Annual Radiological Environmental Operating Report

Browns Ferry
Nuclear Plant
1996

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

BROWNS FERRY NUCLEAR PLANT

1996

TENNESSEE VALLEY AUTHORITY

ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION

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EXECUTIVE SUMMARY

This report describes the environmental radiological monitoring program conducted by TVA in the vicinity of Browns Ferry Nuclear Plant (BFN) in 1996. 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. Station locations are selected after careful consideration of the weather patterns and projected radiation doses to the various areas around the plant. 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 and Cs-137 were found in sediment samples downstream from the plant. This activity in stream sediment 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 6.9.1.5 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 other useful or interesting information for individuals who do not work with this material routinely.

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, uranium-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 from outer space. We are all exposed to this natural radiation 24 hours per day.

The average dose equivalent at sea level resulting from radiation from outer space (part of natural background radiation) is about 27 mrem/year. This essentially doubles with each 6600-foot increase in altitude in the lower atmosphere. Another part of natural background radiation comes from naturally occurring radioactive materials in the soil and rocks. Because the quantity of naturally occurring radioactive material varies according to geographical location, the part of the natural background radiation coming from this radioactive material also depends upon the geographical location. Most of the remainder of the natural background radiation comes from the radioactive materials within each individual's body. We absorb these materials from the food we eat which contains naturally occurring radioactive materials from the soil. An example of this is K-40 as described above. Even building materials affect the natural background radiation levels in the environment. Living or working in a building which is largely made of earthen material, such as concrete or brick, will generally result in a higher natural background radiation level than would exist if the same structure were made of wood. This is due to the naturally occurring radioisotopes in the concrete or brick, such as trace amounts of uranium, radium, thorium, etc.

Because the city of Denver, Colorado, is over 5000 feet in altitude and the soil and rocks there contain more radioactive material than the U.S. average, the people of Denver receive around 350 mrem/year total natural background radiation dose equivalent compared to about 295 mrem/year for the national average. People in some locations of the world receive over 1000 mrem/year natural background radiation dose equivalent, primarily because of the greater quantity of radioactive materials in the soil and rocks in those locations. Scientists have never been able to show that these levels of radiation have caused physical harm to anyone.

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
Total		355 (approximately)

As can be seen from the table, 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.

Significant discussion recently has centered around exposures from radon. Radon-222 (radon) is an inert gas given off as a result of the decay of naturally occurring radium-226 in soil.

When dispersed in the atmosphere, radon concentrations are relatively low. However, when the gas is trapped in closed spaces, it can build up until concentrations become significant. The National Council of Radiation Protection and Measurements (Reference 2) has estimated that the average annual effective dose equivalent from radon in the United States is approximately 200 mrem/year. This estimated dose is approximately twice the average dose equivalent from all other natural background sources.

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. However, nuclear plants include many complex systems to control the nuclear fission process and to safeguard against the possibility of reactor malfunction, which could lead to the release of radioactive materials. 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.

All paths 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 an 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	≤3 mrem/year
Any organ	≤10 mrem/year
Gaseous Effluents	
Noble gases:	
Gamma radiation	≤10 mrad/year
Beta radiation	≤20 mrad/year
Particulates:	
Any organ	≤15 mrem/year

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	≤25 mrem/year
Thyroid	≤75 mrem/year
Any other organ	≤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 areas. 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. At least two dairy farms are 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 from the site. The Tennessee River is also a popular sport fishing area.

BFN consists of three boiling water reactors; each unit is rated at 1098 megawatts (electrical). 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.

ENVIRONMENTAL RADIOLOGICAL 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 environmental radiological 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 1996 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 environmental radiological 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 determination of impact during the operating phase also considers the presence of control stations that have been established in the environment. Results of environmental samples taken at control stations (far from the plant) are compared with those from indicator stations (near the plant) to 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 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. The laboratory participates in the 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 1996 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 (Ca_2F: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^2 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 station. Sixteen stations are located around the plant near the site boundary, one station in each of the sixteen compass sectors. Dosimeters are also placed at the perimeter and remote air monitoring sites and at 19 additional stations out to approximately 32 miles from the site. 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 Hewlett Packard Model 9000 computer system. Nine of the locations also have TLD devices processed by the NRC. The results from the NRC measurements are reported in NUREG 0837.

Since the calcium sulfate phosphor is much more sensitive that 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 station. 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 eight of the ten intercomparisons of environmental dosimeters conducted by the U.S. Department of Energy and other interested parties. The results, shown in Table 2 and Figure 3, 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 stations are grouped according to the distance from the plant. The first group consists of all stations 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 stations more than 6 miles from the plant. Past data have shown that the results from all stations greater than 2 miles from the plant are essentially the same. Therefore, for purposes

of this report, all stations 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 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 environmental radiological monitoring program are referenced.

The quarterly gamma radiation levels determined from the TLDs deployed around BFN in 1996 are summarized in Table H-1. The results from all measurements at individual stations 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 mR/year BFN 1996
Onsite Stations	66
Offsite Stations	57

The data in Table H-1 indicate that the average quarterly radiation levels at the BFN onsite stations are approximately 2.4 mR/quarter higher than levels at the offsite stations. 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 stations 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 stations with those from the offsite stations over the period from 1976 through 1996. To reduce the seasonal variations present in the data sets, a 4-quarter moving average was constructed for each data set. Figure H-2 presents a trend plot of the direct radiation levels as defined by the moving averages. The data follow the same general trend as the raw data, but the curves are much smoother. Figures H-3 and H-4 depict 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 stations are higher than the levels at offsite stations.

All results reported in 1996 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 increase 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 directions 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 remote air monitors 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. The remote stations are used as control or baseline stations.

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 and radionuclides produced as a result of fallout from previous nuclear weapons tests. 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. This system is housed in a building approximately 2 feet by 3 feet by 4 feet. The filter is contained in a sampling head mounted on the outside of the monitor building. The filter is replaced every 7 days. 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 a complete 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. 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 1996.

Results

The results from the analysis of air particulate samples are summarized in Table H-3. Gross beta activity in 1996 was consistent with levels reported in previous years. The average level at indicator stations was 0.020 pCi/m^3 while the average at control stations was 0.021 pCi/m^3. The annual averages of the gross beta activity in air particulate filters at these stations for the years 1968-1996 are presented in Figure H-5. 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 natural radioactive materials 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 canister samples collected in 1996.

Since no plant-related air activity was detected, no rainwater samples from the vicinity of BFN were analyzed during this reporting period.

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-13.

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 is located in this area; however, one additional dairy farm has been identified within 7 miles of the plant. These two dairies are considered indicator stations and routinely provide milk samples. No other milk-producing animals have been identified within 5 miles of the plant. The results of the 1996 land use survey are presented in Appendix G.

Sample Collection and Analysis

Milk samples are purchased every 2 weeks from two dairies within 7 miles of the plant and from at least one of two control farms. These 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 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 radioanalytical 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. Once each quarter, the sample is ashed after the gamma analysis is completed and analyzed for Sr-89,90.

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 1996 samples of cabbage, corn, green beans, potatoes, and tomatoes were collected from local vegetable gardens. In addition, samples of apples were also obtained from the area. 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 a total of six samples. The average Sr-90 concentration reported from indicator locations was 2.3 pCi/liter while the average reported for control stations was 2.8 pCi/liter. These levels are less than concentrations measured in samples collected prior to plant operation and are consistent with concentrations expected in milk as a result of fallout from atmospheric nuclear weapons tests (Reference 1). Figure H-6 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 1350 pCi/liter of K-40 was identified in all milk samples.

Similar results were reported for vegetation samples (Table H-6). All I-131 values were less than the nominal LLD. Strontium-90 was identified in three indicator samples and two control samples. The levels of Sr-90 were consistent with historical data and are representative of the concentrations of Sr-90 in the environment as the result of past nuclear weapons testing. Again, the largest concentrations identified were for the naturally occurring isotopes K-40 and Be-7.

The only fission or activation product identified in soil samples was Cs-137. The maximum concentration was approximately 0.7 pCi/g in a sample from one of the control stations. This concentration is consistent with levels previously reported from fallout. All other radionuclides reported were naturally occurring isotopes (Table H-7). A plot of the annual average Cs-137 concentrations in soil is presented in Figure H-7. 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. 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-13.

