). The intensity of the light pulse is proportional to the amount of radiation to which the material was exposed. Materials which display these characteristics are used in the manufacture of TLDs.

From 1968 through 1989, TVA used a Victoreen dosimeter consisting of a manganese activated calcium fluoride ( $\text{Ca}_2\text{F:Mn}$ ) TLD material encased in a glass bulb. In 1989, TVA began the process of changing from the Victoreen dosimeter to the Panasonic Model UD-814 dosimeter, and completely changed to the Panasonic dosimeter in 1990. This dosimeter contains four elements consisting of one lithium borate and three calcium sulfate phosphors. The calcium sulfate phosphors are shielded by approximately 1000 mg/cm<sup>2</sup> plastic and lead to compensate for the over-response of the detector to low energy radiation.

The TLDs are placed approximately 1 meter above the ground, with two or more TLDs at each monitoring location. Monitoring locations for TLDs are located in each of the sixteen compass sectors surrounding the site. One monitoring point is located in each sector near the site boundary and a second monitoring point is located at a distance of approximately five miles in each sector. Nine additional locations are distributed through the sectors out to a distance of approximately 32 miles. The TLDs are exchanged every 3 months and the accumulated exposure on the detectors is read with a Panasonic Model UD-710A automatic reader interfaced with a computer system for analysis of the data.

Since the calcium sulfate phosphor is much more sensitive than the lithium borate, the measured exposure is taken as the median of the results obtained from the calcium sulfate phosphors in all detectors from the monitoring location. The values are corrected for gamma response, system variations, and transit exposure, with individual gamma response calibrations for each element. The system meets or exceeds the performance specifications outlined in Regulatory Guide 4.13 for environmental applications of TLDs.

Since 1974, TVA has participated in the intercomparisons of environmental dosimeters conducted by the U.S. Department of Energy and other interested parties. The results, shown in Table 2, demonstrate that direct radiation levels determined by TVA are generally within ten percent of the calculated or known values.

### Results

All results 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 locations within 1 mile of the plant. The second group lies between 1 and 2 miles, the third group between 2 and 4 miles, the fourth between 4 and 6 miles, and the fifth group is made up of all locations more than 6 miles from the plant. Past data have shown that the results from all monitoring points greater than 2 miles from the plant are essentially the same. Therefore, for

purposes of this report, all locations 2 miles or less from the plant are identified as “onsite” stations and all others are considered “offsite.” Prior to 1976, direct radiation measurements in the environment were made with dosimeters that were not as precise at lower exposures. Consequently, the environmental radiation levels reported in the preoperational phase of the BFN monitoring program exceed current measurements of background radiation levels. For this reason, data collected prior to 1976 are not included in this report. For comparison purposes, direct radiation measurements made in the TVA Watts Bar Nuclear Plant (WBN) construction phase and preoperational radiological environmental monitoring program are referenced.

The quarterly gamma radiation levels determined from the TLDs deployed around BFN in 1999 are summarized in Table H-1. The results from all measurements at individual locations are presented in Table H-2. The exposures are measured in milliroentgens. For purposes of this report, one milliroentgen (mR), one millirem (mrem), and one millirad are assumed to be numerically equivalent. The rounded average annual exposures are shown below.

Annual Average  
Direct Radiation Levels

	<u>mR/Year</u> <u>BFN 1999</u>
Onsite Stations	65
Offsite Stations	56

The data in Table H-1 indicate that the average quarterly radiation levels at the BFN onsite locations are approximately 2.4 mR/quarter higher than levels at the offsite locations. This difference is consistent with levels measured for preoperation and construction phases of TVA nuclear plant sites where the average radiation levels on site were generally 2-6 mR/quarter higher than the levels offsite. The causes of these differences have not been isolated; however, it is postulated that the differences are probably attributable to combinations of influences such as natural variations in environmental radiation levels, earth-moving activities onsite, and the mass

of concrete employed in the construction of the plant. Other undetermined influences may also play a part. These conclusions are supported by the fact that similar differences between onsite and offsite locations were measured in the vicinity of the WBN site during the construction and preoperational phase.

Figure H-1 compares plots of the environmental gamma radiation levels from the onsite or site boundary locations with those from the offsite locations over the period from 1976 through 1999. Figure H-2 depicts the environmental gamma radiation levels measured during the construction and preoperational phase of the WBN site. Note that the data follow a similar pattern to the BFN data and that, as discussed above, the levels reported at onsite locations are higher than the levels at offsite stations.

All results reported in 1999 are consistent with direct radiation levels identified at locations which are not influenced by the operation of BFN. There is no indication that BFN activities increased the background direct 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. In the current program, five local air monitoring stations are located on or adjacent to the plant site in the general direction of greatest wind frequency. Three of these stations (LM-1, LM-2, and LM-3) are located on the plant side of the Tennessee River and two stations (LM-6 and LM-7) are located immediately across the river from the plant site. One additional station (station LM-4) is located at the point of maximum predicted offsite concentration of radionuclides based on preoperational meteorological data. Three perimeter air monitoring stations are located in communities out to about 13 miles from the plant, and two monitors used as controls are located out to 32 miles. 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 and H-4. Radioactivity levels identified in this reporting period are consistent with background radioactivity levels. There is no indication of an increase in atmospheric radioactivity as a result of BFN.

### 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. This allows an accurate determination of the volume of air passing through the filter. The sampling system is housed in a metal building. The filter is contained in a sampling head mounted on the outside of the monitor 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 collected using a commercially available cartridge containing 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.

Rainwater is sampled by use of a collection tray attached to the monitor building. The collection tray is protected from debris by a screen cover. As water drains from the tray, it is collected in one of two 5-gallon jugs inside the monitor building. A 1-gallon sample is removed from the container every 4 weeks. Any excess water is discarded. Rainwater samples are held to be analyzed only if the air particulate samples indicate the presence of elevated activity levels or if fallout is expected. For example, rainwater samples were analyzed during the period of fallout following the accident at Chernobyl in 1986. No rainwater samples from the vicinity of BFN were analyzed in 1999.

### Results

The results from the analysis of air particulate samples are summarized in Table H-3. Gross beta activity in 1999 was consistent with levels reported in previous years. The average gross beta concentrations at indicator and control stations was 0.022 pCi/m<sup>3</sup>. The annual averages of the gross beta activity in air particulate filters at these stations for the years 1968-1999 are presented in Figure H-3. Increased levels due to fallout from atmospheric nuclear weapons testing are evident, especially in 1969, 1970, 1971, 1977, 1978, and 1981. Evidence of a small increase resulting from the Chernobyl accident can also be seen in 1986. These patterns are consistent with data from monitoring programs conducted by TVA at other nuclear power plant sites during construction and preoperational stages.

Only naturally occurring radionuclides were identified by the monthly gamma spectral analysis of the air particulate samples. No fission or activation products were found at levels greater than the LLDs. As shown in Table H-4, iodine-131 was not detected in any of the charcoal cartridge samples collected in 1999.

## 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, vegetation, soil, and food crops are collected and analyzed to determine the potential impacts from exposure to this pathway. The results from the analysis of these samples are shown in Tables H-5 through H-12.

A land use survey is conducted annually to locate milk producing animals and gardens within a 5-mile radius of the plant. Only one dairy farm was located in this area and this farm ended dairy operations during 1999. No other milk-producing animals have been identified within 5 miles of the plant. One dairy farm is located within 7 miles of the plant. This farm is included in the BFN monitoring program as an indicator location. The results of the 1999 land use survey are presented in Appendix G.

### Sample Collection and Analysis

Milk samples were scheduled for collection every 2 weeks from two dairies identified as indicator locations and from at least one of two control farms. As noted above, the dairy at the Smith-Bennett Farm went out of business during 1999. All milk cows had been sold by June 1, 1999, and no milk was available from this location after that date. Milk samples are placed on ice for transport to the radioanalytical laboratory. A specific analysis for I-131 and a gamma spectral analysis are performed on each sample and Sr-89, 90 analysis is performed every 4 weeks.

Samples of vegetation are collected every 4 weeks for I-131 analysis. The vegetation samples are collected from one farm which previously produced milk and from one control dairy farm.

The samples are collected by cutting or breaking enough vegetation to provide between 100 and 200 grams of sample. Care is taken not to include any soil with the vegetation. The sample is placed in a container with 1650 ml of 0.5 N NaOH for transport back to the laboratory. A second sample of between 750 and 1000 grams is also collected from each location. After drying and grinding, this sample is analyzed by gamma spectroscopy.

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. When the gamma analysis is complete, the sample is ashed and analyzed for Sr-89, 90.

Samples representative of food crops raised in the area near the plant are obtained from individual gardens, corner markets, or cooperatives. Types of foods may vary from year to year as a result of changes in the local vegetable gardens. In 1999, samples of cabbage, corn, green beans, potatoes, and tomatoes were collected from local vegetable gardens. 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-5. No radioactivity which could be attributed to BFN was identified. All I-131 results were less than the established nominal LLD of 0.4 pCi/liter. Strontium-90 was identified in one sample. The Sr-90 concentration measured in this sample was approximately 2.11 pCi/liter. This level is less than concentrations measured in samples collected prior to plant operation and is consistent with concentrations expected in milk as a result of fallout from atmospheric nuclear weapons tests (Reference 1). Figure H-4 displays the average Sr-90 concentrations measured in milk since 1968. The concentrations have steadily decreased as a result of the 28-year half-life of Sr-90 and the washout and transport of the element through the soil over the period.

The results for Strontium-89 analysis were less than the LLD of 3.5 pCi/liter. By far the predominant isotope reported in milk samples was the naturally occurring K-40. An average of approximately 1335 pCi/liter of K-40 was identified in all milk samples.

Similar results were found for vegetation samples as reported in Table H-6. All I-131 values were less than nominal LLD. Gamma spectroscopy analysis identified only naturally occurring radionuclides. The largest concentrations identified were for the isotopes K-40 and Be-7.

The only fission or activation product identified in soil samples was Cs-137. The average concentration measured in samples from indicator locations was 0.23 pCi/g. The average concentration for control locations was slightly lower at 0.21 pCi/g. These concentrations are consistent with levels previously reported from fallout. All other radionuclides reported were naturally occurring isotopes. The results of the analysis of soil samples are reported in Table H-7. A plot of the annual average Cs-137 concentrations in soil is presented in Figure H-5. Like the levels of Sr-90 in milk, 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.

Only naturally occurring radioactivity was identified in food crops. The predominant natural radionuclide detected in samples of food crops was K-40. As noted earlier, K-40 is one of the major radionuclides found naturally in the environment and is the predominant radioactive component in normal foods and human tissue. Analysis of these samples indicated no contribution from plant activities. The results are reported in Tables H-8 through H-12.

## LIQUID PATHWAY MONITORING

Potential exposures from the liquid pathway can occur from drinking water, ingestion of fish, and from direct radiation exposure to radioactive materials deposited in the river sediment. The liquid pathway monitoring program conducted during 1999 included the collection of samples of surface (river/reservoir) water, groundwater, drinking water supplies, fish, and shoreline sediment. Samples from the reservoir are collected both upstream and downstream from the plant.

Results from the analysis of aquatic samples are presented in Tables H-13 through H-18. Radioactivity levels in water and shoreline sediment were consistent with background and/or fallout produced levels previously reported. Trace levels of Co-60 and Cs-137 were identified in samples of game fish.

### Sample Collection and Analysis

Samples of surface water are collected from the Tennessee River using automatic sampling systems from one downstream station and one upstream station. The upstream sample is collected from the raw water intake at the Decatur, Alabama water plant and is utilized as control sampling location for both surface and drinking water. A timer turns on the system at least once every two hours. The line is flushed and a sample collected into a collection container. A 1-gallon sample is removed from the container every 4 weeks and the remaining water in the jug is discarded. The 4-week composite sample is analyzed by gamma spectroscopy and for gross beta activity. A quarterly composite sample is analyzed for tritium.

Samples are also collected by an automatic sampling system at the first downstream drinking water intake. This sample is collected at the intake for drinking water plant and is raw untreated water. These samples are collected in the same manner as the surface water samples. These monthly samples are analyzed by gamma spectroscopy and for gross beta activity. A quarterly composite is analyzed for tritium.

At other selected locations, grab samples are collected from drinking water systems which use the Tennessee River as their source. These samples are analyzed every 4 weeks by gamma spectroscopy and for gross beta activity. A quarterly composite sample from each station is analyzed for tritium.

A groundwater well onsite is equipped with an automatic water sampler. Water is also collected from a private well in an area unaffected by BFN. Samples from the wells are collected every 4 weeks and analyzed by gamma spectroscopy. A quarterly composite sample is analyzed for tritium.

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

Shoreline sediment was collected from two downstream recreational use areas and one upstream location. The samples were collected at the normal water level shoreline and analyzed by gamma spectroscopy.

### Results

All radioactivity in surface water samples was below the detection limits except the gross beta activity and naturally occurring isotopes identified by gamma spectral analysis. These results are consistent with previously reported levels. A trend plot of the gross beta activity in surface water samples from 1968 through 1999 is presented in Figure H-6. A summary table of the results for this reporting period is shown in Table H-13.

For drinking water (public water), gross beta activity averaged 2.8 pCi/liter at the downstream stations and 2.9 pCi/liter at control stations. The results are shown in Table H-14 and a trend plot of the gross beta activity from 1968 to the present is presented in Figure H-7.

No fission or activation products were detected in groundwater samples. Only naturally occurring radon decay products (Pb-214 and Bi-214) were identified in these samples. Results from the analysis of groundwater samples are presented in Table H-15.

Cesium-137 was identified in samples of game fish collected from both the indicator and control locations. The highest concentration measured in a game fish sample from the indicator reservoir was 0.04 pCi/g. The highest concentration measured in samples from the control location was 0.05 pCi/g. These concentrations are consistent with data from previous monitoring years. One sample of game fish collected in the indicator reservoir also contained a measurable concentration of Co-60. The concentration was 0.19 pCi/g. The only other isotopes found in fish were naturally occurring. The results are summarized in Tables H-16 and H-17. Plots of the annual average Cs-137 concentrations in fish are presented in Figures H-8 and H-9.

Only naturally occurring radionuclides were identified by the gamma spectral analyses of samples of shoreline sediment. The results from the analysis of shoreline sediment are provided in Table H-18.

## ASSESSMENT AND EVALUATION

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

The area around the plant is analyzed to determine the pathways through which the public may receive an exposure. As indicated in Figure 2, the two major ways by which radioactivity is introduced into the environment are through liquid and gaseous effluents.

For liquid effluents, the public can be exposed to radiation from three sources: drinking water from the Tennessee river, eating fish caught in the Tennessee River, and direct exposure to radioactive material due to activities on the banks of the river (recreational activities). Data used to determine these doses are based on guidance given by the NRC for maximum ingestion rates, exposure times, and distribution of the material in the river. Whenever possible, data used in the dose calculation are based on specific conditions for the BFN area.

For gaseous effluents, the public can be exposed to radiation from several sources: direct radiation from the radioactivity in the air, direct radiation from radioactivity deposited on the ground, inhalation of radioactivity in the air, ingestion of vegetation which contains radioactivity deposited from the atmosphere, and ingestion of milk from animals which consumed vegetation containing deposited radioactivity. The concentrations of radioactivity in the air and the soil are estimated by computer models which use the actual meteorological conditions to determine the

distribution of the effluents in the atmosphere. Again, as many of the parameters as possible are based on actual site specific data.