AQUATIC MONITORING

Potential exposures from the liquid pathway can occur from drinking water, ingestion of fish and invertebrates, or from direct radiation exposure to radioactive materials deposited in the river sediment. The aquatic monitoring program includes the collection of samples of surface (river/reservoir) water, groundwater, drinking water supplies, fish, Asiatic clams (not consumed by humans), and bottom 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-14 through H-21. Radioactivity levels in water, fish and clams were consistent with background and/or fallout produced levels previously reported. The presence of Co-60 and Cs-137 was identified in sediment samples; however, the projected exposure to the public from this medium is less than 0.1 mrem/year.

Sample Collection and Analysis

Samples of surface water are collected from the Tennessee River using automatic sampling pumps from one downstream station and one upstream station. A timer turns on the pump approximately once every hour. 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 Sr-89,90 and tritium. During the year a program modification was approved to delete the Sr-89,90 analysis. This modification was effective for the fourth quarter sampling period.

Samples are also collected by an automatic sampling pump at the first downstream drinking water intake. 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.

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 Sr-89,90 and tritium. The program modification discussed above for surface water samples also deleted the requirement for Sr-89,90 analysis of public water quarterly composite samples effective with the fourth quarter. The sample collected by the automatic pumping device is taken directly from the river at the intake structure. Since the sample at this point is raw water, not water processed through the water treatment plant, the control sample should also be unprocessed water. Therefore, the upstream surface water sample is also considered as a control sample for drinking water.

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 Sr-89,90 and tritium. Consistent with the changes for surface water and drinking water sampling, the requirement for Sr-89,90 analysis was deleted effective with the fourth quarter groundwater composites.

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. An additional sample of smallmouth buffalo have also been processed as whole fish. After drying and grinding, the samples are analyzed by gamma spectroscopy. The program modification discussed above also eliminated the requirement for sampling of whole smallmouth buffalo. As a result of this program change, the whole fish samples were only collected during the spring sampling period for 1996.

Bottom sediment is collected semiannually from selected Tennessee River Mile (TRM) locations using a dredging apparatus or Scuba divers. The samples are dried and ground and

analyzed by gamma spectroscopy. After this analysis is complete, the samples are ashed and analyzed for Sr-89,90.

Samples of Asiatic clams are collected from one location below the plant and one location above the plant. The clams are usually collected in the dredging or diving process with the sediment. Enough clams are collected to produce approximately 50 grams of wet flesh. The flesh is separated from the shells, and the dried flesh samples are analyzed by gamma spectroscopy. Sufficient quantities of clams to provide a sample are becoming more and more difficult to find.

Results

All radioactivity in surface water samples was below the detection limits except the gross beta activity and naturally occurring isotopes. These results are consistent with previously reported levels. A trend plot of the gross beta activity in surface water samples from 1968 through 1996 is presented in Figure H-8. A summary table of the results for this reporting period is shown in Table H-14.

For drinking water, average gross beta activity was 2.7 pCi/liter at the downstream stations and 2.9 pCi/liter at the control stations. The results are shown in Table H-15 and a trend plot of the gross beta activity from 1968 to the present is presented in Figure H-9.

No concentrations of 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-16.

Cesium-137 was identified in three fish samples (crappie flesh). A concentration of 0.06 pCi/g was measured from one indicator location sample while the highest concentration in control location samples was 0.07 pCi/g. These concentrations are consistent with data from previous monitoring years. The only other radioisotope found in fish were naturally occurring. Concentrations of K-40 ranged from 6.7 pCi/g to 14.3 pCi/g. The results

are summarized in Tables H-17, H-18, and H-19. Plots of the annual average Cs-137 concentrations in fish are presented in Figures H-10, H-11, and H-12. Since the concentrations downstream are essentially equivalent to the upstream levels, the Cs-137 activity is most likely the result of fallout or other upstream effluents rather than activities at BFN.

Radionuclides of the types produced by nuclear power plant operations were identified in sediment samples. The materials identified were Cs-137 and Co-60. The average levels of Cs-137 were 0.59 pCi/g in downstream samples and 0.13 pCi/g upstream. The Cs-137 concentrations at downstream stations have been historically higher than concentrations upstream. This relationship is graphically represented in Figure H-13 which presents a plot of the Cs-137 concentrations in sediment since 1968.

Cobalt-60 concentrations in downstream samples averaged 0.059 pCi/g, while concentrations in upstream samples were below the LLD. The maximum concentration downstream was 0.062 pCi/g. Figure H-14 presents a graph of the Co-60 concentrations measured in sediment since 1968. A realistic assessment of the impact to the general public from these radioisotopes produces a negligible dose equivalent. Results from the analysis of sediment samples are shown in Table H-20.

Only naturally occurring radioisotopes were identified in clam flesh samples. The results are presented in Table H-21.

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 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 1996 are presented in Table 3. These estimates were made using the concentrations of the liquids and gases measured at the effluent monitoring points. Also shown are the ODCM limits for these doses and a comparison between the calculated dose and the corresponding limit. The maximum calculated whole body dose equivalent from measured liquid effluents as presented in Table 3 is 0.074 mrem/year, or 2.5 percent of the limit. The maximum organ dose equivalent from gaseous effluents is 0.072 mrem/year. This represents 0.5 percent of the ODCM 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 seen in aquatic media. The distribution of Cs-137 in sediment and fish is consistent with fallout levels identified in samples both upstream and downstream from the plant during the preoperational phase of the monitoring program. Co-60 was identified in sediment samples downstream from the plant in concentrations which would produce no measurable increase in the dose to the general public. No increases of radioactivity have been seen in water samples.

Dose estimates were made from concentrations of radioactivity found in samples of environmental media. Media evaluated include, but are not limited to, air, milk, food products, drinking water, and fish. Inhalation and ingestion 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 environmental radiological 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 result of fallout or natural background radiation. Any activity which may be present as a result of plant operations does not represent a significant contribution to the exposure of Members of the Public.

REFERENCES

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

2. National Council on Radiation Protection and Measurements, Report No. 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

	Concentrations in Water, pCi/Liter			Concentrations in Air, pCi/Cubic Meter		
	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]
H-3	1,000,000	20,000	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	30,000	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		0.011
Ba-140	8,000	200	25	2,000		0.015
La-140	9,000	200	10	2,000		0.01

Note: 1 pCi = 3.7×10^{-2} Bq.

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

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

2 Source: BFN Offsite Dose Calculation Manual, Table 2.3-2

3 Source: Table E-1 of this report.

Table 1

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

	Concentrations in Water, pCi/Liter			Concentrations in Air, pCi/Cubic Meter		
	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]
H-3	1,000,000	20,000	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	30,000	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		0.011
Ba-140	8,000	200	25	2,000		0.015
La-140	9,000	200	10	2,000		0.01

Note: 1 pCi = 3.7×10^{-2} Bq.

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

2 Source: BFN Offsite Dose Calculation Manual, Table 2.3-3

3 Source: Table E-1 of this report.

Table 2

Results from the
Intercomparison of Environmental Dosimeters

Year	TVA Results mrem	Average, all Respondents mrem	Calculated Exposure (See Note 1) mrem	% Difference TVA: Calculated	% Difference Respondents: Calculated
Field Dosimeters					
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
Low Irradiated Dosimeters					
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
High Irradiated Dosimeters					
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

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
1996
mrem/year

Liquid Effluents

Type	1996 Dose	NRC Limit	Percent of NRC Limit	EPA Limit	Percent of EPA Limit
Total Body	7.4E-2	3	2.5	25	0.3
Any Organ	1.1E-1	10	1.1	25	0.4

Gaseous Effluents

Type	1996 Dose	NRC Limit	Percent of NRC Limit	EPA Limit	Percent of EPA Limit
Noble Gas (Gamma)	8.8E-4	10	0.009	25	0.004
Noble Gas (Beta)	1.2E-3	20	0.006	25	0.005
Any Organ	7.2E-2	15	0.5	25	0.3

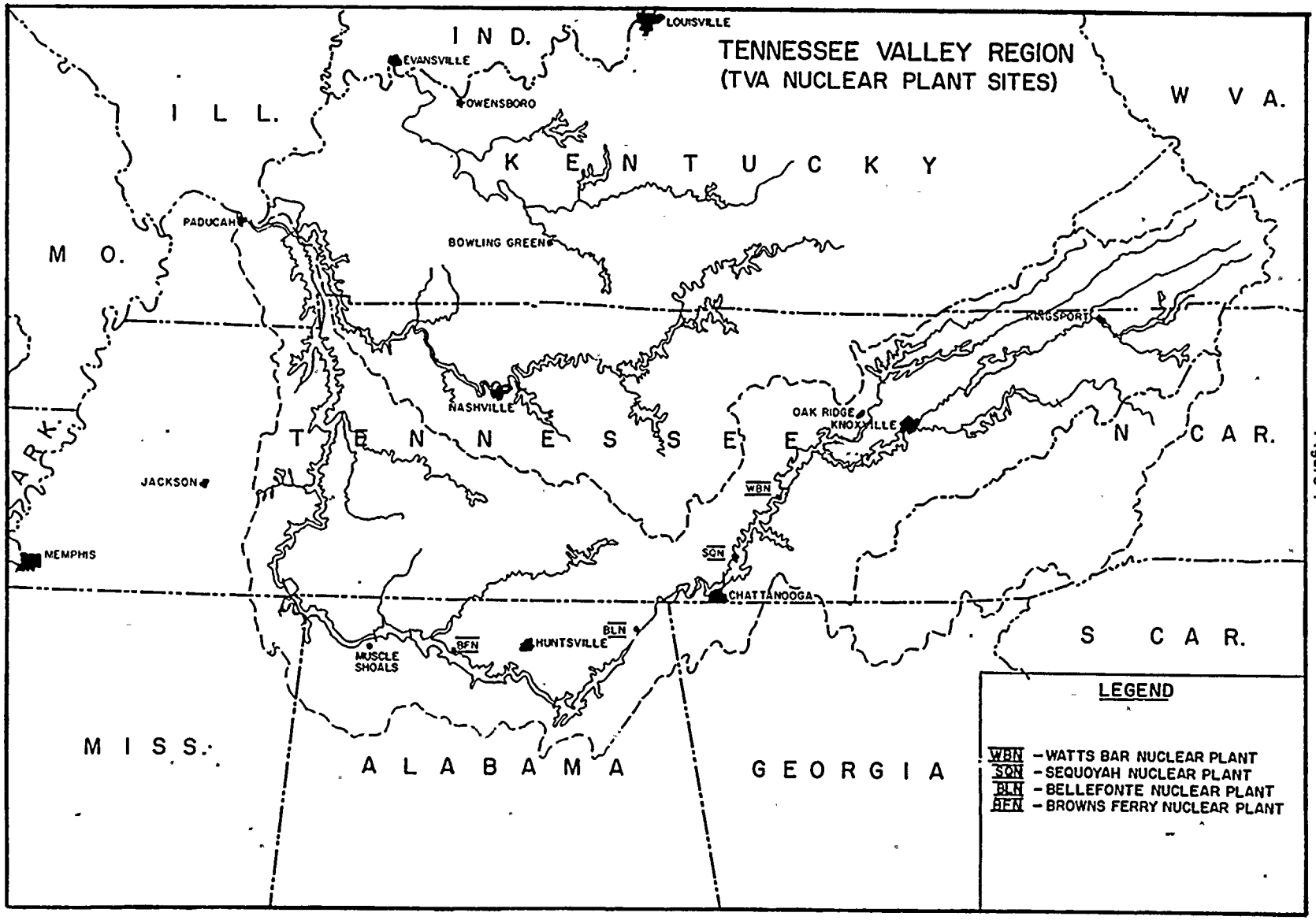
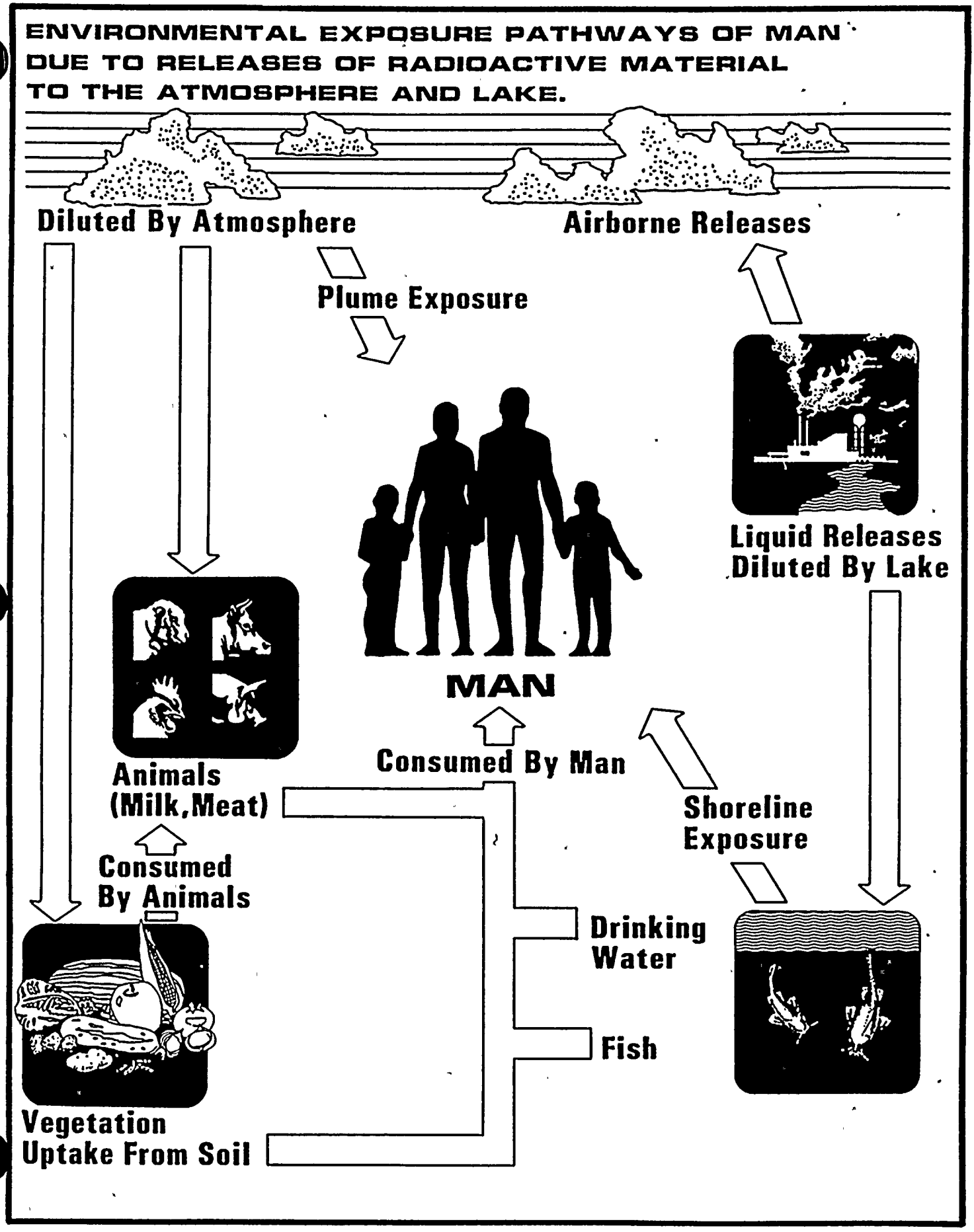

TENNESSEE VALLEY REGION
(TVA NUCLEAR PLANT SITES)
LOUISVILLE
EVANSVILLE
OWENSBORO
PADUCAH
BOWLING GREEN
KINGSPORT
NASHVILLE
OAK RIDGE
KNOXVILLE
JACKSON
MEMPHIS
WBN
SQN
CHATTANOOGA
BLN
BFN
HUNTSVILLE
MUSCLE SHOALS
I N D.
I L L.
K E N T U C K Y
W V A.
M O.
T E N N E S S E E
N C A R.
S C A R.
M I S S.
A L A B A M A
G E O R G I A
LEGEND
WBN - WATTS BAR NUCLEAR PLANT
SQN - SEQUOYAH NUCLEAR PLANT
BLN - BELLEFONTE NUCLEAR PLANT
BFN - BROWNS FERRY NUCLEAR PLANT