### Results

The estimated doses to the maximum exposed individual due to radioactivity released from BFN in 1999 are presented in Table 3. These estimates were made using the concentrations of the liquids and gases measured at the effluent monitoring points. The maximum calculated whole body dose equivalent from measured liquid effluents as reported in Table 3 is 0.037 mrem/year, or 1.2 percent of the limit. The maximum organ dose equivalent from gaseous effluents was 0.04 mrem/year which represents 0.3 percent of the NRC limit. A more complete description of the effluents released from BFN and the corresponding doses projected from these effluents can be found in the BFN Annual Radioactive Effluent Release Reports.

As stated earlier in the report, the estimated increase in radiation dose equivalent to the general public resulting from the operation of BFN is negligible 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, Co-60 and Cs-137 were identified in aquatic media. The distribution of Cs-137 in fish is consistent with fallout levels identified in samples both upstream and downstream from the plant during the preoperational phase of the monitoring program. The trace level of Co-60 measured in the one sample of game fish would present no measurable increase in the dose to the general public.

Dose estimates were made from concentrations of radioactivity found in samples of environmental media. Inhalation, ingestion and direct doses estimated for persons at the indicator locations were essentially identical to those determined for persons at control stations.

More than 99 percent of those doses were contributed by the naturally occurring radionuclide K-40 and by Sr-90 and Cs-137, which are long-lived radioisotopes found in fallout from nuclear

weapons testing. Concentrations of Sr-90 and Cs-137 are consistent with levels measured in TVA's preoperational radiological environmental monitoring programs.

### Conclusions

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

## REFERENCES

1. Merrill Eisenbud, Environmental Radioactivity, Academic Press, Inc., New York, NY, 1987.
2. National Council on Radiation Protection and Measurements, Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," September 1987.
3. United States Nuclear Regulatory Commission, Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," July 1981.

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

	<u>Concentrations in Water, pCi/Liter</u>			<u>Concentrations in Air, pCi/Cubic Meter</u>		
	<u>Effluent Concentration<sup>1</sup></u>	<u>Reporting Level<sup>2</sup></u>	<u>Lower limit of Detection<sup>3</sup></u>	<u>Effluent Concentration<sup>1</sup></u>	<u>Reporting Level<sup>2</sup></u>	<u>Lower limit of Detection<sup>3</sup></u>
H-3	1,000,000	20,000	300	100,000		
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 x10<sup>-2</sup> 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: BFN Offsite Dose Calculation Manual, Table 2.3-2

3 Source: Table E-1 of this report.

Table 2  
Results from the  
Intercomparison of Environmental Dosimeters

<u>Year</u>	<u>TVA Results</u> <u>mrem</u>	<u>Average, all</u> <u>Respondents</u> <u>mrem</u>	<u>Calculated</u> <u>Exposure</u> <u>(See Note 1)</u> <u>mrem</u>	<u>% Difference</u> <u>TVA:</u> <u>Calculated</u>	<u>% Difference</u> <u>Respondents:</u> <u>Calculated</u>
<b>Field Dosimeters</b>					
74	15.0	16.3	16.3	-8.0	0.0
77	30.4	31.5	34.9	-12.9	-9.7
79	13.8	16.0	14.1	-2.1	13.5
81	31.8	30.2	30.0	6.0	0.7
82	43.2	45.0	43.5	-0.7	3.4
84	73.0	75.1	75.8	-3.7	-0.9
86a	33.2	28.9	29.7	11.8	-2.7
86b	9.4	10.1	10.4	-9.6	-2.9
93a	24.4	26.4	27.0	-9.6	-2.2
93b	27.6	26.4	27.0	2.2	-2.2
96a	16.9	18.9	19.0	-11.1	-0.5
96b	17.6	18.9	19.0	-7.4	-0.5
<b>Low Irradiated Dosimeters</b>					
74	27.9	28.5	30.0	-7.0	-5.0
79	12.1	12.1	12.2	-0.8	-0.8
86	18.2	16.2	17.2	5.8	-5.8
93a	24.9	25.0	25.9	-3.9	-3.5
93b	27.8	25.0	25.9	7.3	-3.5
<b>High Irradiated Dosimeters</b>					
77	99.4	86.2	91.7	8.4	-6.0
79	46.1	43.9	45.8	0.7	-4.1
81a	84.1	75.8	75.2	11.8	0.8
81b	102.0	90.7	88.4	15.4	2.6
82a	179.0	191.0	202.0	-11.4	-5.4
82b	136.0	149.0	158.0	-13.9	-5.7
84a	85.6	77.9	79.9	7.1	-2.5
84b	76.8	73.0	75.0	2.4	-2.7
93a	67.8	69.8	72.7	-6.7	-4.0
93b	80.2	69.8	72.7	10.3	-4.0
96a	60.7	55.2	58.1	4.5	-5.0
96b	59.4	55.2	58.1	2.2	-5.0

Notes: 1. The calculated exposure is the "known" exposure determined by the testing agency.

Table 3

Maximum Dose Due to Radioactive Effluent Releases  
 Browns Ferry Nuclear Plant  
 1999  
 mrem/year

Dose From Liquid Effluents

<u>Type</u>	<u>1999 Dose</u>	<u>NRC Limit</u>	<u>Percent of NRC Limit</u>
Total Body	3.7E-2	3	1.2
Any Organ	5.1E-2	10	0.5

Doses From Gaseous Effluents

<u>Type</u>	<u>1999 Dose</u>	<u>NRC Limit</u>	<u>Percent of NRC Limit</u>
Noble Gas (Gamma)	8.5E-5	10	<0.01
Noble Gas (Beta)	5.5E-5	20	<0.01
Any Organ	4.0E-2	15	0.3

Total Cumulative Dose

<u>Type</u>	<u>1999 Dose</u>	<u>EPA Limit</u>	<u>Percent of EPA Limit</u>
Total Body or Any Other Organ	1.2E-1	25	0.5
Thyroid	8.2E-2	75	0.1

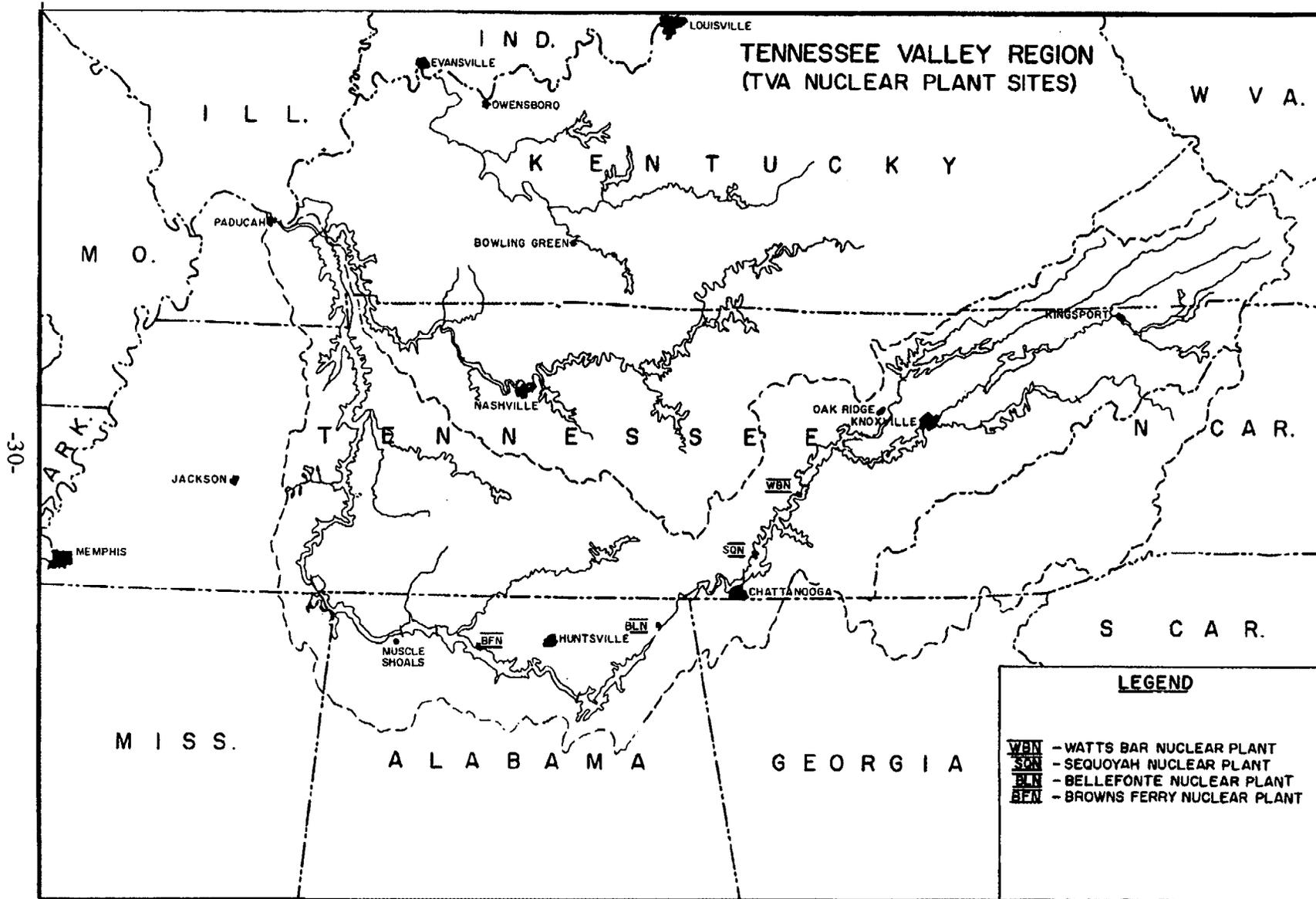
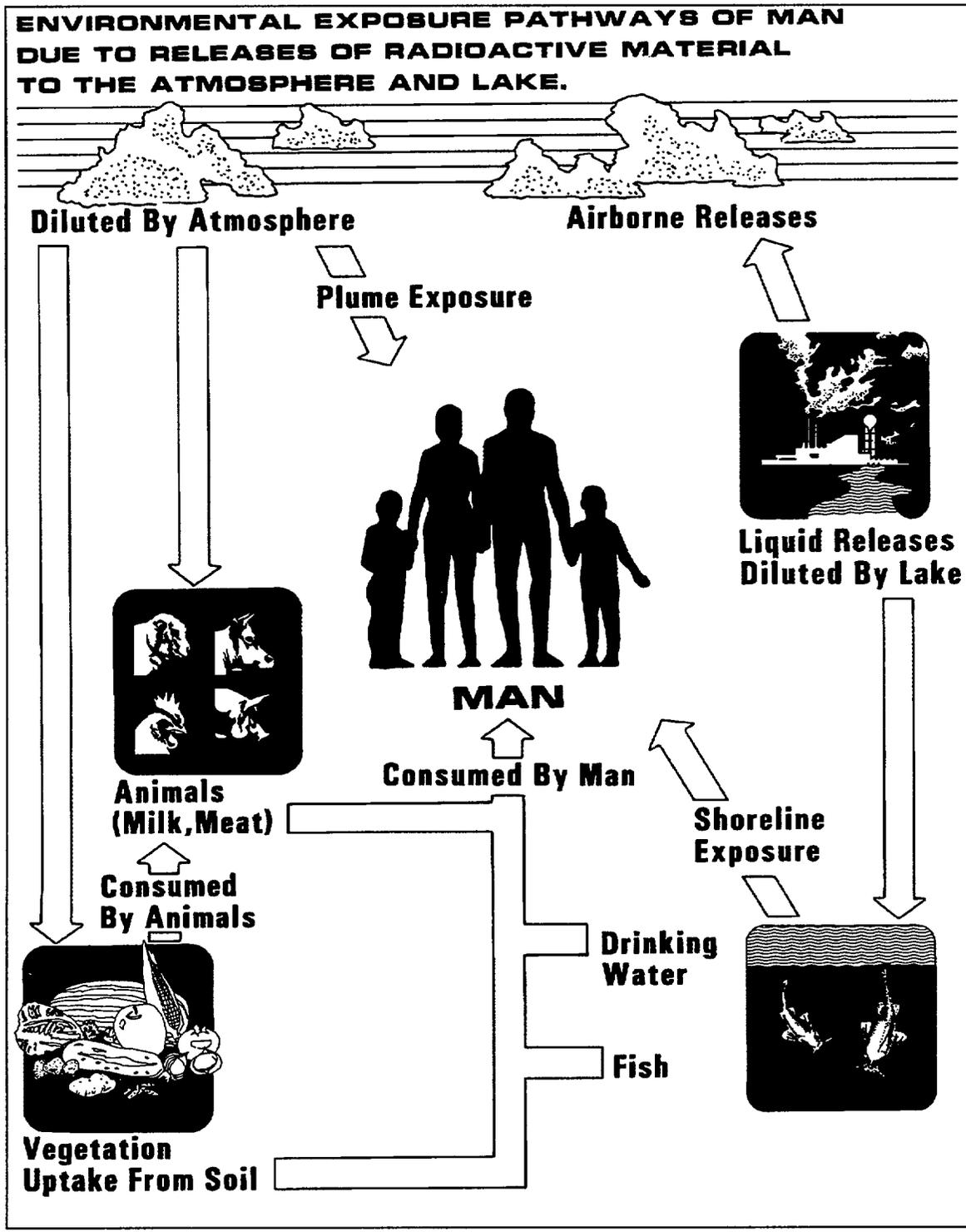


Figure 1

Figure 2



APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM AND  
SAMPLING LOCATIONS

Table A-1  
 BROWNS FERRY NUCLEAR PLANT  
 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM<sup>a</sup>

Exposure Pathway and/or Sample	Number of Samples and Locations <sup>b</sup>	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Particulates	<p>Six samples from locations (in different sectors) at or near the site boundary (LM-1, LM-2, LM-3, LM-4, LM-6, and LM-7).</p> <p>Two samples from control locations greater than 10 miles from the plant (RM-1 and RM-6).</p> <p>Three samples from locations in communities approximately 10 miles from the plant (PM-1, PM-2, and PM-3).</p>	<p>Continuous sampler operation with sample collection as required by dust loading but at least once per 7 days.</p>	<p>Analyze for gross beta radioactivity greater than or equal to 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is greater than 10 times the average of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 31 days.</p>
b. Radioiodine	<p>Same locations as air particulates.</p>	<p>Continuous sampler operation with charcoal canister collection at least once per 7 days.</p>	<p>I-131 by gamma scan on each sample.</p>
c. Rainwater	<p>Same locations as air particulates.</p>	<p>Composite sample at least once per 31 days.</p>	<p>Analyzed for gamma nuclides only if radioactivity in other media indicates the presence of increased levels of fallout</p>

Table A-1  
 BROWNS FERRY NUCLEAR PLANT  
 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
d. Soil	Samples from same locations as air particulates.	Once every year.	Gamma scan, Sr-89, Sr-90 once per year.
e. Direct	Two or more dosimeters placed at locations (in different sectors) at or near the site boundary in each of the 16 sectors.	At least once per 92 days.	Gamma dose once per 92 days.
	Two or more dosimeters placed at stations located approximately 5 miles from the plant in each of the 16 sectors.	At least once per 92 days.	Gamma dose once per 92 days.
	Two or more dosimeters in at least 9 additional locations of special interest.		
2. WATERBORNE			
a. Surface Water	One sample upstream (TRM 306.0). One sample immediately downstream of discharge (TRM 293.5).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days <sup>c</sup> .	Gross beta and gamma scan on 4-week composite. Composite for tritium at least once per 92 days.
b. Drinking water	One sample at the first potable surface water supply downstream from the plant (TRM 286.5).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days <sup>c</sup> .	Gross beta and gamma scan on 4-week composite. Composite for tritium analysis at least once per 92 days.