Figure 1


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

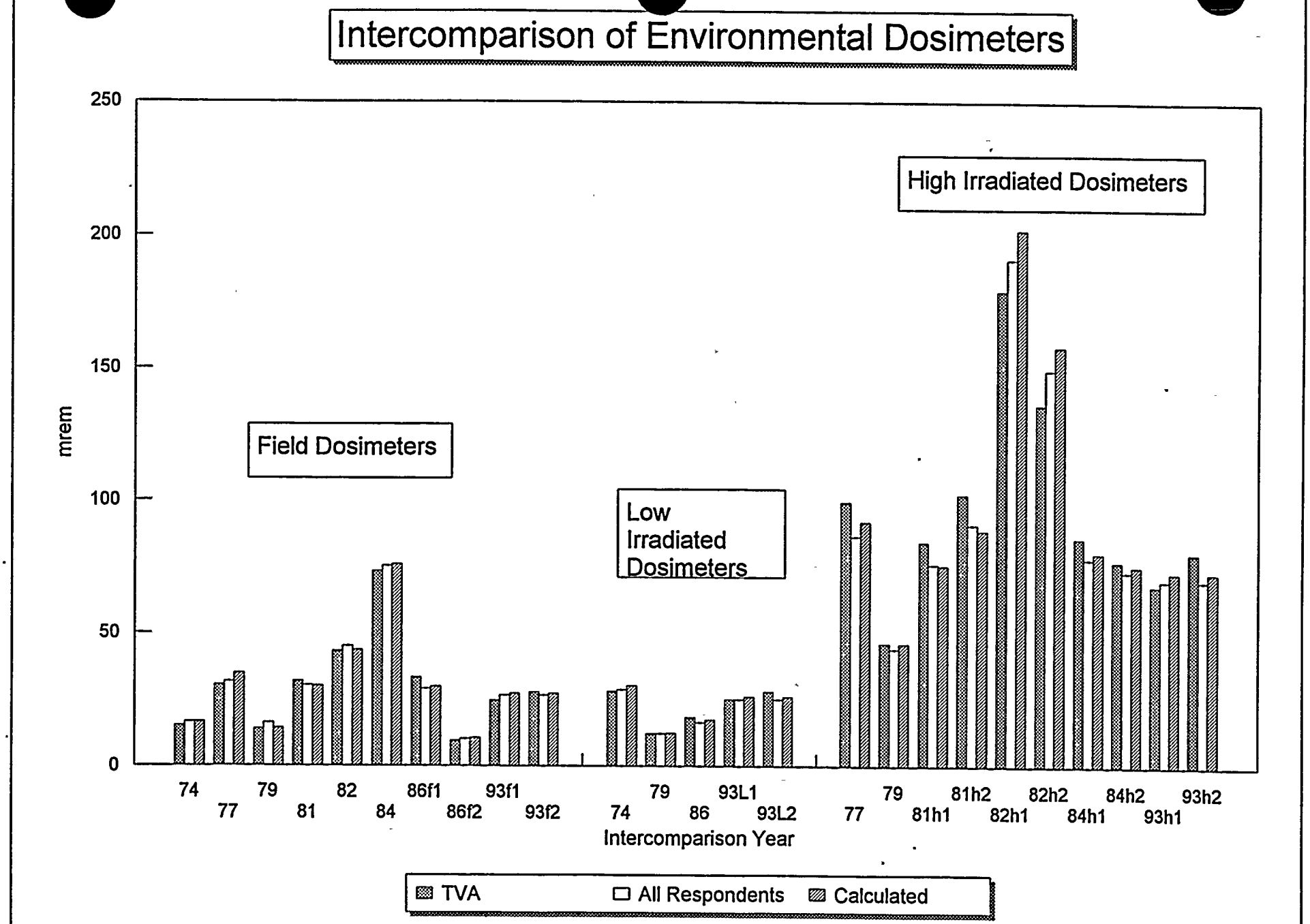

Intercomparison of Environmental Dosimeters
250
200
150
100
50
0
mrem
Field Dosimeters
Low Irradiated Dosimeters
High Irradiated Dosimeters
74
77
79
81
82
84
86f1
86f2
93f1
93f2
74
79
86
93L1
93L2
77
79
81h1
81h2
82h1
82h2
84h1
84h2
93h1
93h2
Intercomparison Year
TVA
All Respondents
Calculated

FIGURE 3

APPENDIX A

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM AND SAMPLING LOCATIONS

Table A-1

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE			
Particulates	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) Two samples from control locations greater than 10 miles from the plant (RM-1 and RM-6) Three samples from locations in communities approximately 10 miles from the plant (PM-1, PM-2, and PM-3)	Continuous sampler operation with sample collection as required by dust loading but at least once per 7 days	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.
Radioiodine	Same locations as air particulates	Continuous sampler operation with charcoal canister collection at least once per 7 days	I-131 by gamma scan every 7 days
Rainwater	Same location as air particulate	Composite sample at least once per 31 days	Analyzed for gamma nuclides only if radioactivity in other media indicates the presence of increased levels of fallout

Table A-1

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
Soil	Samples from same locations as air particulates	Once every year	Gamma scan, Sr-89, Sr-90 once per year
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 8 additional locations of special interest		
WATERBORNE			
Surface Water	One sample upstream (TRM 305.0) 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[c]	Gross beta and gamma scan on 4-week composite. Composite for tritium at least once per 92 days

Table A-1

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
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[c]	Gross beta and gamma scan on 4-week composite. Composite for tritium analysis at least once per 92 days
	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 at least once per 31 days	Gross beta and gamma scan on each sample. Composite for tritium analysis at least once per 92 days
	One sample at a control location (TRM 306)	Grab sample taken at least once per 31 days	Same as downstream locations.
	One additional sample at a control location[d] (TRM 305)	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[c]	Same as downstream location.
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 upgradient 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

Table A-1

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
AQUATIC			
Sediment	One sample upstream from discharge point (TRM 297.0)	At least once per 184 days	Gamma scan, Sr-89 and Sr-90 analyses
	One sample in immediate downstream area of discharge point (TRM 293.7)		
	One additional sample downstream from the plant (TRM 288.8)		
INGESTION			
Milk	At least 2 samples from dairy farms in the immediate vicinity of the plant (Farms B and Bn)	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)		

Table A-1

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
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.		
Clams	One sample downstream from the discharge	At least once per 184 days	Gamma scan on flesh only
	One sample upstream from the plant		
	(No permanent stations established; depends on location of clams)		

Table A-1

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program[a]

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

a. The sampling program outlined in this table is that which was in effect at the end of 1996.
b. Sampling 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 surface water control sample shall be considered a control for the drinking water sample.

Table A-2

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program
Sampling Locations

Map Location Number[a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected[b]
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	M,W
19	Farm R	SW	12.5	C	M,V[f]
22	Well No. 6	NW	0.02	I	W
23	TRM[c] 282.6	-	11.4[d]	I	PW
24	TRM 306.0	-	12.0[d]	C	PW
25	TRM 259.6	-	34.4[d]	I	PW
26	TRM 274.9	-	19.1[d]	I	PW
28	TRM 293.5	-	0.5[d]	I	SW
29	TRM 305.0	-	11.0[d]	C[e]	SW
31	TRM 293.7	-	0.3[d]	I	SD
32	TRM 288.8	-	5.2[d]	I	SD
34	Farm Be	NW	28.8	C	M
36	Farm T	WNW	3.2	I	V
37	TRM 297.0	-	3.0	C	SD
70	TRM 259.8	-	34.2[d]	I	PW
71	TRM 286.5	-	7.5[d]	I	PW
	Wheeer Reservoir (TRM 275-349)		-	I	F, CL
	Guntersville Reservoir (TRM 349-424)		-	C	F

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

b. Sample Codes:

AP = Air particulate filter	CF = Charcoal filter (Iodine)	CL = Clams
F = Fish	M = Milk	PW = Public drinking water
R = Rainwater	S = Soil	SD = Sediment
SW = Surface water	V = Vegetation	W = Well water

c. TRM = Tennessee River Mile.

d. Miles from plant discharge at TRM 294.

e. Also used as a control for public water.

f. Farm Gl ceased dairy operations on April 24, 1995. Replaced by Farm R on May 8, 1995.