Table A-1  
 BROWNS FERRY NUCLEAR PLANT  
 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
c. Drinking Water (Continued)	Four additional samples of potable surface water downstream from the plant (TRM 282.6, TRM 274.9, TRM 259.8 and TRM 259.6).	Grab sample taken from water supply at a facility using water from the public supply being monitored. Sample collected at least once per 31 days.	Gross beta and gamma scan on 4-week composite. Composite for tritium analysis at least once per 92 days.
	One sample at a control location <sup>d</sup> (TRM 306).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days <sup>e</sup> .	Same as downstream location.
d. Ground water	One sample adjacent to the plant (Well No. 6).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days.	Gamma scan on each composite. Composite for tritium analysis at least once per 92 days.
	One sample at a control location up gradient from the plant (Farm Bn).	Grab sample taken at least once per 31 days.	Gamma scan on each sample. Composite for tritium analysis at least once per 92 days.
e. Shoreline Sediment	One sample upstream from a recreational area (TRM 305).	At least once per 184 days.	Gamma scan of each sample.

Table A-1  
 BROWNS FERRY NUCLEAR PLANT  
 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
e. Shoreline Sediment (Continued)	One sample from each of at least two downstream locations with recreational use (TRM 293 and 279.5).	At least once per 184 days.	Gamma scan of each sample.
4. INGESTION			
a. Milk	Samples from the one dairy farm in the immediate vicinity of the plant (Farm B).	At least once per 15 days when animals are on pasture; at least once per 31 days at other times.	Gamma scan and I-131 on each sample. Sr-89 and Sr-90 at least once per 31 days.
	At least one sample from control location (Farm Be and/or R).		
b. Fish	Two samples representing commercial and game species in Guntersville Reservoir above the plant.	At least once per 184 days.	Gamma scan at least once per 184 days on edible portions.
	Two samples representing commercial and game species in Wheeler Reservoir near the plant.		

Table A-1  
 BROWNS FERRY NUCLEAR PLANT  
 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
d. Fruits and Vegetables	<p>Samples of food crops such as greens, corn, green beans, tomatoes, and potatoes grown at private gardens and/or farms in the immediate vicinity of the plant.</p> <p>One sample of each of the same foods grown at greater than 10 miles distance from the plant.</p>	At least once per year at time of harvest.	Gamma scan on edible portion.
e. Vegetation	<p>Samples from farms producing milk but not providing a milk sample (Farm T).</p> <p>Control samples from one control dairy (Farm R).</p>	Once per 31 days.	I-131, gamma scan once per 31 days.

- 
- a. The sampling program outlined in this table is that which was in effect at the end of 1999.
  - b. Sample locations, sector and distance from plant, are described in Table A-2 and A-3 and shown in Figures A-1, A-2, and A-3.
  - c. Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
  - d. The sample location at the Decatur City Water Plant serves as a control sample for both surface water and drinking water.

Table A-2  
 BROWNS FERRY NUCLEAR PLANT  
 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM  
 SAMPLING LOCATIONS

Map Location Number <sup>a</sup>	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected <sup>b</sup>
1	PM-1	NW	13.8	I	AP,CF,R,S
2	PM-2	NE	10.9	I	AP,CF,R,S
3	PM-3	SSE	7.5	I	AP,CF,R,S
4	LM-7	W	2.1	I	AP,CF,R,S
5	RM-1	W	31.3	C	AP,CF,R,S
6	RM-6	E	24.2	C	AP,CF,R,S
7	LM-1	N	1.0	I	AP,CF,R,S
8	LM-2	NNE	0.9	I	AP,CF,R,S
9	LM-3	ENE	0.9	I	AP,CF,R,S
10	LM-4	NNW	1.7	I	AP,CF,R,S
11	LM-6	SSW	3.0	I	AP,CF,R,S
12	Farm B	NNW	6.8	I	M
13	Farm Bn	N	5.0	I	W
19	Farm R	SW	12.5	C	M,V
22	Well No.6	NW	0.02	I	W
23	TRM <sup>c</sup> 282.6	-	11.4 <sup>d</sup>	I	PW
24	TRM 306.0	-	12.0 <sup>d</sup>	C	PW, SW
25	TRM 259.6	-	34.4 <sup>d</sup>	I	PW
26	TRM 274.9	-	19.1 <sup>d</sup>	I	PW
28	TRM 293.5	-	0.5 <sup>d</sup>	I	SW
34	Farm Be	NW	28.8	C	M
36	Farm T	WNW	3.2	I	V
70	TRM 259.8	-	34.2 <sup>d</sup>	I	PW
71	TRM 286.5	-	7.5 <sup>d</sup>	I	PW
72	TRM305	-	11.0 <sup>d</sup>	C	SS
73	TRM293	-	1.0 <sup>d</sup>	I	SS
74	TRM 279.5	-	14.5 <sup>d</sup>	I	SS
	Wheeler Reservoir (TRM 275-349)		-	I	F
	Guntersville Reservoir (TRM 349-424)		-	C	F

a. See Figures A-1, A-2, and A-3

b. Sample codes:

AP = Air particulate filter  
 F = Fish  
 R = Rainwater  
 SW = Surface Water

CF = Charcoal filter (Iodine)  
 M = Milk  
 S = Soil  
 V = Vegetation

PW = Public drinking water  
 SS = Shoreline sediment  
 W = Well water

c. TRM = Tennessee River Mile.

d. Miles from plant discharge at (TRM 294).

Table A-3  
 BROWNS FERRY NUCLEAR PLANT  
 THERMOLUMINESCENT DOSIMETER (TLD) LOCATIONS

Map Location Number <sup>a</sup>	Station	Sector	Approximate Distance (miles)	Onsite (On) <sup>b</sup> or Offsite (Off)
1	NW-3	NW	13.8	Off
2	NE-3	NE	10.9	Off
3	SSE-2	SSE	7.5	Off
5	W-3	W	31.3	Off
6	E-3	E	24.2	Off
7	N-1	N	1.0	On
8	NNE-1	NNE	0.9	On
9	ENE-1	ENE	0.9	On
10	NNW-2	NNW	1.7	On
38	N-2	N	5.0	Off
39	NNE-2	NNE	0.7	On
40	NNE-3	NNE	5.2	Off
41	NE-1	NE	0.8	On
42	NE-2	NE	5.0	Off
43	ENE-2	ENE	6.2	Off
44	E-1	E	0.8	On
45	E-2	E	5.2	Off
46	ESE-1	ESE	0.9	On
47	ESE-2	ESE	3.0	Off
48	SE-1	SE	0.5	On
49	SE-2	SE	5.4	Off
50	SSE-1	SSE	5.1	Off
51	S-1	S	3.1	Off
52	S-2	S	4.8	Off
53	SSW-1	SSW	3.0	Off
54	SSW-2	SSW	4.4	Off
55	SW-1	SW	1.9	On
56	SW-2	SW	4.7	Off
57	SW-3	SW	6.0	Off
58	WSW-1	WSW	2.7	Off
59	WSW-2	WSW	5.1	Off
60	WSW-3	WSW	10.5	Off
61	W-1	W	1.9	On
62	W-2	W	4.7	Off
63	W-4	W	32.1	Off
64	WNW-1	WNW	3.3	Off
65	WNW-2	WNW	4.4	Off
66	NW-1	NW	2.2	Off
67	NW-2	NW	5.3	Off
68	NNW-1	NNW	1.0	On
69	NNW-3	NNW	5.2	Off

a. See Figures A-1, A-2, and A-3.

b. TLDs designated "onsite" are those located 2 miles or less from the plant.  
 TLDs designated "offsite" are those located more than 2 miles from the plant.