Table A-3

BROWNS FERRY NUCLEAR PLANT
Thermoluminescent Dosimeter (TLD) Locations

Map Location Number[a]	Station	Sector	Approximate Distance (miles)	Onsite (On)[b] or Offsite (Off)
1	NW-3	NW	13.8	Off
2	NE-3	NE	10.9	Off
3	SSE-2	SSE	8.2	Off
5	W-3	W	31.3	Off
6	E-3	E	24.2	Off
7	N-1	N	0.97	On
8	NNE-1	NNE	0.88	On
9	ENE-1	ENE	0.92	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

Environmental Radiological Sampling Locations

Within 1 Mile of Plant

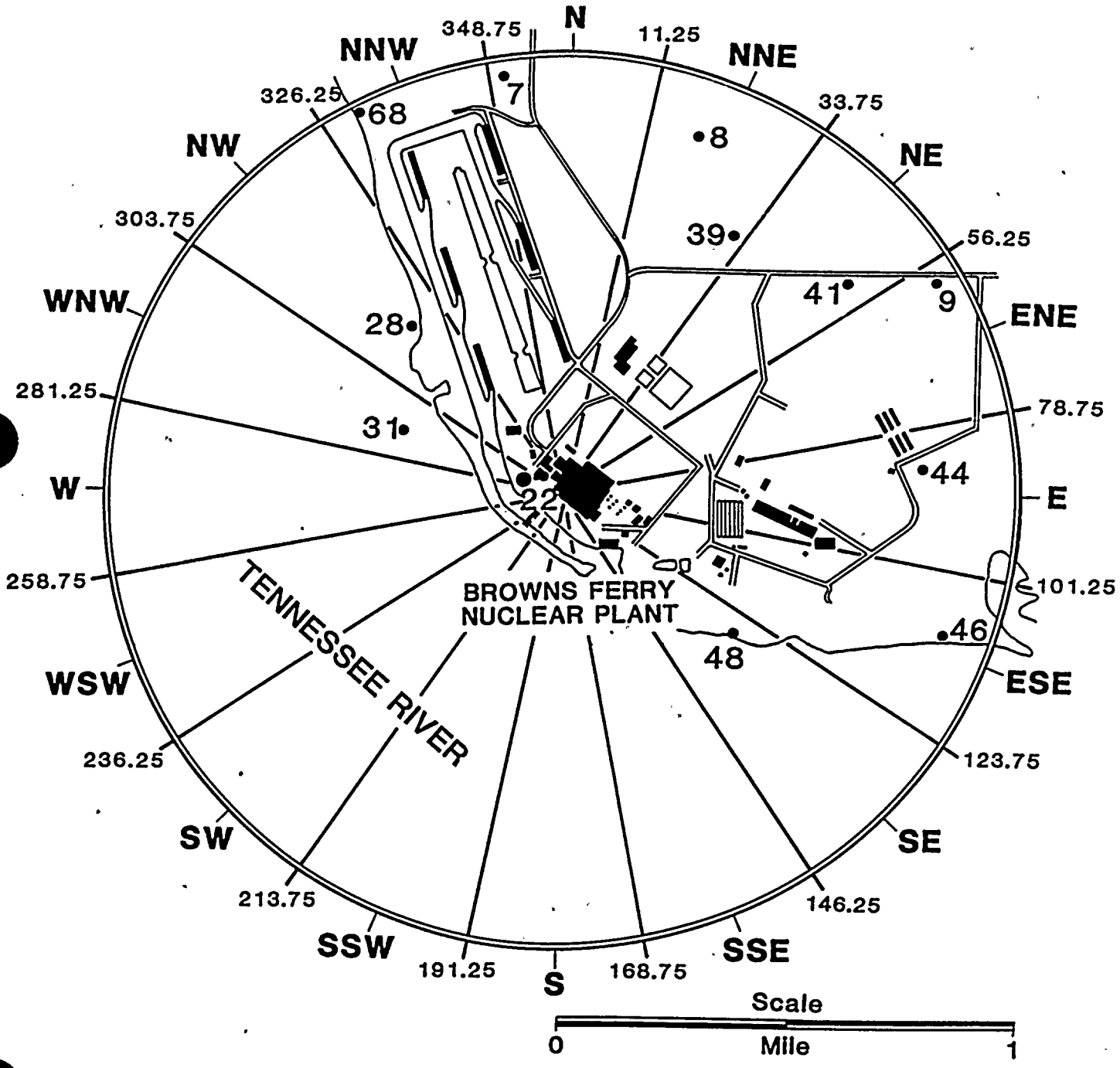


Figure A-2

Environmental Radiological Sampling Locations

From 1 to 5 Miles From the Plant

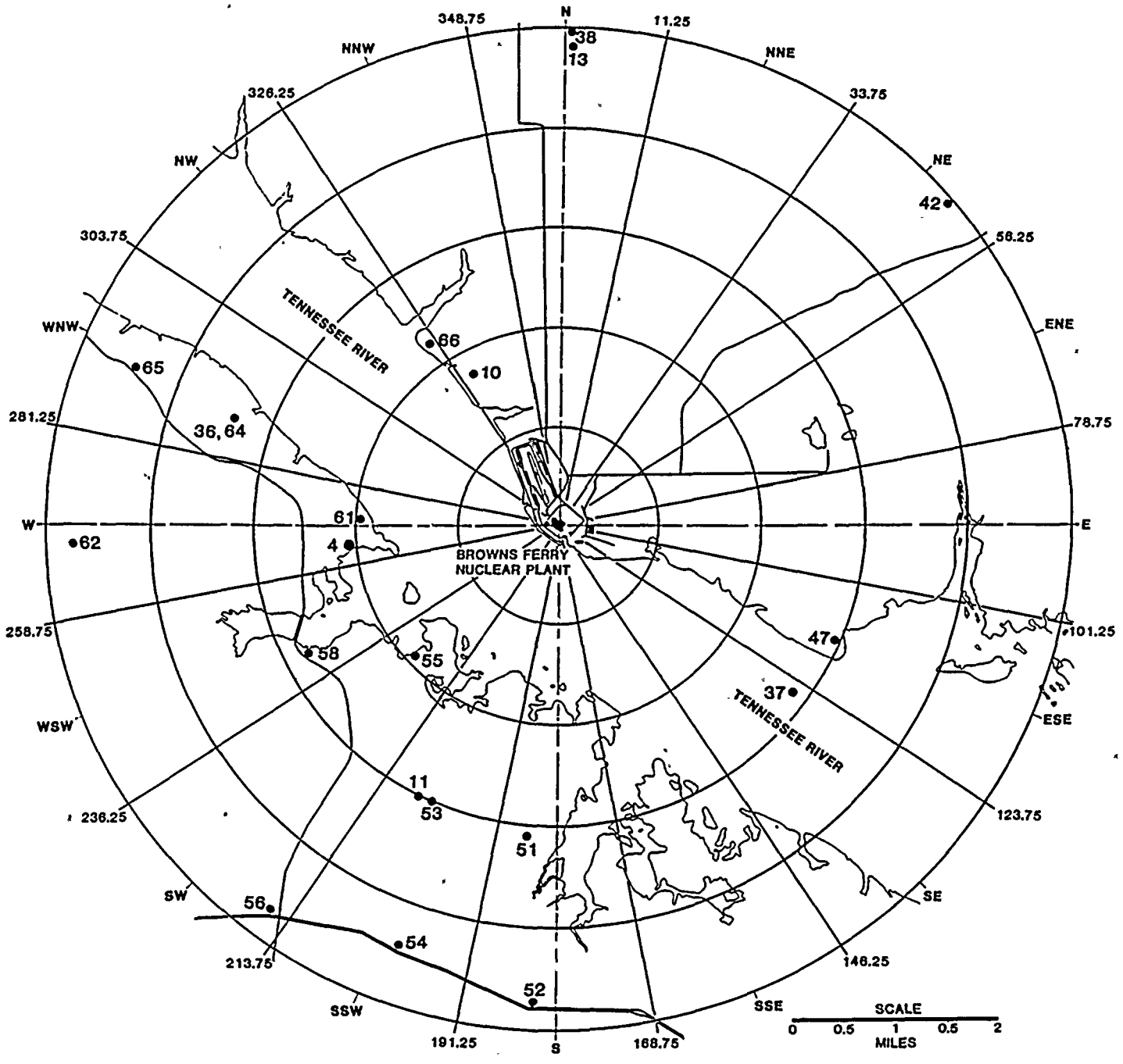
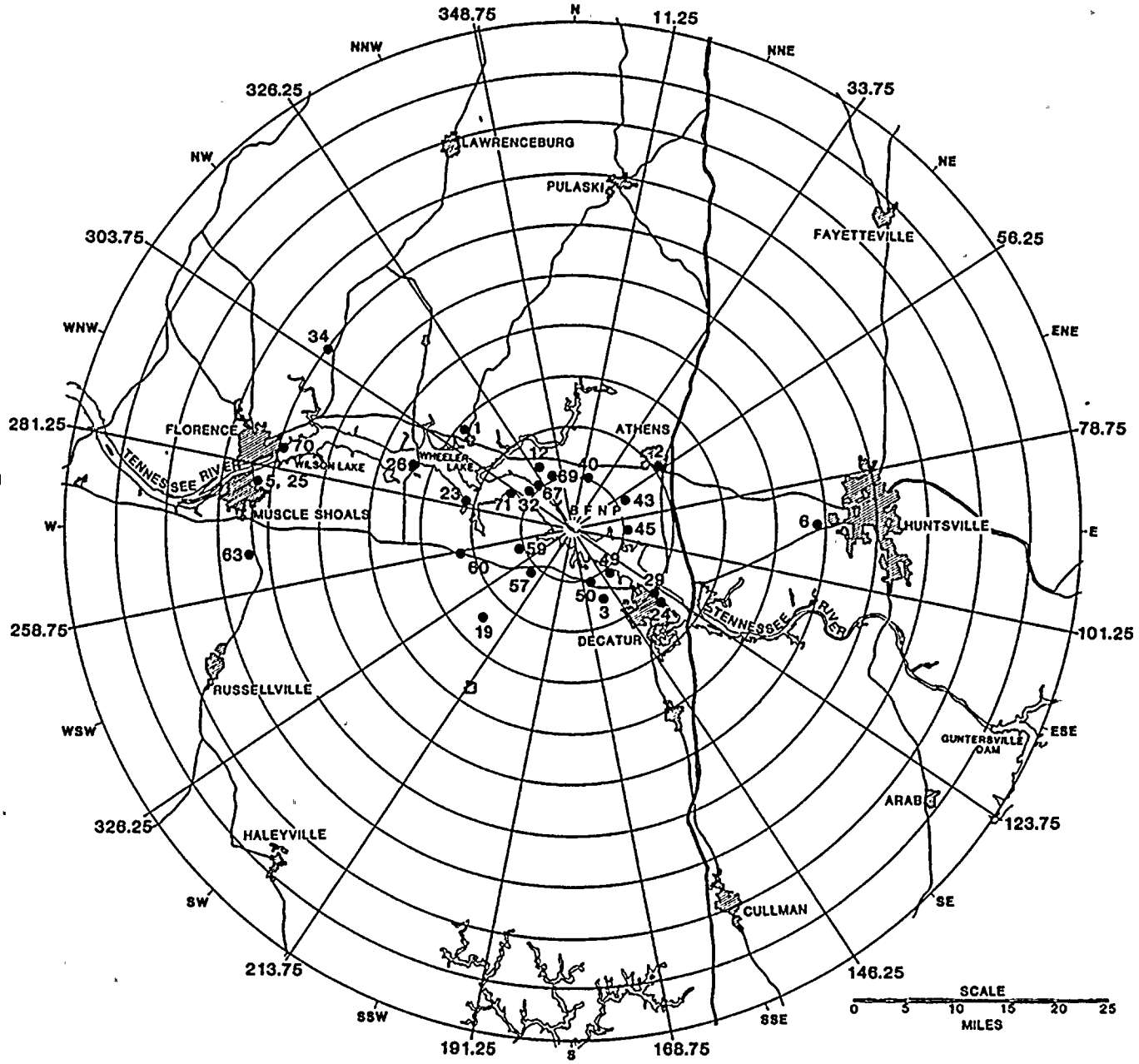


Figure A-3

Environmental Radiological Sampling Locations

Greater Than 5 Miles From The Plant



APPENDIX B

Environmental Radiological Monitoring Program Modifications

For 1996, several modifications were made in the radiological environmental monitoring program. The extra particulate sampling performed at two locations for gross alpha, Sr-89,90 and transuranic radionuclides was eliminated along with the transuranic radionuclide analysis of soil samples. Also the second downstream surface water sampling location was eliminated. These modifications were made to delete program elements that were in addition to the minimum required program and were eliminated to improve the overall program efficiency. The historical monitoring data from these sampling locations reported no radioactivity resulting from plant operations.

In April 1996, a new location was identified as the first downstream user of potable water. The West Morgan - East Lawrence Water Authority added a new water intake at TRM 286.5. This location replaced the water intake for the Champion Paper Company at the TRM 282.6 as the nearest downstream user of potable water. To address this change, the continuous sampler located at the Champion Paper Company water intake was moved to the West Morgan - East Lawrence Water Authority water intake. The Champion Paper Company was changed to a grab public water sampling location.

In September 1996, additional program modifications were implemented to eliminate discretionary monitoring. The historical data from these monitoring efforts do not show any radioactivity resulting from plant operations. The changes included the elimination of the sampling of whole smallmouth buffalo from the fish sampling program and elimination of sediment sampling at one upstream location (TRM 307.5) and one downstream location (TRM 278.0). Sampling of smallmouth buffalo flesh and sediment sampling at one upstream and two downstream locations was not effected by this change. The analyses for Sr-89,90 were eliminated for quarterly composites of surface water, public water and well water and for vegetation samples. Table B-1 provides a detail summary of the 1996 modifications.

Table B-1

Environmental Radiological Monitoring Program Modifications

Date	Station	Location	Remarks
4/15/96	TRM 286.5	7.5(a)	Added collection of continuous public water.
4/15/96	TRM 282.6	11.4(a)	Discontinued collection of continuous public water and added collection of grab public water.
9/23/96	Wheeler and Guntersville Reserviors	NA	Discontinued collection of whole smallmouth buffalo.
9/23/96	TRM 307.5 and TRM 278	see station description	Discontinued sediment sampling.
9/23/96	Farm T	3.2 miles WNW	Discontinued Sr-89,90 analyses for vegetation samples.
9/23/96	Farm R	12.5 miles SW	Discontinued Sr-89,90 analyses for vegetation samples.
9/23/96	TRM 305 and TRM 293.5	see station description	Discontinued Sr-89,90 analyses for quarterly surface water composite samples.
9/23/96	All Public Water Sampling Stations	see station descriptions	Discontinued Sr-89,90 analyses for quarterly composite samples.
9/23/96	Well No. 6 and Farm Bn	see station descriptions	Discontinued Sr-89,90 analyses for quarterly well water composite samples.
1996 (calendar year)	TRM 285.2	8.8(a)	Discontinued collection of surface water.
	LM-1	1.0 miles N	Discontinued gross alpha, Sr-89,90 and transuranic analyses for air particulate filters. Discontinued transuranic analyses on soil samples.
	RM-6	24.2 miles E	Discontinued gross alpha, Sr-89,90 and transuranic analyses for air particulate filters. Discontinued transuranic analyses on soil samples.

(a). Miles from the plant discharge.

Appendix C

Program Deviations

During 1996 a small number of samples were not collected due to equipment malfunctions or unavailability of the sample. Equipment malfunctions prevented the collection of the weekly air filter and charcoal filter sample from one of the 11 monitoring locations on three different occasions during the year. In each case, the equipment problem was corrected and samples were collected as scheduled the following week.

One public water sample was not collected due to equipment failure. The repairs were made and the sampler was fully operational in time for the next sampling period.

On four occasions milk was not available at one of the two control dairy locations.

Table C-1 lists these missed samples. All other samples were collected as scheduled.

Table C-1

Environmental Radiological Monitoring Program Deviations

Date	Station	Location	Remarks
3/11/96	LM-2	0.9 miles NNE	Air filter and charcoal filter samples were not collected due to a malfunction in the sampling pump. The equipment was repaired and operational for the next sampling period.
4/22/96	LM-3	0.9 miles ENE	Air filter and charcoal filter samples were not collected due to a malfunction in the sampling pump. The equipment was repaired and operational for the next sampling period.
6/24/96	LM-1	1.0 miles N	Air filter and charcoal filter samples were not collected due to a malfunction in the sampling pump. The equipment was repaired and operational for the next sampling period.
8/5/96	TRM 286.5	7.5 (a)	The public water sample was not collected due to a problem with the sampling pump. The equipment was repaired and operational for the next sampling period.
1/2/96 2/12/96 3/25/96 9/23/96	Farm R	12.5 miles SW	Milk was not available from the Richardson Dairy. Samples were collected from the other control dairy.

(a). Miles from the plant discharge.

APPENDIX D

Analytical Procedures

Analyses of environmental samples are performed by the radioanalytical laboratory located at the Western Area Radiological Laboratory facility in Muscle Shoals. 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. For solid samples, a specified amount of the sample is packed into a deep stainless steel planchet. 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 100 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 type 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 germanium detector system.