Figure A-1

Radiological Environmental Monitoring Locations

Within 1 Mile of Plant

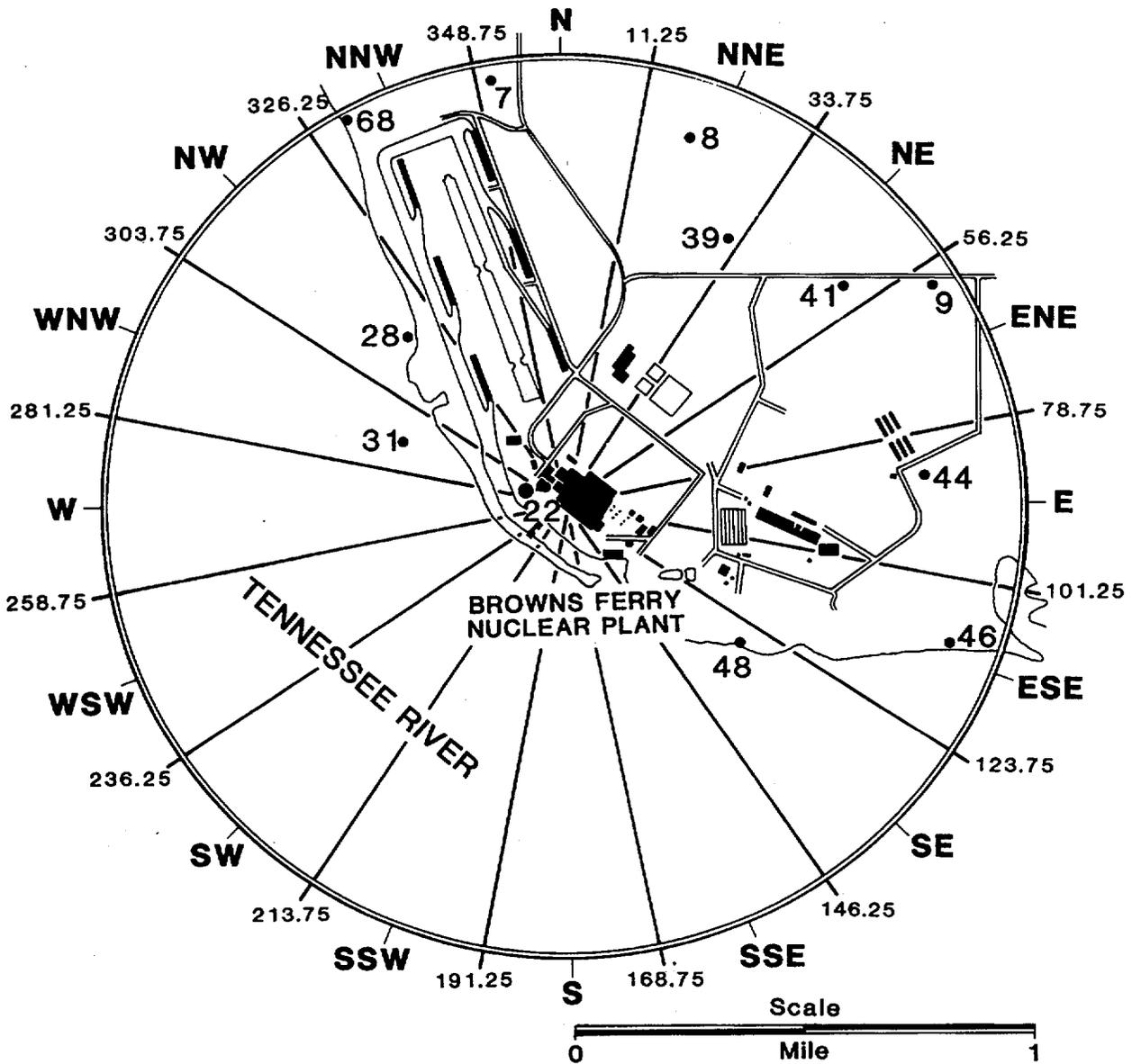


Figure A-2

Radiological Environmental Monitoring Locations

From 1 to 5 Miles from the Plant

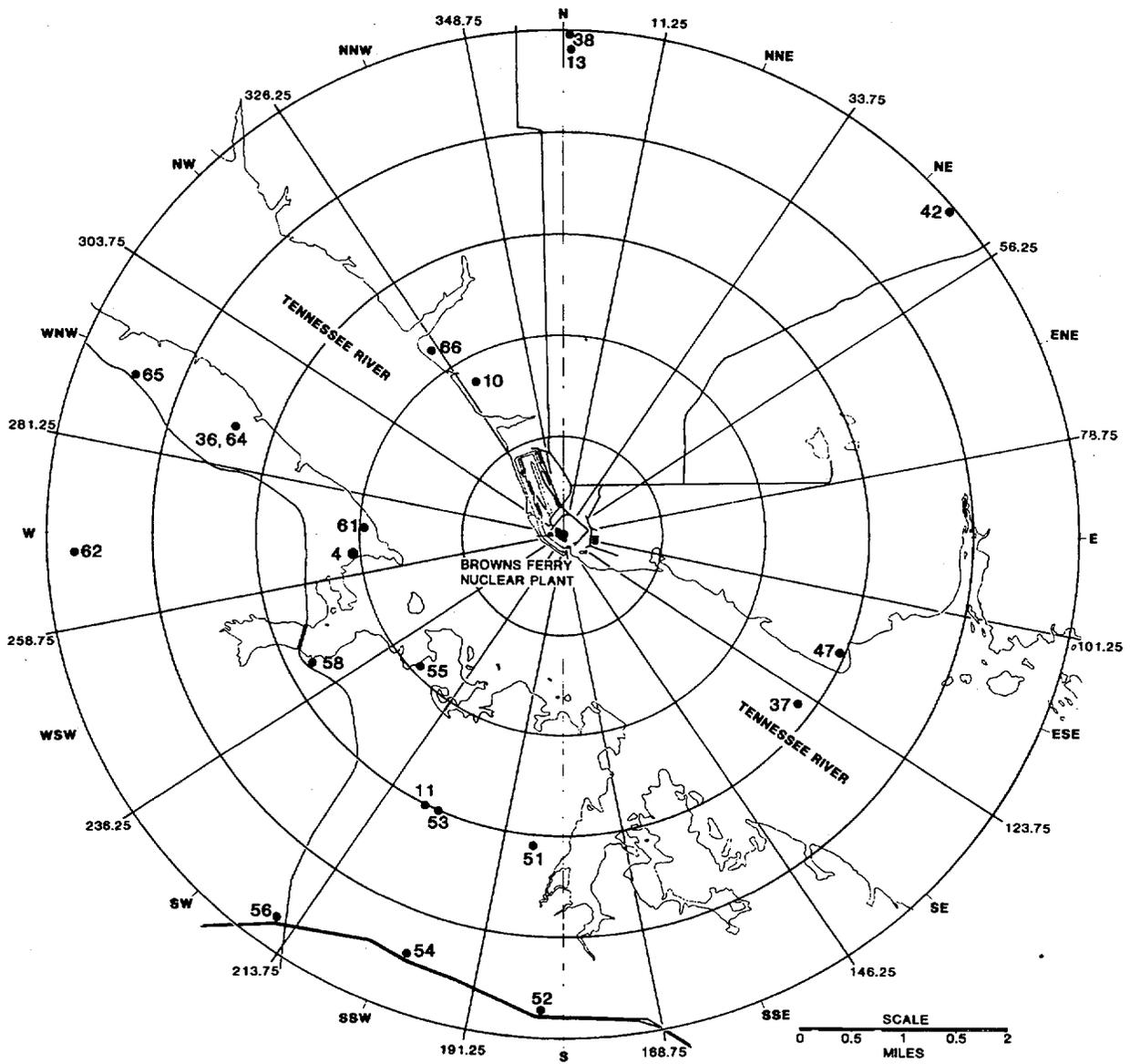
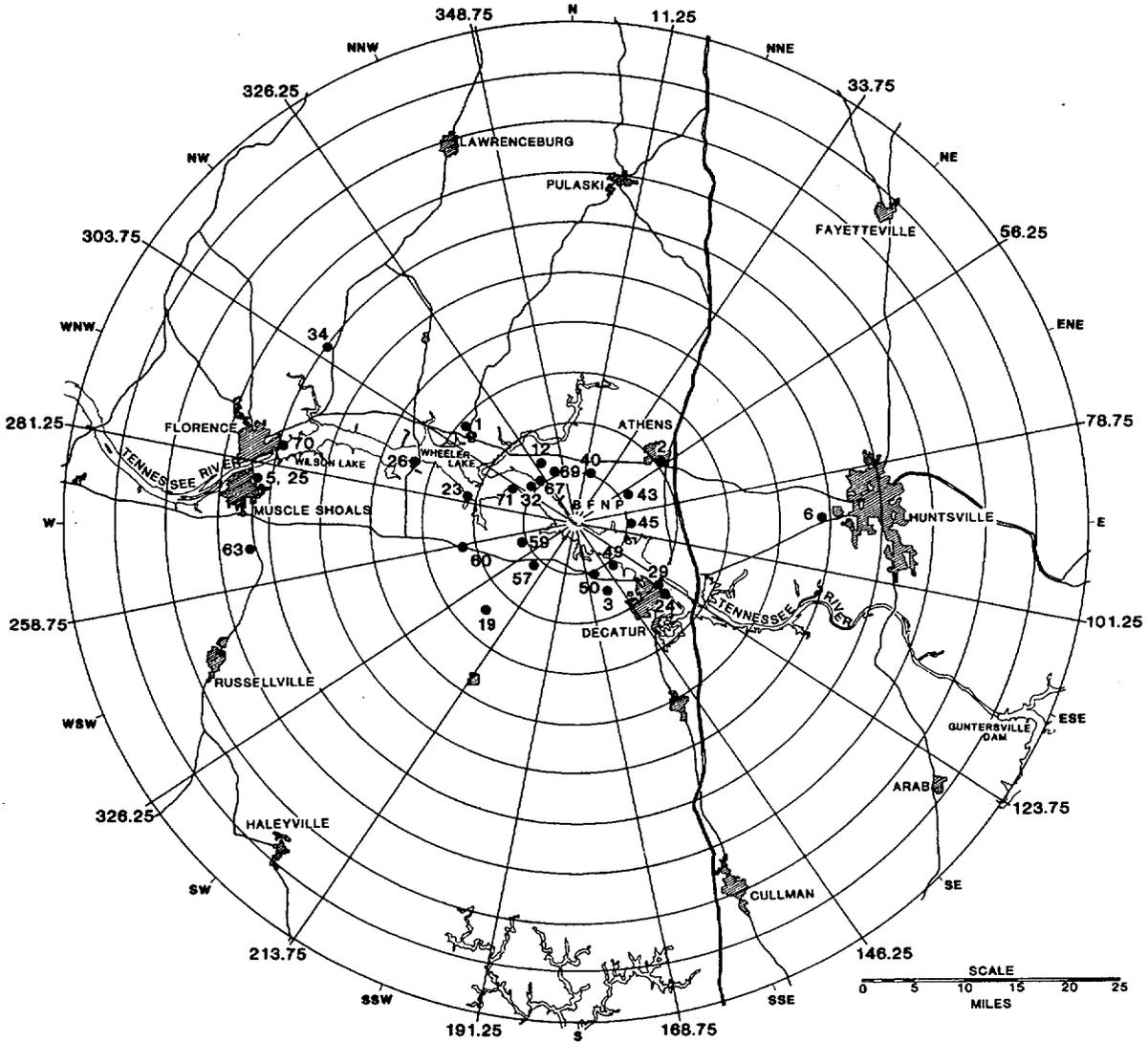


Figure A-3

Radiological Environmental Monitoring Locations

Greater than 5 Miles from the Plant



APPENDIX B

1999 PROGRAM MODIFICATIONS

## APPENDIX B

### Radiological Environmental Monitoring Program Modifications

During 1999, the only modification made in the BFN radiological environmental monitoring program resulted from the loss of one of the indicator dairy farms used for milk sampling. There has only been one farm with milk producing animals located within a five mile radius of BFN. This farm was the Smith-Bennett Dairy. In May of 1999, the owner of this farm sold all of the milk cows and went out of the dairy farming business. Milk was not available from this location after June 1, 1999. Another dairy farm located in the NNW sector at approximately 6.8 miles continued to be used as an indicator sampling location.

There were no other changes in the BFN monitoring program in 1999.

APPENDIX C  
PROGRAM DEVIATIONS

## APPENDIX C

### Program Deviations

Near the end of May, 1999, the dairy operated at the Smith-Bennett farm went out of business. There was no milk available for collection at this location after June 1, 1999. There are no other locations with milk production within the five mile radius of the BFN site. In addition to the unavailability of milk from this location, a total of six other samples were not collected as scheduled due to equipment problems. Details of the missed samples are provided below and in Table C-1.

There were two sampling periods when air filter and charcoal cartridge samples were not available from one of the eleven sampling locations due to equipment problems. Repairs were made to the sampling equipment, and samples were collected as scheduled for the next sampling period.

The ground water sample scheduled for collection on January 19, 1999, from the on site monitoring well was not available due to a loss of power to the sampling pump. Power was restored and samples collected as scheduled during the next sampling period.

The public water sample scheduled for collection at the West Morgan - East Lawrence water system intake was not collected on April 12, 1999, due to problems with the sampling system.

Two samples of surface water could not be collected on June 21, 1999, due to problems with the sampling equipment at both sampling locations.

Table C-1

Radiological Environmental Monitoring Program Deviations

<u>Date</u>	<u>Station</u>	<u>Location</u>	<u>Remarks</u>
01/19/99	Well #6	0.02 miles NW	The ground water sample was not available from the on site monitoring well due to a loss of power to the sampling pump. Service was restored and the sample collected as scheduled for the next sampling period.
04/12/99	TRM 282.6	11.4 miles downstream	The public water sample could not be collected at this location due to problems with the sampling equipment. The sampling system was repaired and sampling was conducted as scheduled for the next sampling period.
05/10/99	TRM 306.0	12.0 miles upstream	The sampling equipment used for surface/public water sampling at this location was not operating correctly and an adequate sample could not be collected. Repairs were made and the sampling system performed correctly for the next sampling period.
05/10/99	TRM 293.5	0.5 miles downstream	The sampling of surface water could not be performed as scheduled due to problems with the sampling system. The system was repaired and sampling conducted as scheduled for the next sampling period.
06/01/99	Farm Bn	5.0 miles N	The dairy operating at this location went out of business in May. No milk was available from this farm after June 1, 1999.
06/21/99	PM-1	13.8 miles NW	The air filter and charcoal cartridge could not be collected due to equipment problems. The sampling system was repaired and returned to service in time to provide samples for the next sampling period.
12/20/99	LM-1	1.0 miles N	The air filter and charcoal cartridge could not be collected due to equipment problems. The sampling system was repaired and returned to service in time to provide samples for the next sampling period.

APPENDIX D  
ANALYTICAL PROCEDURES

## Appendix D

### Analytical Procedures

Analyses of environmental samples are performed by the radioanalytical laboratory located at the WARL facility in Muscle Shoals. All 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 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, water, or vegetation samples 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 detection can be obtained.

After a radiochemical separation, samples analyzed for Sr-89, 90 are counted on a low background beta counting system. The sample is counted a second time after a 7-day ingrowth period. 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 detectors interfaced with a computer based multichannel analyzer system. Spectral data reduction is performed by the computer program HYPERMET.

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

All of 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 (LLD)

## Appendix E

### Nominal Lower Limits of Detection

Sensitive radiation detection devices can produce a signal even when no radioactivity is present in a sample being analyzed. This signal may come from trace amounts of radioactivity in the components of the device, from cosmic rays, from naturally occurring radon gas, or from electronic noise. The signal registered when no activity is present in the sample is called the background.

The point at which the signal is determined to represent radioactivity in the sample is called the critical level. This point is based on statistical analysis of the background readings from any particular device. However, any sample measured over and over in the same device will give different readings, some higher than others. The sample should have a well-defined average reading, but any individual reading will vary from that average. In order to determine the activity present in a sample that will produce a reading above the critical level, additional statistical analysis of the background readings is required. The hypothetical activity calculated from this analysis is called the lower limit of detection (LLD). A listing of typical LLD values that a laboratory publishes is a guide to the sensitivity of the analytical measurements performed by the laboratory.

Every time an activity is calculated from a sample, the background must be subtracted from the sample signal. For the very low levels encountered in environmental monitoring, the sample signals are often very close to the background. The measuring equipment is being used at the limit of its capability. For a sample with no measurable activity, which often happens, about half the time its signal should fall below the average machine background and half the time it should be above the background. If a signal above the background is present, the calculated activity is

compared to the calculated LLD to determine if there is really activity present or if the number is an artifact of the way radioactivity is measured.

A number of factors influence the LLD, including sample size, count time, count efficiency, chemical processes, radioactive decay factors, and interfering isotopes encountered in the sample. The most likely values for these factors have been evaluated for the various analyses performed in the environmental monitoring program. The nominal LLDs calculated from these values, in accordance with the methodology prescribed in the ODCM, are presented in Table E-1. The maximum values for the lower limits of detection specified in the ODCM are shown in Table E-2.

The nominal LLDs are also presented in the data tables. For analyses for which nominal LLDs have not been established, and LLD of zero is assumed in determining if a measured activity is greater than the nominal LLD.

TABLE E-1

Nominal LLD Values  
A. Radiochemical Procedures

	Air Filters (pCi/m <sup>3</sup> )	Water (pCi/L)	Milk (pCi/L)	Wet Vegetation (pCi/Kg wet)	Sediment and Soil (pCi/g dry)
Gross Beta	0.002	1.9			
Tritium		300			
Iodine-131		0.4	0.4	6.0	
Strontium-89		5.0	3.5	31.0	1.6
Strontium-90		2.0	2.0	12.0	0.4

Table E-1  
Nominal LLD Values  
B. Gamma Analyses (GeLi)

	Air Particulates <u>pCi/m<sup>3</sup></u>	Charcoal Filter <u>pCi/m<sup>3</sup></u>	Water and Milk <u>pCi/L</u>	Vegetation and Grain <u>pCi/g, dry</u>	Wet Vegetation <u>pCi/kg, wet</u>	Soil and Sediment <u>pCi/g, dry</u>	Fish <u>pCi/g, dry</u>	Clam Flesh <u>pCi/g, dry</u>	Foods Tomatoes Potatoes, etc. <u>pCi/kg, wet</u>
Ce-141	.005	.02	10	.07	35	.10	.07	.35	20
Ce-144	.01	.07	30	.15	115	.20	.15	.85	60
Cr-51	.02	0.15	45	.30	200	.35	.30	2.4	95
I-131	.005	0.03	10	.20	60	.25	.20	1.7	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	2.4	50
La-140	.01	0.04	10	.20	50	.20	.20	1.4	25
Fe-59	.005	0.04	10	.08	40	.05	.08	.45	25
Be-7	.02	0.15	45	.25	200	.25	.25	1.9	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	2.0	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

Table E-2

Maximum Values for the Lower Limits of Detection (LLD)  
Specified by the BFN Offsite Dose Calculation Manual

<u>Analysis</u>	<u>Water</u> <u>pCi/L</u>	<u>Airborne</u> <u>Particulate</u> <u>or Gases</u> <u>pCi/m<sup>3</sup></u>	<u>Fish</u> <u>pCi/kg, wet</u>	<u>Milk</u> <u>pCi/L</u>	<u>Food</u> <u>Products</u> <u>pCi/kg, wet</u>	<u>Sediment</u> <u>pCi/kg, dry</u>
gross beta	4	1 x 10 <sup>-2</sup>	N.A.	N.A.	N.A.	N.A.
H-3	2000 <sup>a</sup>	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 <sup>b</sup>	7 x 10 <sup>-2</sup>	N.A.	1	60	N.A.
Cs-134	15	5 x 10 <sup>-2</sup>	130	15	60	150
Cs-137	18	6 x 10 <sup>-2</sup>	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. LLD for analysis of drinking water and surface water samples shall be performed by gamma spectroscopy at approximately 15 pCi/liter. If levels greater than 15 pCi/liter are identified in surface water samples downstream from the plant, or in the event of an unanticipated release of I-131, drinking water samples will be analyzed at an LLD of 1.0 pCi/liter for I-131.

APPENDIX F

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

## Appendix F

### Quality Assurance/Quality Control Program

A thorough 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, a complete training and retraining system, 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.

Radiation detection devices can be tested in a number of ways. There are two primary tests which are performed on all devices. In the first type, the device is operated without a sample on the detector to determine the background count rate. The background counts are usually low values and are due to machine noise, cosmic rays, or trace amounts of radioactivity in the materials used to construct the detector. Charts of background counts are kept and monitored to ensure that no unusually high or low values are encountered.

In the second test, the device is operated with a known amount of radioactivity present. The number of counts registered from such a radioactive standard should be very reproducible. These reproducibility checks are also monitored to ensure that they are neither higher nor lower than expected. When counts from either test fall outside the expected range, the device is inspected for malfunction or contamination. It is not placed into service until it is operating properly.

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 may be blanks, replicate samples, blind samples or 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 same 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 the other routine samples. The duplicate samples 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 a sample into two portions. Such a sample can provide 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 by the quality control staff or by the person performing the analyses. The staff member performing the analyses 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, the lab staff has immediate knowledge of the quality of the measurement process. A portion of these samples are also blanks.

Blind spikes are samples containing radioactivity which are introduced into the analysis process disguised as ordinary environmental samples. The person performing the analysis does not know that 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 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 review process. Blind spikes test this process. Furthermore, the activity can be put into such samples at the extreme limit of detection (near the LLD) to determine whether or not the laboratory can find any unusual radioactivity whatsoever.

At present, 5 percent of the laboratory workload is in the category of internal cross-checks. These samples have a known amount of radioactivity added and are presented to the person performing the analysis labeled as cross-check samples. This means that the quality control staff knows the radioactive content or "right answer" but the lab staff does 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. During 1999, all analysis results for internal cross-check samples were within agreement limits when compared to the known value.