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

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

TABLE E-1

Nominal LLD Values
A. Radiochemical Procedures

	Air Filters (pCi/m^3)	Water (pCi/L)	Milk (pCi/L)	Fish (pCi/g dry)	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	0.0011	5.0	3.5	0.09	31.0	1.6
Strontium-90	0.0004	2.0	2.0	0.03	12.0	0.4

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

	Air Particulates pCi/m3	Charcoal Filter pCi/m3	Water and Milk pCi/L	Vegetation and Grain pCi/g, dry	Wet Vegetation pCi/kg, wet	Soil and Sediment pCi/g, dry	Fish pCi/g, dry	Clam Flesh pCi/g, dry	Foods Tomatoes Potatoes, etc. pCi/kg, wet
Ce-141	.005	.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	30
Tl-208	.002	0.02	10	.03	30	.06	.03	.25	130
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

Analysis	Water pCi/L	Airborne Particulate or Gases pCi/m^3	Fish pCi/kg, wet	Milk pCi/L	Food Products pCi/kg, wet	Sediment pCi/kg, dry
gross beta	4	1×10^{-2}	N.A.	N.A.	N.A.	N.A.
H-3	2000[a]	N.A.	N.A.	N.A.	N.A.	N.A.
Mn-54	15	N.A.	130	N.A.	N.A.	N.A.
Fe-59	30	N.A.	260	N.A.	N.A.	N.A.
Co-58,60	15	N.A.	130	N.A.	N.A.	N.A.
Zn-65	30	N.A.	260	N.A.	N.A.	N.A.
Zr-95	30	N.A.	N.A.	N.A.	N.A.	N.A.
Nb-95	15	N.A.	N.A.	N.A.	N.A.	N.A.
I-131	1[b]	7×10^{-2}	N.A.	1	60	N.A.
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-140	60	N.A.	N.A.	60	N.A.	N.A.
La-140	15	N.A.	N.A.	15	N.A.	N.A.

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

b. 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

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. They provide information about the variability of radioactive content in the various sample media.

If enough sample is available for a particular analysis, the laboratory analyst can split it 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 analysts themselves. The analysts are told 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 analysts have 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 analyst does not know they contain 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 they can be used to test the data review process. If an analysis routinely generates numerous zeroes for a particular isotope, the presence of the isotope is brought to the attention of the laboratory supervisor in the daily review process. Blind spikes test this process since they contain radioactivity at levels high enough to be detected. Furthermore, the activity can be put into such samples at the extreme limit of detection (near the LLD) to 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 analysts labeled as cross-check samples. This means that the quality control staff knows the radioactive content or "right answer" but the analysts do not. They are aware they are being tested. Such samples test the best performance of the laboratory by determining if the analysts 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. Internal cross-checks can also tell if there is a difference in performance between two analysts. Like blind spikes or analytical knowns, these samples can also be spiked with low levels of activity to test detection limits.

A series of cross-checks is produced by the EPA in Las Vegas. These interlaboratory comparison samples or "EPA cross-checks" are considered to be the primary indicator of laboratory performance. They provide an independent check of the entire measurement process that cannot be easily provided by the laboratory itself. That is, unlike internal cross-checks, EPA cross-checks test the calibration of the laboratory detection devices since different radioactive standards produced by individuals outside TVA are used in the cross-checks. The results of the analysis of these samples are reported back to EPA which then issues a report of all the results of all participants. These reports indicate how well the laboratory is doing compared to others across the nation. Like internal cross-checks, the EPA cross-checks provide information to the laboratory about the precision and accuracy of the radioanalytical work it does.

The results of TVA's participation in the EPA Interlaboratory Comparison Program are presented in table F-1 and Figure F-1. For 1996, all EPA cross-check sample concentrations measured by TVA's laboratory were within ± 3-sigma of the EPA reported values.

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

Table F-1

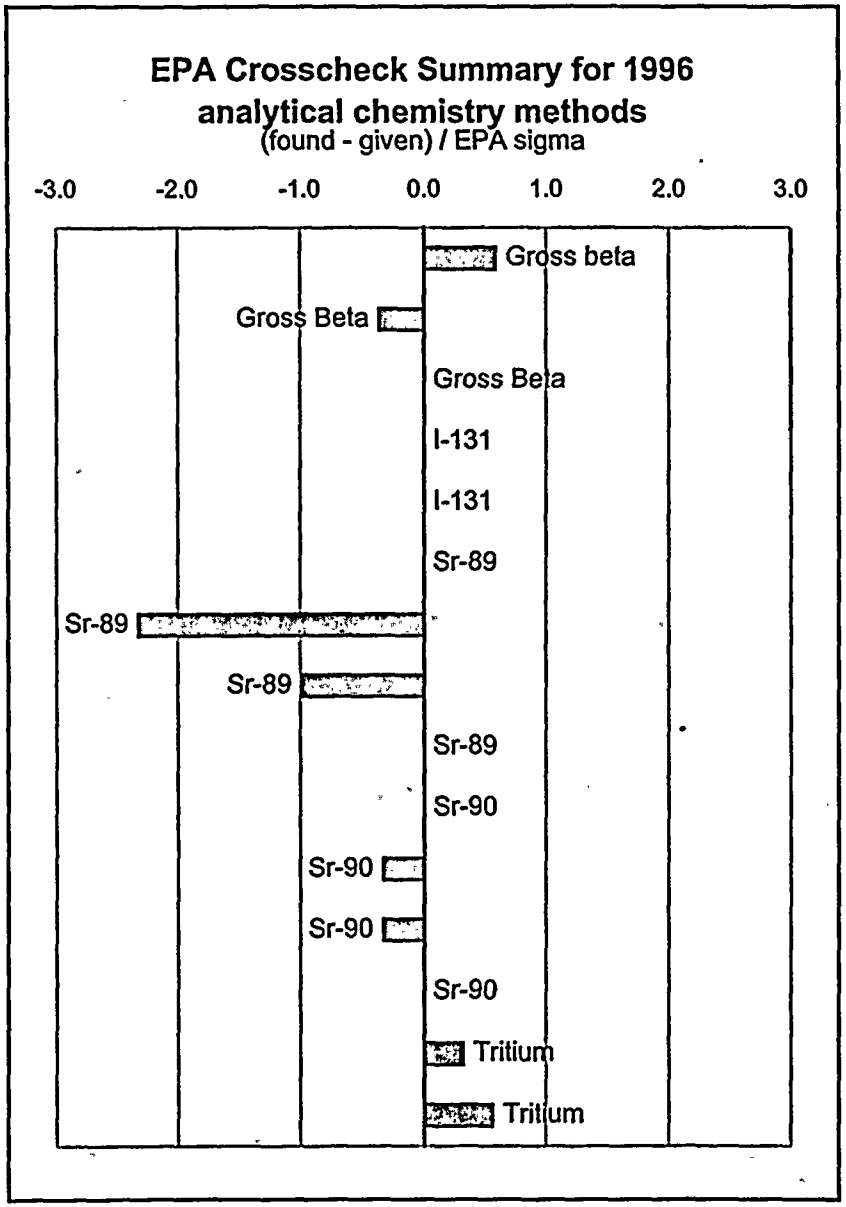
RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

A. Radiochemical Analysis of Water (pCi/L)

	Gross Beta		Strontium-89		Strontium-90		Tritium		Iodine-131	
Date	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.
01/96	7±9	8	73±9	74	5±9	5				
02/96									67±12	65
03/96							22002±3810	21643		
04/96			43±9	44	16±9	15				
07/96	45±9	49	25±9	26	12±9	11				
08/96							10879±1844	10907		
10/96	35±9	42							27±10	25
10/96			10±9	9	25±9	25				

B. Gamma-Spectral Analysis of Water (pCi/L)

	Barium-133		Cobalt-60		Zinc-65		Cesium-134		Cesium-137	
Date	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.	EPA Value (±3 sigma)	TVA Avg.
04/96			31±9	31			46±9	43	50±9	50
06/96	745±130	729	99±9	99	300±52	310	79±9	72	197±17	194
10/96			15±9	15			20±9	20	30±9	29
11/96	64±10	66	44±9	44	35±9	34	11±9	11	19±9	20