In the past years the laboratory has participated in the interlaboratory comparison program produced by the EPA in Las Vegas. The EPA has discontinued this program and there were no "EPA cross-checks" in 1999. To replace the independent cross-check that had been provided through the EPA program, the laboratory participated in an environmental level cross-check program available through Analytics, Inc., during 1999. The results of TVA's participation in this cross-check program are presented in Table F-1.

TVA splits certain environmental samples with laboratories operated by the States of Alabama and Tennessee and the EPA National Air and Radiation Environmental Laboratory in Montgomery, Alabama. When radioactivity has been present in the environment in measurable quantities, such as following atmospheric nuclear weapons testing, following the Chernobyl incident, or as naturally occurring radionuclides, the split samples have provided TVA with yet another level of information about laboratory performance. These samples demonstrate performance on actual environmental sample matrices rather than on the constructed matrices used in cross-check programs.

All the quality control data are routinely collected, examined, and reported to laboratory supervisory personnel. The data 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 1999 External Cross Checks

<u>Test Period</u>	<u>Sample Type / Analysis</u>	<u>Results</u>		<u>Agreement Range</u>
		<u>Known</u>	<u>TVA</u>	
First Quarter	Water (pCi/L)			
	Gross Beta	201	205	171 - 231
First Quarter	Charcoal Filter (pCi/Filter)			
	<sup>131</sup> I	90	81	63 - 117
First Quarter	Water (pCi/L)			
	<sup>131</sup> I	91	87	64 - 118
	<sup>141</sup> Ce	177	168	150 - 204
	<sup>51</sup> Cr	398	417	279 - 517
	<sup>134</sup> Cs	114	103	97 - 131
	<sup>137</sup> Cs	240	232	204 - 276
	<sup>54</sup> Mn	152	155	129 - 175
	<sup>59</sup> Fe	79	86	64 - 94
	<sup>65</sup> Zn	195	205	137 - 254
	<sup>60</sup> Co	181	184	154 - 208
Third Quarter	Water (pCi/L)			
	<sup>3</sup> H	4534	4040	3174 - 5894
	<sup>89</sup> Sr	77	86	62 - 92
	<sup>90</sup> Sr	38	37	23 - 53
Third Quarter	Air Filter (pCi/Filter)			
	Gross Beta	60	50	45 - 75
Third Quarter	Air Filter (pCi/Filter)			
	<sup>141</sup> Ce	110	107	94 - 127
	<sup>51</sup> Cr	83	69	58 - 108
	<sup>134</sup> Cs	54	49	39 - 69
	<sup>137</sup> Cs	122	120	104 - 140
	<sup>54</sup> Mn	95	101	80 - 110
	<sup>59</sup> Fe	43	47	28 - 58
	<sup>65</sup> Zn	92	96	64 - 120
	<sup>60</sup> Co	72	71	57 - 87
Third Quarter	Sand (pCi/g) (Simulated soil)			
	<sup>141</sup> Ce	0.399	0.349	0.339 - 0.459
	<sup>51</sup> Cr	0.301	0.280	0.211 - 0.391
	<sup>134</sup> Cs	0.195	0.216	0.166 - 0.224
	<sup>137</sup> Cs	0.439	0.406	0.373 - 0.505
	<sup>54</sup> Mn	0.343	0.347	0.292 - 0.394
	<sup>59</sup> Fe	0.154	0.144	0.131 - 0.177
	<sup>65</sup> Zn	0.331	0.312	0.232 - 0.430
	<sup>60</sup> Co	0.260	0.241	0.221 - 0.299

APPENDIX G

LAND USE SURVEY

## Appendix G

### Land Use Survey

A land use survey was conducted to identify 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. The land use survey also identified the location of all milk animals and gardens of greater than 500 square feet producing fresh leafy vegetables within a distance of 3 miles from the plant.

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

In order to identify the locations around BFN which have the greatest relative potential for impact by the plant, radiation doses were projected for individuals living near BFN. These projections used the data obtained in the survey and historical meteorological data. The calculations also assumed that releases were equivalent to the design basis source terms. The dose projections are relative in nature and do not reflect actual exposures to individuals living near BFN. Calculated doses to individuals based on measured effluents from the plant were well below applicable dose limits (see Assessment and Evaluation Section and Table 3).

Dose projections from air submersion were calculated for the nearest resident in each sector and dose projections from drinking milk or eating foods produced near the plant were calculated for the areas with milk producing animals and gardens, respectively.

There were no changes in the distances for the locations of the nearest resident or nearest garden in the results from 1999 land use survey as compared to the 1998 data. Therefore, there were no changes in the values for air submersion doses or the doses calculated for ingestion of home-grown foods.

During May 1999, the milk cows located at the dairy farm in the N Sector (Farm Bn) were sold and the dairy went out of business. With this change, there were no locations with milk production within the five mile radius of BFN identified in the 1999 land use survey. The nearest milk production was at the dairy farm located 6.8 miles NNW of the plant. As in past years, the relative projected doses were calculated for this farm and the farm was included in the monitoring program as an indicator sampling location. There was a minor change in the calculated dose value due to a change in the feeding factor.

Tables G-1, G-2, and G-3 show the comparative calculated doses for 1998 and 1999.

Table G-1

## BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Air Submersion Dose to the Nearest Resident  
Within Five Miles of Plant  
mrem/year

<u>Sector</u>	<u>1998 Survey</u>		<u>1999 Survey</u>	
	<u>Approximate Distance Miles</u>	<u>Annual Dose</u>	<u>Approximate Distance Miles</u>	<u>Annual Dose</u>
N	1.24	0.45	1.24	0.45
NNE	1.01	0.14	1.01	0.14
NE	2.54	0.12	2.54	0.12
ENE	1.52	0.17	1.52	0.17
E	1.00	0.33	1.00	0.33
ESE	1.15	0.22	1.15	0.22
SE	a		a	
SSE	a		a	
S	2.78	0.15	2.78	0.15
SSW	2.59	0.18	2.59	0.18
SW	2.76	0.10	2.76	0.10
WSW	2.47	0.08	2.47	0.08
W	1.57	0.19	1.57	0.19
WNW	3.39	0.10	3.39	0.10
NW	2.09	0.30	2.09	0.30
NNW	1.02	0.76	1.02	0.76

Note a - There is no residence within the five mile radius for this section

Table G-2

## BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Dose to Child's Bone from  
Ingestion of Home-Grown Foods  
mrem/year

Sector	1998 Survey		1999 Survey		Number of Gardens Within 3 miles (1998)
	Approximate Distance Miles	Annual Dose	Approximate Distance Miles	Annual Dose	
N	1.24	8.11	1.24	8.11	2
NNE	3.10	1.18	3.10	1.18	1
NE	2.67	1.27	2.67	1.27	1
ENE	2.68	1.33	2.68	1.33	1
E	2.70	1.75	2.70	1.75	1
ESE	1.56	4.08	1.56	4.08	1
SE	a		a		0
SSE	a		a		0
S	2.78	2.28	2.78	2.28	1
SSW	2.59	2.68	2.59	2.68	1
SW	2.77	1.15	2.77	1.15	1
WSW	2.84	0.56	2.84	0.56	1
W	1.85	1.15	1.85	1.15	1
WNW	a		a		0
NW	a		a		0
NNW	1.10	10.10	1.10	10.10	4

note a – Garden not found within 5 miles.

Table G-3

BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Dose to Receptor Thyroid  
from Ingestion of Milk  
mrem/year

<u>Location</u>	<u>Sector</u>	Approximate <u>Distance</u> <u>(Miles)<sup>a</sup></u>	<u>Feeding Factor</u>		<u>Consumer Age *</u>		<u>Annual Dose</u>		<u>X/Q</u> <u>s / m<sup>3</sup></u>
			<u>1998</u>	<u>1999</u>	<u>1998</u>	<u>1999</u>	<u>1997</u>	<u>1998</u>	
Farm B	NNW	6.8	0.01	0.18	A	A	0.005	0.011	1.32E-08

NOTE: The feeding factor is an estimate of the percentage of the time the animals are feeding from pasture.  
A feeding factor of 0.01 is used in the dose calculation when the estimated feeding factor is 0.

\* A = Adult, age 17 + years

APPENDIX H

DATA TABLES AND FIGURES

Table H - 1

DIRECT RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from  
BROWNS FERRY Nuclear Plant for Each Quarter - 1999

mR / Quarter (a)

Distance Miles	Average External Gamma Radiation Levels (b)				per annum mR/yr
	1st qtr	2nd qtr	3rd qtr	4th qtr	
0 - 1	15.8 ± 1.1	15.9 ± 1.0	18.2 ± 1.1	17.4 ± 1.1	67
1 - 2	14.2 ± 1.6	14.6 ± 1.3	15.6 ± 1.4	15.2 ± 1.5	60
2 - 4	12.9 ± 1.1	13.4 ± 1.1	14.8 ± 1.4	14.3 ± 1.4	55
4 - 6	12.8 ± 1.2	13.2 ± 1.4	15.1 ± 1.7	14.0 ± 1.5	55
> 6	13.3 ± 0.9	13.5 ± 0.8	15.3 ± 1.1	14.7 ± 1.0	57
Average, 0 - 2 miles (onsite)	15.4 ± 1.4	15.6 ± 1.2	17.5 ± 1.6	16.8 ± 1.5	65
Average, > 2 miles (offsite)	13.0 ± 1.1	13.4 ± 1.2	15.1 ± 1.5	14.3 ± 1.4	56

(a) Field periods normalized to one standard quarter (2190 hours)

(b) Average of the individual measurements in the set ± 1 standard deviation of the set

TABLE H - 2

## DIRECT RADIATION LEVELS

Individual Stations at Browns Ferry Nuclear Plant

Map Location Number	TLD Station Number	Direction, degrees	Approx Distance, miles	Environmental Radiation Levels				Annual Exposure mR/year
				mR / quarter				
				1st Qtr Jan - Mar 1999	2nd Qtr Apr - Jun 1999	3rd Qtr Jul - Sep 1999	4th Qtr Oct - Dec 1999	
7	N-1	348	1.0	17.0	17.1	18.9	18.5	71.5
38	N-2	1	5.0	11.7	12.0	14.9	13.3	52.0
8	NNE-1	12	.9	15.1	15.9	17.7	16.9	65.6
39	NNE-2	31	.7	16.2	16.5	18.1	18.7	69.6
40	NNE-3	19	5.2	12.2	12.9	15.5	13.8	54.4
41	NE-1	51	.8	16.4	16.9	18.8	17.9	70.0
42	NE-2	49	5.0	14.6	15.2	18.2	16.7	64.7
2	NE-3	56	10.9	14.7	14.3	16.2	15.2	60.4
9	ENE-1	61	.9	16.8	16.2	19.3	18.0	70.2
43	ENE-2	62	6.2	13.9	14.3	17.6	16.2	61.9
44	E-1	85	.8	17.2	16.7	20.0	17.8	71.7
45	E-2	91	5.2	13.7	14.2	15.8	14.1	57.8
6	E-3	90	24.2	14.3	13.7	15.8	15.0	58.7
46	ESE-1	110	.9	14.0	14.1	17.0	15.3	60.4
47	ESE-2	112	3.0	13.5	13.8	15.8	14.7	57.8
48	SE-1	130	.5	14.9	15.1	17.2	16.5	63.7
49	SE-2	135	5.4	9.4	9.3	10.9	9.8	39.3
50	SSE-1	163	5.1	13.5	13.6	15.3	14.5	56.9
3	SSE-2	165	7.5	14.5	14.1	15.9	15.6	60.2
51	S-1	185	3.1	13.7	14.1	15.2	15.2	58.1
52	S-2	182	4.8	12.3	12.3	13.4	13.0	50.9

TABLE H - 2 continued

## DIRECT RADIATION LEVELS

## Individual Stations at Browns Ferry Nuclear Plant

Map Location Number	TLD Station Number	Direction, degrees	Approx Distance, miles	Environmental Radiation Levels				Annual Exposure mR/year
				mR / quarter				
				1st Qtr Jan - Mar 1999	2nd Qtr Apr - Jun 1999	3rd Qtr Jul - Sep 1999	4th Qtr Oct - Dec 1999	
53	SSW-1	203	3.0	11.6	11.6	13.0	12.0	48.1
54	SSW-2	199	4.4	13.3	13.1	14.6	14.3	55.2
55	SW-1	228	1.9	12.7	13.0	14.3	13.5	53.4
56	SW-2	219	4.7	13.5	13.6	14.8	14.0	55.9
57	SW-3	224	6.0	12.4	12.0	14.4	13.5	52.3
58	WSW-1	244	2.7	11.7	12.1	13.2	13.1	50.1
59	WSW-2	251	5.1	13.7	14.3	15.5	14.5	58.0
60	WSW-3	257	10.5	12.6	12.7	13.8	13.4	52.4
61	W-1	275	1.9	13.4	14.4	15.0	15.5	58.2
62	W-2	268	4.7	12.6	12.9	13.8	12.9	52.1
5	W-3	275	31.3	12.4	12.5	14.2	13.6	52.7
63	W-4	265	32.1	13.4	13.9	14.8	15.2	57.3
64	WNW-1	291	3.3	13.5	13.2	14.5	14.1	55.3
65	WNW-2	293	4.4	13.3	13.4	14.4	14.0	55.1
66	NW-1	326	2.2	14.7	14.9	17.1	16.3	63.0
67	NW-2	321	5.3	13.5	14.5	16.8	15.2	60.0
1	NW-3	310	13.8	13.8	13.0	14.9	14.8	56.5
68	NNW-1	331	1.0	14.7	14.8	16.5	16.2	62.1
10	NNW-2	331	1.7	16.3	16.2	17.5	17.1	67.0
69	NNW-3	339	5.2	13.5	13.7	16.6	15.5	59.3

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN AIR FILTER  
 PCI/M3 - 0.037 BQ/M3

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	570					
	2.00E-03	2.19E-02( 466/ 466) 1.01E-02- 6.05E-02	LM-6BF BAKER BOTTOM 3.0 MILES SSW	2.27E-02( 52/ 52) 1.23E-02- 5.49E-02	2.20E-02( 104/ 104) 1.15E-02- 5.71E-02	
GAMMA SPECTROSCOPY	143					
BE-7	2.00E-02	1.18E-01( 117/ 117) 6.45E-02- 6.19E-01	LM-7BF LAKEVIEW 2.1 MILES WEST	1.55E-01( 13/ 13) 8.83E-02- 6.19E-01	1.15E-01( 26/ 26) 8.30E-02- 1.69E-01	
BI-214	5.00E-03	1.34E-02( 75/ 117) 5.10E-03- 3.98E-02	LM-7BF LAKEVIEW 2.1 MILES WEST	1.77E-02( 10/ 13) 6.00E-03- 3.98E-02	1.31E-02( 13/ 26) 5.50E-03- 2.51E-02	
K-40	4.00E-02	7.48E-02( 1/ 117) 7.48E-02- 7.48E-02	LM-7BF LAKEVIEW 2.1 MILES WEST	7.48E-02( 1/ 13) 7.48E-02- 7.48E-02	26 VALUES < LLD	
PB-214	5.00E-03	1.32E-02( 77/ 117) 5.00E-03- 3.92E-02	LM-7BF LAKEVIEW 2.1 MILES WEST	1.82E-02( 11/ 13) 6.50E-03- 3.92E-02	1.31E-02( 14/ 26) 5.00E-03- 3.08E-02	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN CHARCOAL FILTER  
 PCI/M3 - 0.037 BQ/M3

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS		LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
		MEAN (F) RANGE SEE NOTE 2					
GAMMA SPECTROSCOPY							
	570						
BI-214	5.00E-02	6.98E-02( 46/ 466)	PM-3 BF DECATUR AL	9.39E-02( 1/ 52)	1.07E-01( 7/ 104)		
		5.00E-02- 1.56E-01	8.2 MILES SSE	9.39E-02- 9.39E-02	5.29E-02- 3.09E-01		
K-40	3.00E-01	3.62E-01( 40/ 466)	PM-2 BF ATHENS AL	4.04E-01( 10/ 52)	3.41E-01( 6/ 104)		
		3.02E-01- 5.66E-01	10.9 MILES NE	3.33E-01- 5.66E-01	3.10E-01- 4.40E-01		
PB-214	7.00E-02	8.70E-02( 31/ 466)	PM-3 BF DECATUR AL	1.20E-01( 1/ 52)	1.20E-01( 6/ 104)		
		7.13E-02- 1.20E-01	8.2 MILES SSE	1.20E-01- 1.20E-01	8.37E-02- 2.64E-01		
I-131	SEE NOTE 3						

- NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).  
 NOTE: 3. 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  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN MILK  
 PCI/L - 0.037 BQ/L

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	89	4.00E-01	37 VALUES < LLD		52 VALUES < LLD	
GAMMA SPECTROSCOPY	89					
BI-214		2.00E+01	2.42E+01( 2/ 37) SMITH/BENNETT FARM 2.05E+01- 2.78E+01 5.0 MILES N	2.78E+01( 1/ 11) 2.78E+01- 2.78E+01	3.25E+01( 2/ 52) 2.35E+01- 4.14E+01	
K-40		1.00E+02	1.33E+03( 37/ 37) BROOKS FARM 6.8 MILE 1.20E+03- 1.48E+03 S NNW	1.34E+03( 26/ 26) 1.24E+03- 1.48E+03	1.34E+03( 52/ 52) 1.17E+03- 1.49E+03	
PB-214		2.00E+01	2.10E+01( 1/ 37) SMITH/BENNETT FARM 2.10E+01- 2.10E+01 5.0 MILES N	2.10E+01( 1/ 11) 2.10E+01- 2.10E+01	2.39E+01( 1/ 52) 2.39E+01- 2.39E+01	
SR 89	44	3.50E+00	18 VALUES < LLD		26 VALUES < LLD	
SR 90	44	2.00E+00	2.11E+00( 1/ 18) SMITH/BENNETT FARM 2.11E+00- 2.11E+00 5.0 MILES N	2.11E+00( 1/ 5) 2.11E+00- 2.11E+00	26 VALUES < LLD	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN VEGETATION  
 PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	26	6.00E+00	13 VALUES < LLD		13 VALUES < LLD	
GAMMA SPECTROSCOPY	26					
BE-7	2.00E+02	1.68E+03( 12/ 13)	TERRY FARM	1.68E+03( 12/ 13)	1.10E+03( 12/ 13)	
		3.78E+02- 6.01E+03	3.2 MILES WNW	3.78E+02- 6.01E+03	3.49E+02- 3.83E+03	
BI-214	5.50E+01	1.28E+02( 5/ 13)	TERRY FARM	1.28E+02( 5/ 13)	9.93E+01( 3/ 13)	
		6.25E+01- 2.19E+02	3.2 MILES WNW	6.25E+01- 2.19E+02	5.86E+01- 1.55E+02	
K-40	4.00E+02	5.79E+03( 13/ 13)	TERRY FARM	5.79E+03( 13/ 13)	5.85E+03( 13/ 13)	
		2.59E+03- 7.67E+03	3.2 MILES WNW	2.59E+03- 7.67E+03	3.22E+03- 7.42E+03	
PB-214	8.00E+01	1.95E+02( 2/ 13)	TERRY FARM	1.95E+02( 2/ 13)	1.67E+02( 1/ 13)	
		1.69E+02- 2.20E+02	3.2 MILES WNW	1.69E+02- 2.20E+02	1.67E+02- 1.67E+02	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN SOIL  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS		LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2		CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
		MEAN (F) RANGE SEE NOTE 2						
GAMMA SPECTROSCOPY								
	11							
AC-228	2.50E-01	1.16E+00( 9/ 9)	LM4 BF TRAILER P	1.50E+00( 1/ 1)	8.50E-01( 2/ 2)			
		7.02E-01- 1.50E+00	1.7 MILES NNW	1.50E+00- 1.50E+00	7.58E-01- 9.43E-01			
BI-212	4.50E-01	1.23E+00( 9/ 9)	LM4 BF TRAILER P	1.72E+00( 1/ 1)	7.88E-01( 2/ 2)			
		7.22E-01- 1.72E+00	1.7 MILES NNW	1.72E+00- 1.72E+00	6.88E-01- 8.89E-01			
BI-214	1.50E-01	9.43E-01( 9/ 9)	LM4 BF TRAILER P	1.29E+00( 1/ 1)	6.79E-01( 2/ 2)			
		6.53E-01- 1.29E+00	1.7 MILES NNW	1.29E+00- 1.29E+00	6.22E-01- 7.36E-01			
CS-137	3.00E-02	2.31E-01( 9/ 9)	LM-6BF BAKER BOTTOM	4.45E-01( 1/ 1)	2.14E-01( 2/ 2)			
		1.20E-01- 4.45E-01	3.0 MILES SSW	4.45E-01- 4.45E-01	1.02E-01- 3.25E-01			
K-40	7.50E-01	5.46E+00( 9/ 9)	LM4 BF TRAILER P	7.98E+00( 1/ 1)	3.89E+00( 2/ 2)			
		2.67E+00- 7.98E+00	1.7 MILES NNW	7.98E+00- 7.98E+00	3.54E+00- 4.25E+00			
PB-212	1.00E-01	1.12E+00( 9/ 9)	LM4 BF TRAILER P	1.51E+00( 1/ 1)	7.85E-01( 2/ 2)			
		6.95E-01- 1.51E+00	1.7 MILES NNW	1.51E+00- 1.51E+00	6.94E-01- 8.76E-01			
PB-214	1.50E-01	1.04E+00( 9/ 9)	LM4 BF TRAILER P	1.42E+00( 1/ 1)	7.86E-01( 2/ 2)			
		7.55E-01- 1.42E+00	1.7 MILES NNW	1.42E+00- 1.42E+00	7.31E-01- 8.41E-01			
RA-224	7.50E-01	1.24E+00( 6/ 9)	LM4 BF TRAILER P	1.36E+00( 1/ 1)	1.03E+00( 1/ 2)			
		1.12E+00- 1.36E+00	1.7 MILES NNW	1.36E+00- 1.36E+00	1.03E+00- 1.03E+00			
RA-226	1.50E-01	9.18E-01( 8/ 9)	LM4 BF TRAILER P	1.29E+00( 1/ 1)	6.79E-01( 2/ 2)			
		6.53E-01- 1.29E+00	1.7 MILES NNW	1.29E+00- 1.29E+00	6.22E-01- 7.36E-01			
TL-208	6.00E-02	3.54E-01( 9/ 9)	LM4 BF TRAILER P	4.89E-01( 1/ 1)	2.52E-01( 2/ 2)			
		2.05E-01- 4.89E-01	1.7 MILES NNW	4.89E-01- 4.89E-01	2.18E-01- 2.85E-01			
SR 89	11							
		1.60E+00	9 VALUES < LLD		2 VALUES < LLD			
SR 90	11							
		4.00E-01	9 VALUES < LLD		2 VALUES < LLD			

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

Table H-7

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TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN CABBAGE  
 PCI/KG - 0.037 BQ/KG (WET WT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
	2					
K-40	2.50E+02	1.57E+03( 1/ 1) 1.57E+03- 1.57E+03	LM4 BF TRAILER P 1.7 MILES NNW	1.57E+03( 1/ 1) 1.57E+03- 1.57E+03	1.88E+03( 1/ 1) 1.88E+03- 1.88E+03	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESSES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN CORN  
 PCI/KG - 0.037 BQ/KG (WET WT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
K-40	2.50E+02	2.42E+03( 1/ 1) 2.42E+03- 2.42E+03	BFNP Paradise Shores 1.5 Miles NNW	2.42E+03( 1/ 1) 2.42E+03- 2.42E+03	1.92E+03( 1/ 1) 1.92E+03- 1.92E+03	2

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN GREEN BEANS  
 PCI/KG - 0.037 BQ/KG (WET WT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
K-40	2.50E+02	3.55E+03( 1/ 1) 3.55E+03- 3.55E+03	BFNP Paradise Shores 1.5 Miles NNW	3.55E+03( 1/ 1) 3.55E+03- 3.55E+03	1.87E+03( 1/ 1) 1.87E+03- 1.87E+03	2

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN POTATOES  
 PCI/KG - 0.037 BQ/KG (WET WT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
K-40	2.50E+02	2.77E+03( 1/ 1) 2.77E+03- 2.77E+03	3.0 MILES NNE 3.0 MILES NNE	2.77E+03( 1/ 1) 2.77E+03- 2.77E+03	3.04E+03( 1/ 1) 3.04E+03- 3.04E+03	2

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN TOMATOES  
 PCI/KG - 0.037 BQ/KG (WET WT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
K-40	2.50E+02	1.85E+03( 1/ 1) 1.85E+03- 1.85E+03	BFNP Paradise Shores 1.5 Miles NNW	1.85E+03( 1/ 1) 1.85E+03- 1.85E+03	1.72E+03( 1/ 1) 1.72E+03- 1.72E+03	2

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN SURFACE WATER(Total)  
 PCI/L - 0.037 BQ/L

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA						
24	1.90E+00	2.81E+00( 12/ 12) 2.27E+00- 3.52E+00	TRM 293.5	2.81E+00( 12/ 12) 2.27E+00- 3.52E+00	2.85E+00( 10/ 12) 2.15E+00- 4.00E+00	
GAMMA SPECTROSCOPY						
24						
BI-214	2.00E+01	3.17E+01( 1/ 12) 3.17E+01- 3.17E+01	TRM 293.5	3.17E+01( 1/ 12) 3.17E+01- 3.17E+01	12 VALUES < LLD	
PB-214	2.00E+01	3.18E+01( 1/ 12) 3.18E+01- 3.18E+01	TRM 293.5	3.18E+01( 1/ 12) 3.18E+01- 3.18E+01	12 VALUES < LLD	
TRITIUM						
8	3.00E+02	4 VALUES < LLD			4 VALUES < LLD	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN PUBLIC WATER(Total)  
 PCI/L - 0.037 BQ/L

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	76	1.90E+00	2.75E+00( 53/ 64) W MOR-E LAWR WAT ATH TRM 286.5	3.06E+00( 11/ 12) 2.02E+00- 6.61E+00	2.85E+00( 10/ 12) 2.15E+00- 4.00E+00	
GAMMA SPECTROSCOPY	76					
BI-214	2.00E+01	2.79E+01( 13/ 64) 2.15E+01- 4.65E+01	W MOR-E LAWR WAT ATH TRM 286.5	3.40E+01( 2/ 12) 2.15E+01- 4.65E+01	12 VALUES < LLD	
PB-214	2.00E+01	2.37E+01( 4/ 64) 2.04E+01- 2.67E+01	W MOR-E LAWR WAT ATH TRM 286.5	2.65E+01( 1/ 12) 2.65E+01- 2.65E+01	12 VALUES < LLD	
TRITIUM	24	3.00E+02	20 VALUES < LLD		4 VALUES < LLD	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN WELL WATER(Total)  
 PCI/L - 0.037 BQ/L

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
	25					
BI-214	2.00E+01	4.31E+01( 1/ 12)	BFN WELL #6	4.31E+01( 1/ 12)	2.76E+02( 13/ 13)	
		4.31E+01- 4.31E+01	0.02 MILES W	4.31E+01- 4.31E+01	1.65E+02- 3.72E+02	
PB-214	2.00E+01	2.01E+01( 1/ 12)	BFN WELL #6	2.01E+01( 1/ 12)	2.78E+02( 13/ 13)	
		2.01E+01- 2.01E+01	0.02 MILES W	2.01E+01- 2.01E+01	1.83E+02- 3.77E+02	
TRITIUM	8					
	3.00E+02	4 VALUES < LLD			4 VALUES < LLD	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .

NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN COMMERCIAL FISH  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
BI-214	1.00E-01	2 VALUES < LLD	WHEELER RES TRM 275-349	2 VALUES < LLD	1.42E-01( 1/ 2) 1.42E-01- 1.42E-01	
K-40	4.00E-01	1.16E+01( 2/ 2) 1.09E+01- 1.23E+01	WHEELER RES TRM 275-349	1.16E+01( 2/ 2) 1.09E+01- 1.23E+01	9.80E+00( 2/ 2) 9.79E+00- 9.81E+00	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN GAME FISH  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2		LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2		CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY								
BI-214	1.00E-01	1.10E-01(	1/ 2)	WHEELER RES	1.10E-01(	1/ 2)	2 VALUES < LLD	
		1.10E-01-	1.10E-01	TRM 275-349	1.10E-01-	1.10E-01		
CO-60	3.00E-02	1.94E-01(	1/ 2)	WHEELER RES	1.94E-01(	1/ 2)	2 VALUES < LLD	
		1.94E-01-	1.94E-01	TRM 275-349	1.94E-01-	1.94E-01		
CS-137	3.00E-02	3.59E-02(	1/ 2)	WHEELER RES	3.59E-02(	1/ 2)	4.72E-02(	2/ 2)
		3.59E-02-	3.59E-02	TRM 275-349	3.59E-02-	3.59E-02	4.31E-02-	5.14E-02
K-40	4.00E-01	1.60E+01(	2/ 2)	WHEELER RES	1.60E+01(	2/ 2)	1.66E+01(	2/ 2)
		1.52E+01-	1.68E+01	TRM 275-349	1.52E+01-	1.68E+01	1.56E+01-	1.76E+01

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

TENNESSEE VALLEY AUTHORITY  
 ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION  
 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN SHORELINE SEDIMENT  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY: BROWNS FERRY NUCLEAR PLANT  
 LOCATION OF FACILITY: LIMESTONE ALABAMA

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1999

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SPECTROSCOPY						
	6					
AC-228	2.50E-01	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	8.32E-01( 2/ 2) 4.95E-01- 1.17E+00	
BE-7	2.50E-01	4 VALUES < LLD	JOE WHEELER ST PARK TRM 279.5	2 VALUES < LLD	5.19E-01( 1/ 2) 5.19E-01- 5.19E-01	
BI-212	4.50E-01	4 VALUES < LLD	JOE WHEELER ST PARK TRM 279.5	2 VALUES < LLD	8.78E-01( 2/ 2) 4.87E-01- 1.27E+00	
BI-214	1.50E-01	1.68E-01( 1/ 4) 1.68E-01- 1.68E-01	MALLARD CREEK REC AR TRM 293.0	1.68E-01( 1/ 2) 1.68E-01- 1.68E-01	5.93E-01( 2/ 2) 4.09E-01- 7.77E-01	
K-40	7.50E-01	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	9.29E+00( 2/ 2) 4.01E+00- 1.46E+01	
PB-212	1.00E-01	1.19E-01( 2/ 4) 1.18E-01- 1.20E-01	MALLARD CREEK REC AR TRM 293.0	1.20E-01( 1/ 2) 1.20E-01- 1.20E-01	8.46E-01( 2/ 2) 4.95E-01- 1.20E+00	
PB-214	1.50E-01	1.62E-01( 2/ 4) 1.50E-01- 1.74E-01	MALLARD CREEK REC AR TRM 293.0	1.62E-01( 2/ 2) 1.50E-01- 1.74E-01	6.58E-01( 2/ 2) 4.77E-01- 8.39E-01	
RA-226	1.50E-01	1.68E-01( 1/ 4) 1.68E-01- 1.68E-01	MALLARD CREEK REC AR TRM 293.0	1.68E-01( 1/ 2) 1.68E-01- 1.68E-01	5.93E-01( 2/ 2) 4.09E-01- 7.77E-01	
TL-208	6.00E-02	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	2.62E-01( 2/ 2) 1.56E-01- 3.68E-01	

NOTE: 1. NOMINAL LOWER LIMIT OF DETECTION (LLD) AS DESCRIBED IN TABLE E-1 .  
 NOTE: 2. MEAN AND RANGE BASED UPON DETECTABLE MEASUREMENTS ONLY. FRACTION OF DETECTABLE MEASUREMENTS AT SPECIFIED LOCATIONS IS INDICATED IN PARENTHESES (F).

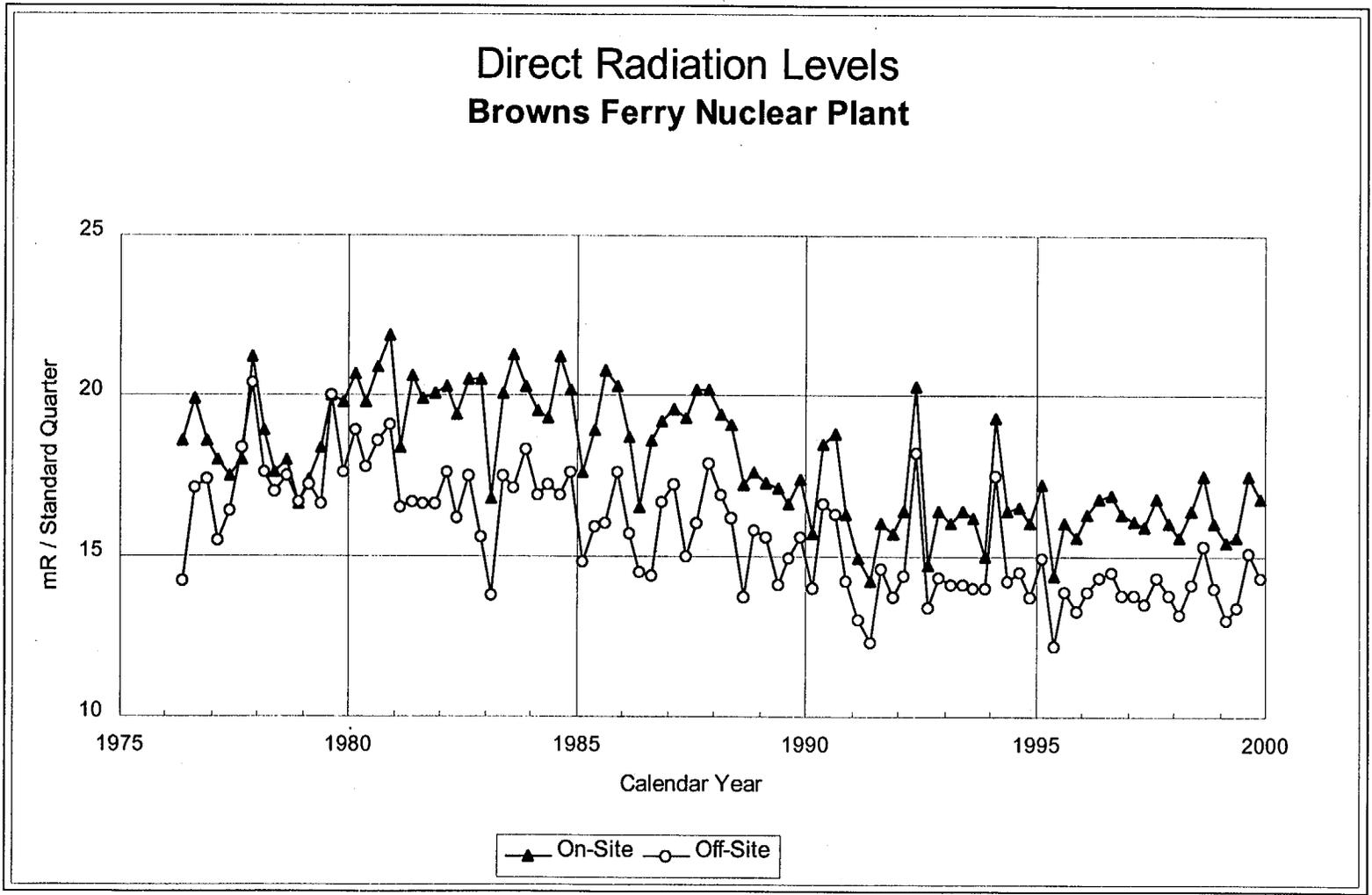


Figure H-1

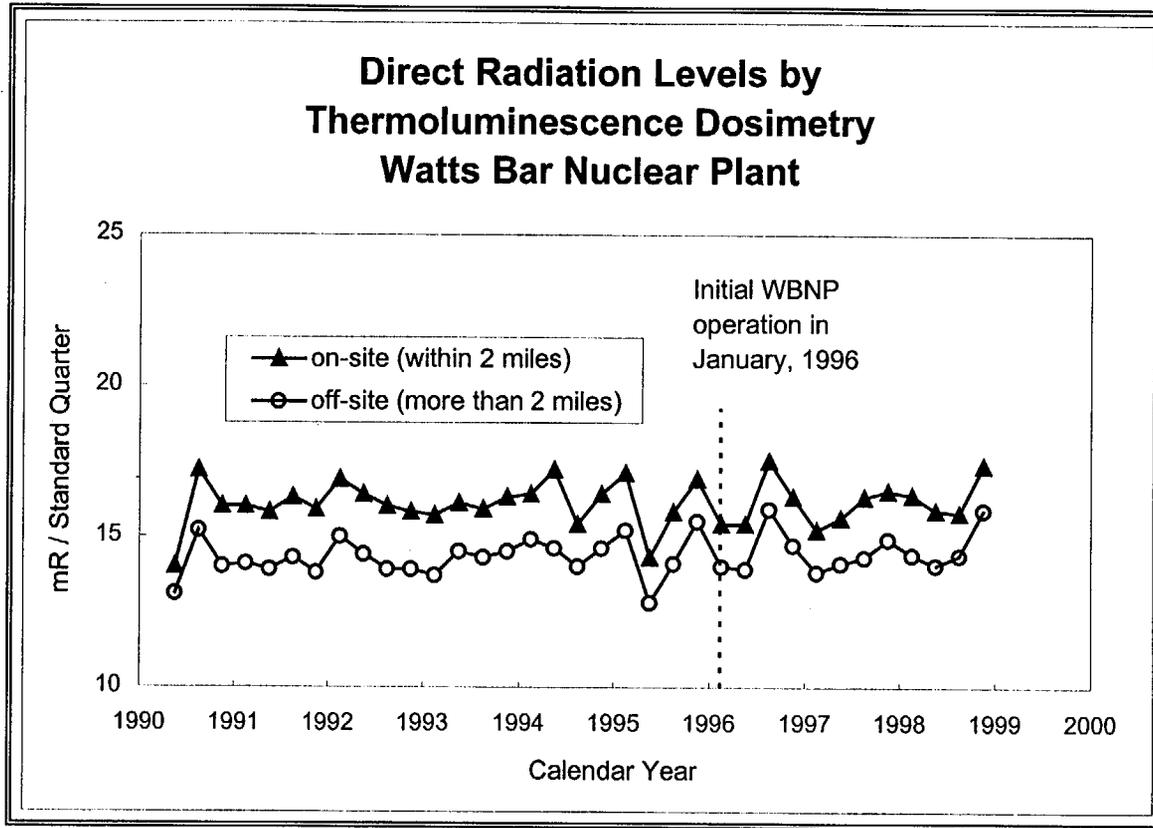


Figure H-2

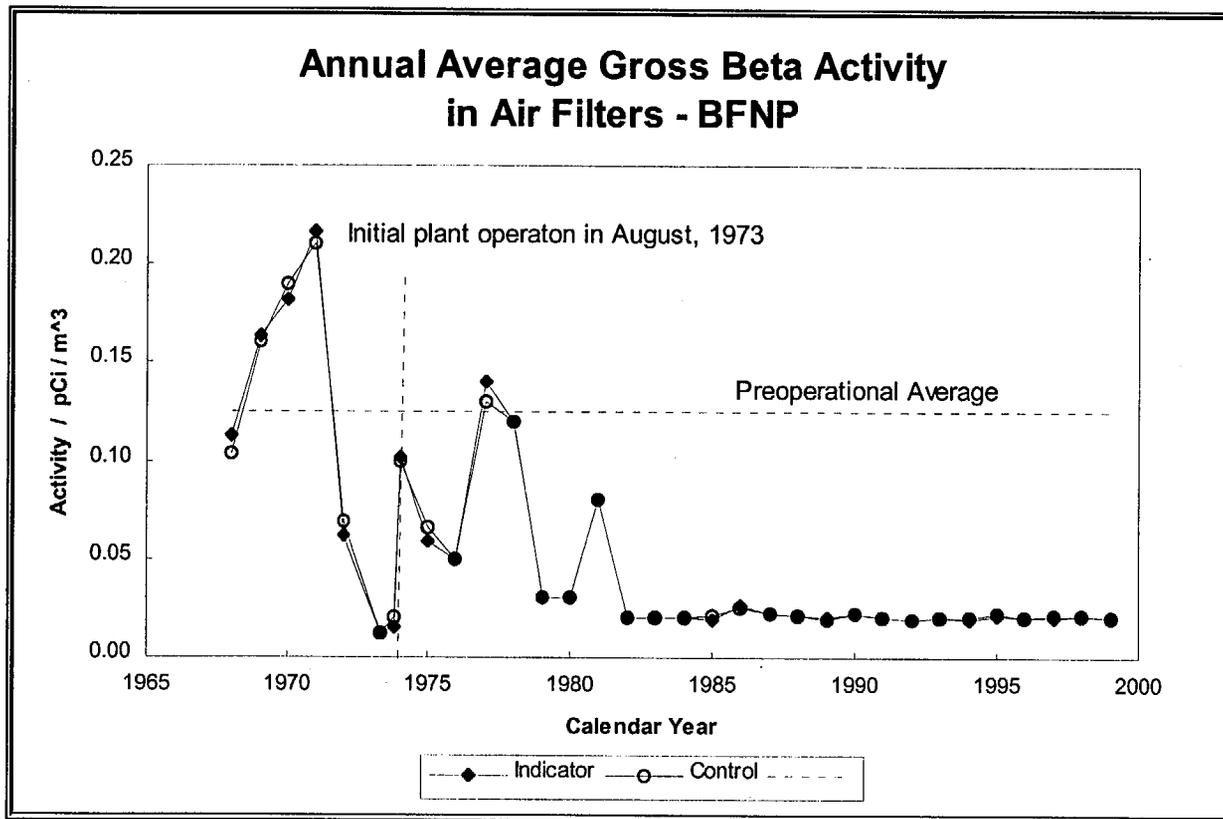


Figure H-3

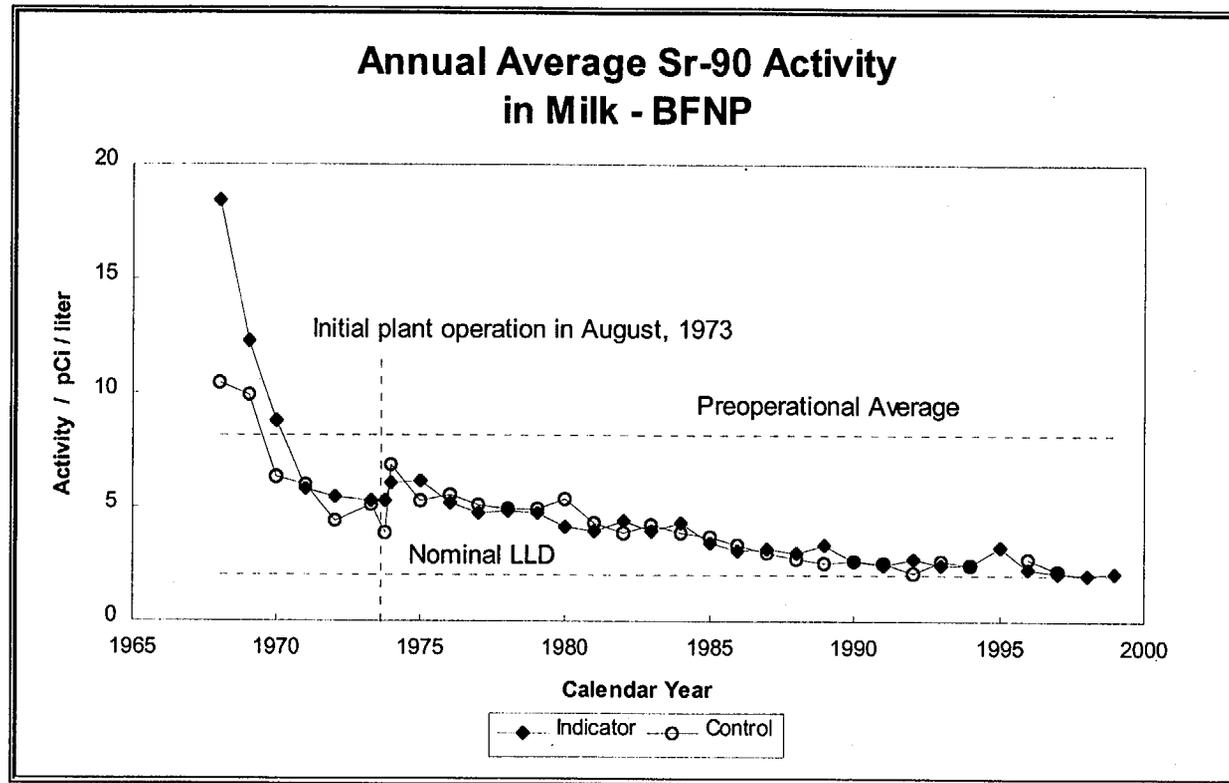


Figure H-4

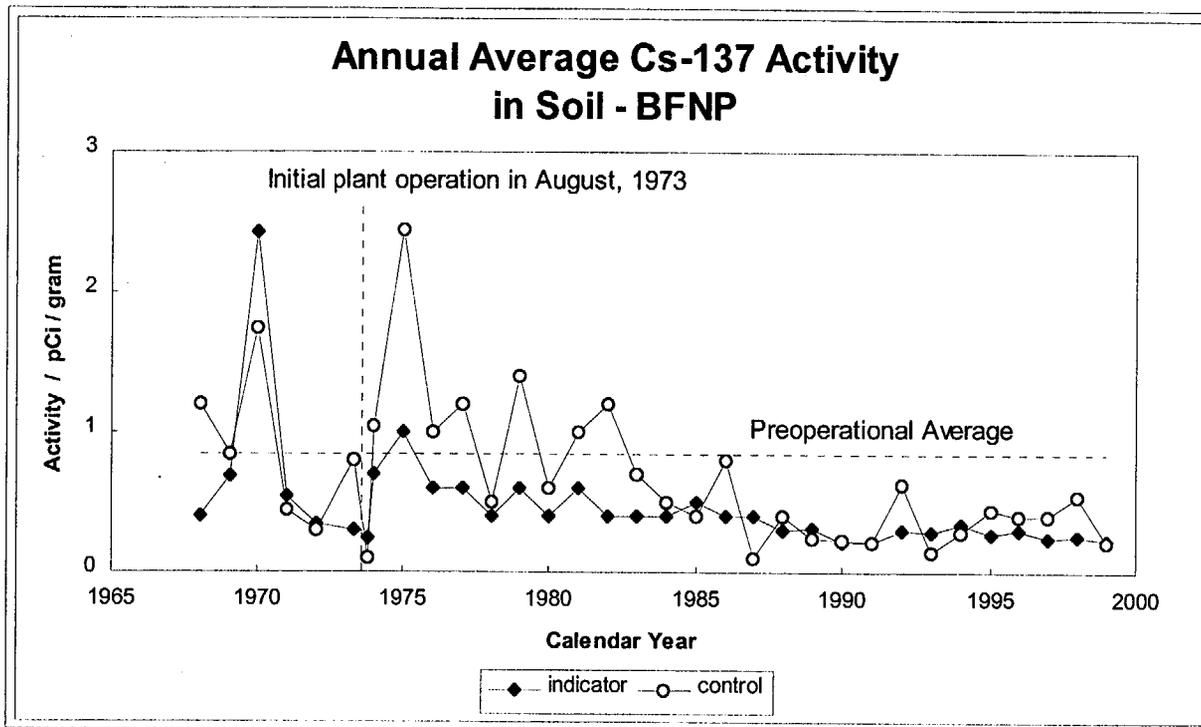


Figure H-5

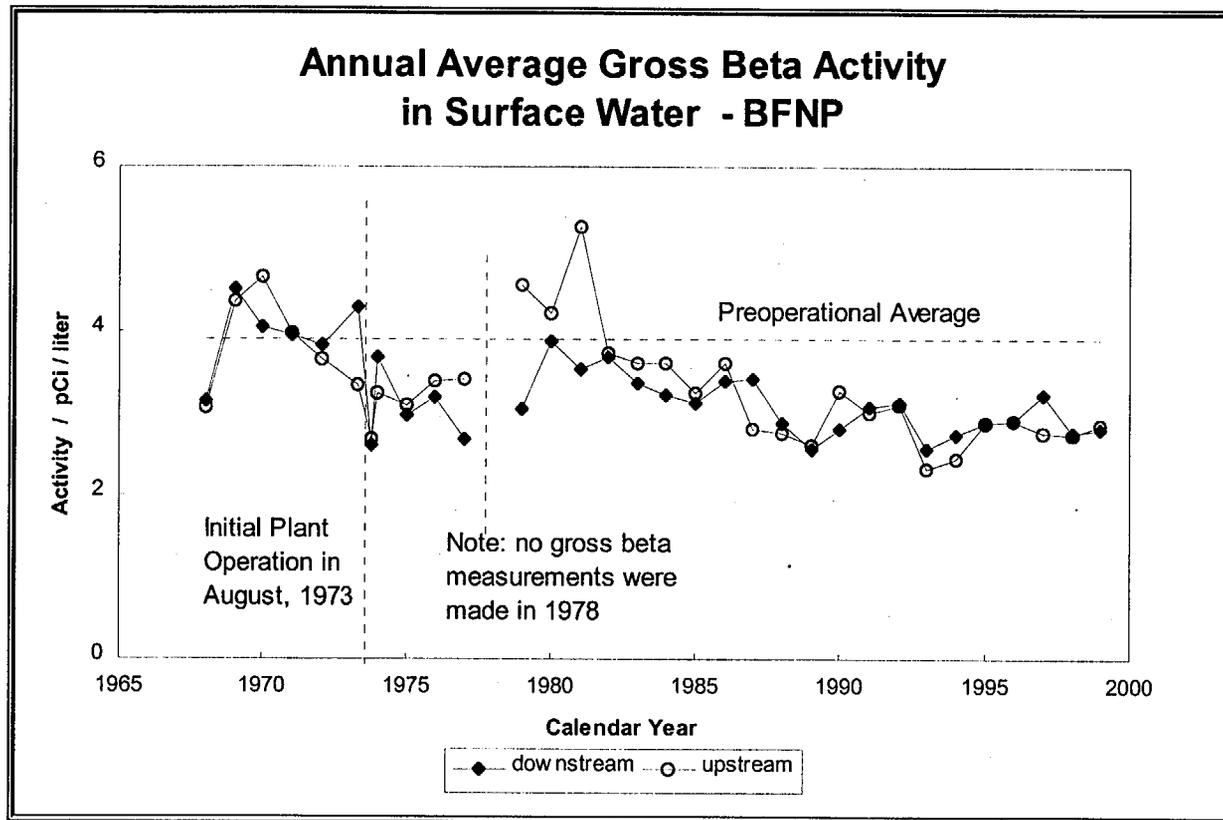


Figure H-6

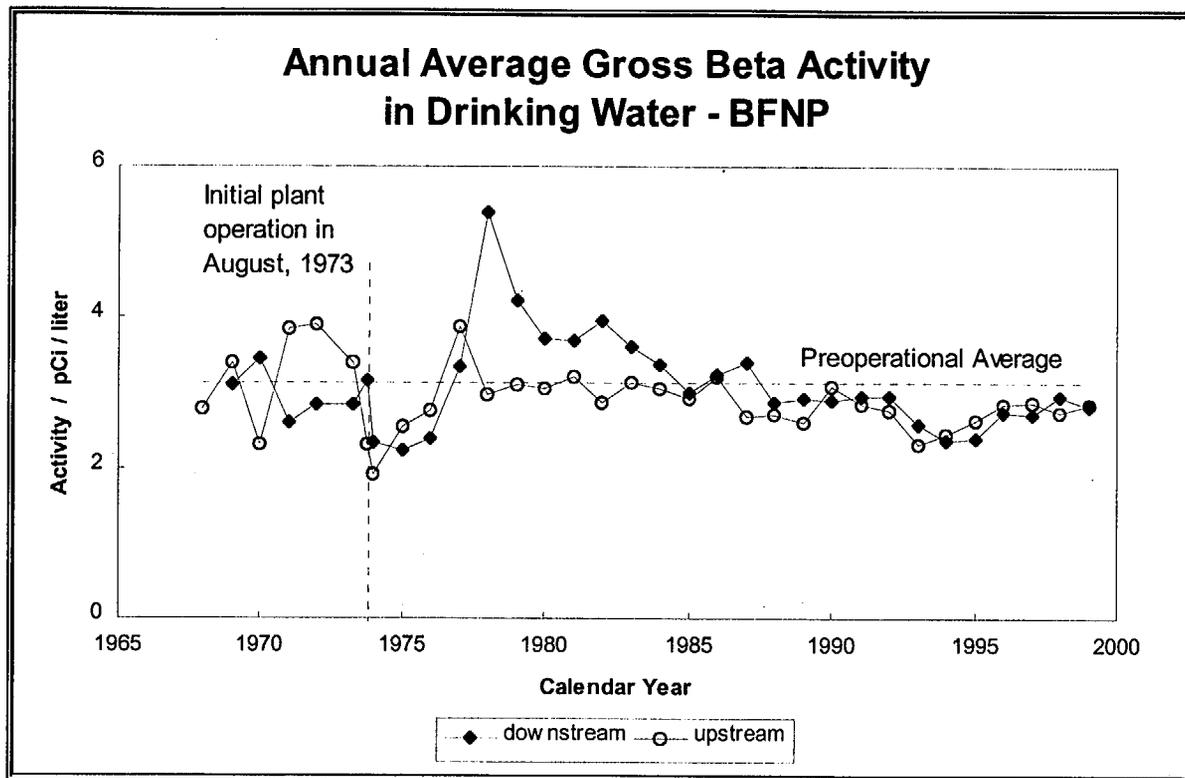


Figure H-7

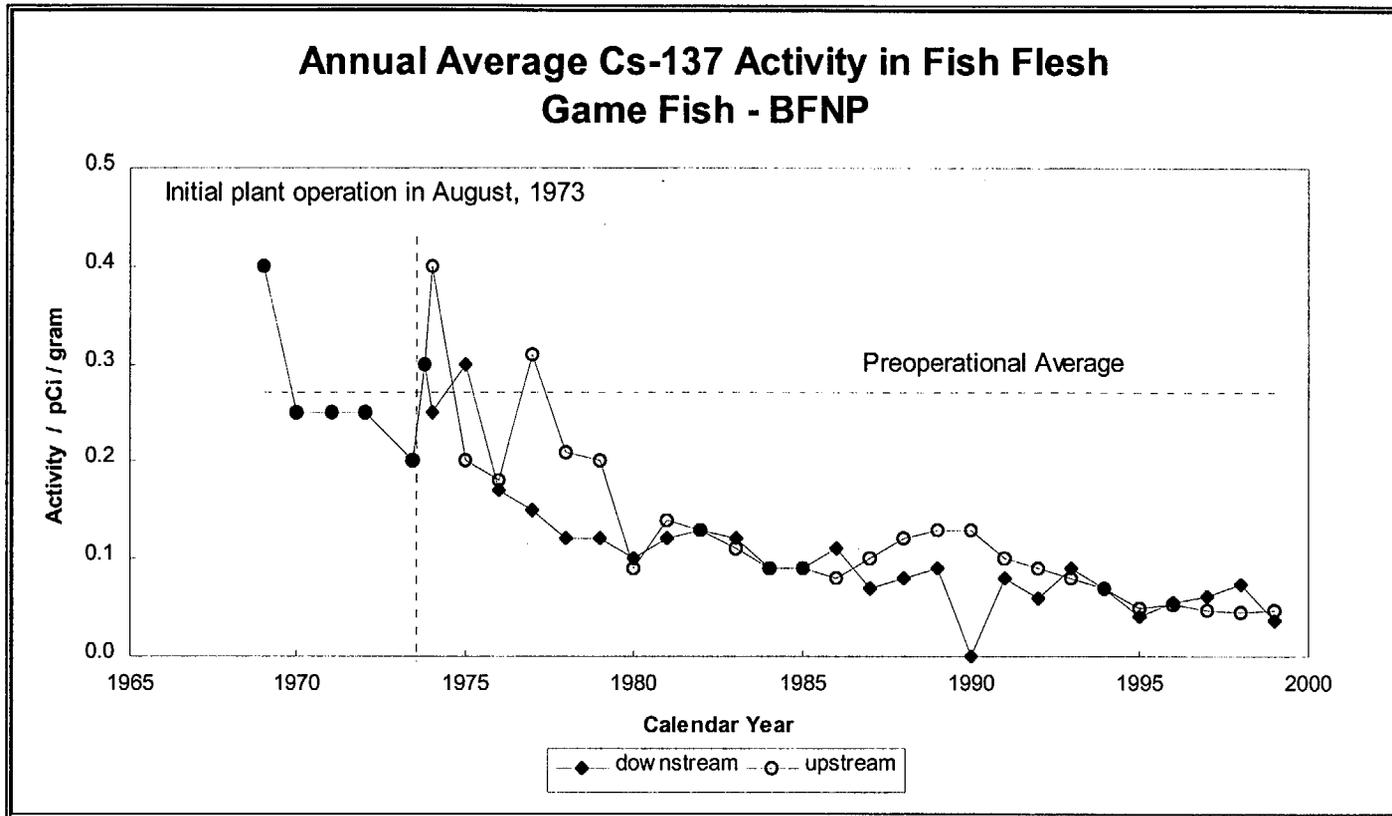


Figure H-8

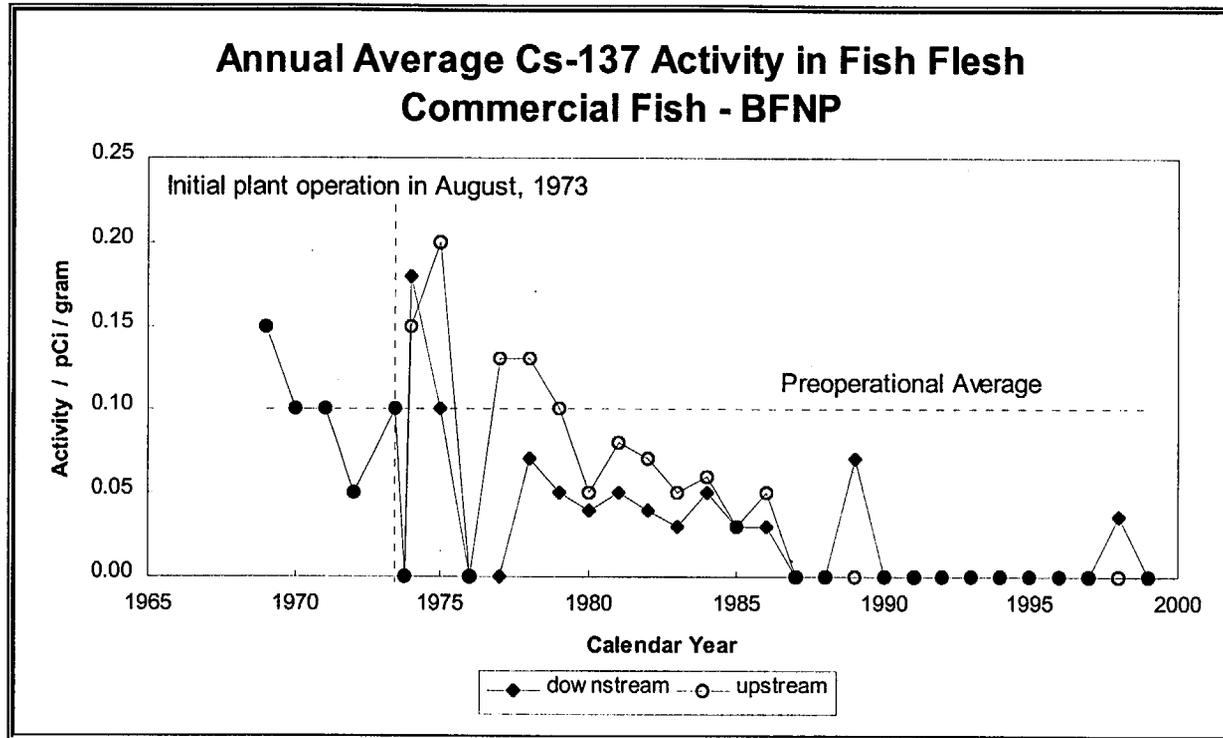


Figure H-9