EPA Crosscheck Summary for 1996
analytical chemistry methods
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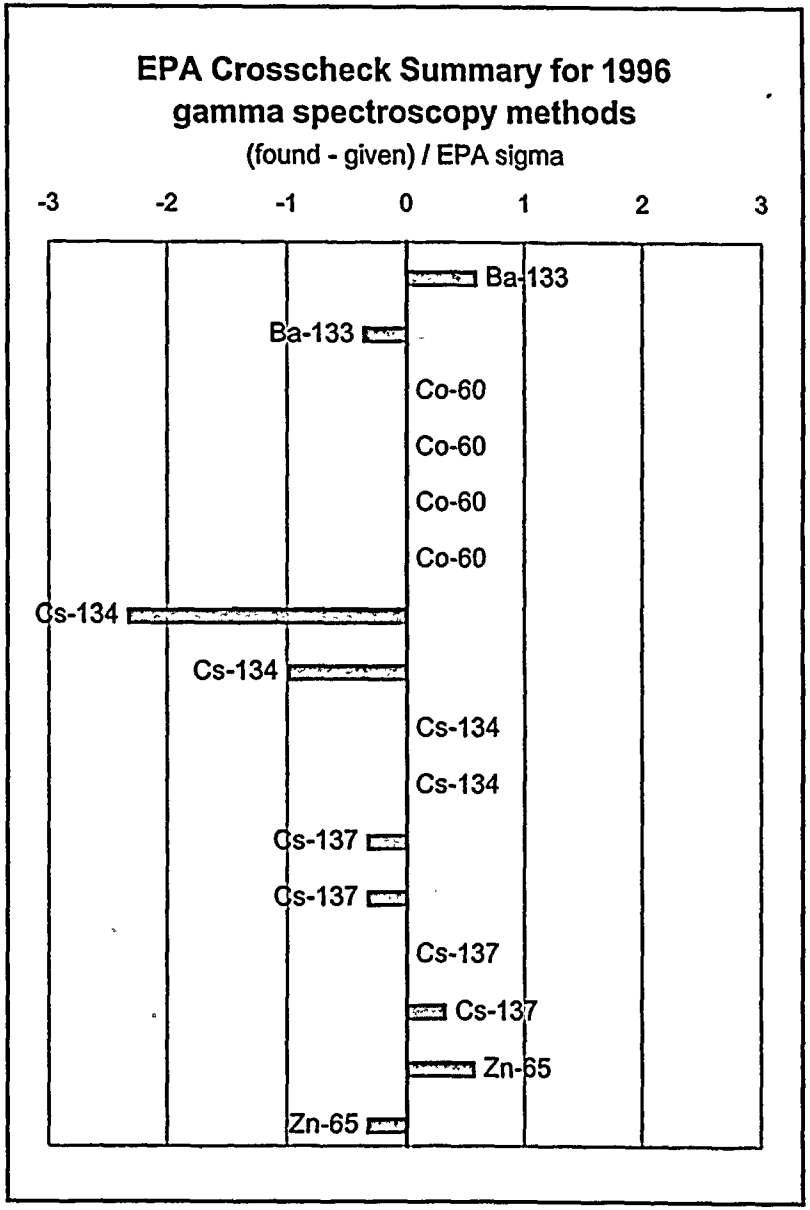
0.0
1.0
2.0
3.0
Gross beta
Gross Beta
Gross Beta
I-131
I-131
Sr-89
Sr-89
Sr-89
Sr-89
Sr-90
Sr-90
Sr-90
Sr-90
Tritium
Tritium


EPA Crosscheck Summary for 1996
gamma spectroscopy methods
(found - given) / EPA sigma
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-1
0
1
2
3
Ba-133
Ba-133
Co-60
Co-60
Co-60
Co-60
Cs-134
Cs-134
Cs-134
Cs-134
Cs-137
Cs-137
Cs-137
Cs-137
Zn-65
Zn-65

Figure F-1

Appendix G

Land Use Survey

A land use survey is conducted annually to identify the location of the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of 16 meteorological sectors within a distance of 5 miles from the plant. The land use survey also identifies 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 is conducted between April 1 and October 1 using appropriate techniques such as door-to-door survey, mail survey, telephone survey, aerial survey, or information from local agricultural authorities or other reliable sources.

In order to identify the locations around BFN which have the greatest relative potential for impact by the plant, radiation doses are projected for individuals living near BFN. These projections use the data obtained in the survey and historical meteorological data. They also assume that the plant is operating and that releases are equivalent to the design basis source terms. The calculated doses 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 are well below applicable dose limits (see Assessment and Evaluation Section and Table 3).

Doses from air submersion are calculated for the nearest resident in each sector, while doses from drinking milk or eating foods produced near the plant are calculated for the areas with milk producing animals and gardens, respectively.

Air submersion doses were calculated for the nearest resident in each sector, the resulting values were similar to those calculated for 1995. Any changes from the 1995 results were small and were due to differences in the distance values used for the nearest resident. These differences occurred from either slight changes in the distance value entered for the location or an actual change in the location. Doses calculated for ingestion of home-grown foods changed in some sectors, reflecting shifts in the location of the nearest garden. The changes were only very slight and did not significantly impact the doses calculated for 1996.

For milk ingestion, projected annual doses were calculated for the same two locations reported in 1995. These were the only two locations where milk producing animals were identified. Samples are collected from both of these farms. The location Farm Bn indicated an increase in the annual dose compared to the 1995 results. This change resulted from the addition of an infant as a consumer of milk at this location.

Tables G-1, G-2, and G-3 show the comparative calculated doses for 1995 and 1996.

Table G - 1

BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Air Submersion Dose
Dose to the Nearest Resident
(Within 5 miles)
mrem / year

	1995 Survey		1996 Survey	
Sector	Approximate Distance (miles)	Annual Dose	Approximate Distance (miles)	Annual Dose
N	1.23	0.33	1.24	0.45
NNE	1.61	0.10	1.58	0.14
NE	2.46	0.10	2.54	0.12
ENE	1.42	0.14	1.52	0.17
E	2.36	0.09	1.00	0.33
ESE	1.32	0.11	1.15	0.22
SE	5.02	0.06	a	
SSE	4.25	0.07	4.60	0.08
S	2.65	0.12	2.78	0.15
SSW	2.46	0.14	2.59	0.18
SW	3.10	0.08	2.76	0.10
WSW	2.46	0.06	2.47	0.08
W	1.51	0.17	1.57	0.18
WNW	2.84	0.09	3.39	0.10
NW	2.08	0.23	2.09	0.30
NNW	1.04	0.57	1.02	0.76

note a -- None identified in this sector

Table G - 2

BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Dose to Child's Bone from
Ingestion of Home-Grown Foods
(Nearest Garden Within 5 miles)
mrem / year

Sector	1995 Survey Approximate Distance (miles)	1995 Survey Annual Dose	1996 Survey Approximate Distance (miles)	1996 Survey Annual Dose	Number of Gardens Within 3 miles (1996)
N	1.23	8.21	1.24	8.11	5
NNE	2.55	1.54	2.57	1.52	1
NE	2.36	1.49	2.67	1.27	2
ENE	1.70	2.44	2.63	1.37	2
E	2.27	2.23	2.41	2.05	2
ESE	2.46	2.19	a		0
SE	a		a		0
SSE	4.35	0.97	4.60	0.88	2
S	2.74	2.33	2.78	2.28	3
SSW	2.55	2.74	2.59	2.68	3
SW	3.87	0.68	a		0
WSW	2.69	0.6	2.67	0.6	2
W	1.61	1.34	1.69	1.27	1
WNW	a		a		0
NW	a		2.09	4.93	1
NNW	1.04	10.6	1.03	10.7	9

note a -- None identified in this sector

Table G - 3

BROWNS FERRY NUCLEAR PLANT

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

Location	Sector	Approximate Distance, miles	Feeding Factor 1995	Feeding Factor 1996	Consumer Age * 1995	Consumer Age * 1996	Annual Dose 1995	Annual Dose 1996	X / Q s / m^3
Farm Bn	N	4.9	0.01	0.38	A	I	0.008	0.224	1.28E-08
Farm B	NNW	6.8	0.33	0.33	A	A	0.016	0.016	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.

* I = Infant, age 0 - 1 years
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 - 1996
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	16.7 ± 1.0	17.1 ± 1.1	17.3 ± 0.9	16.6 ± 1.1	68
1 - 2	15.1 ± 1.5	15.3 ± 1.2	15.4 ± 1.7	15.3 ± 2.9	61
2 - 4	13.7 ± 1.4	14.4 ± 1.7	14.6 ± 1.4	14.4 ± 1.2	57
4 - 6	14.0 ± 1.1	14.3 ± 1.4	14.4 ± 1.3	13.5 ± 1.3	56
> 6	14.0 ± 0.9	14.4 ± 0.9	14.6 ± 0.9	14.1 ± 1.1	57
Average, 0 - 2 miles (onsite)	16.3 ± 1.3	16.8 ± 1.3	16.9 ± 1.4	16.3 ± 1.7	66
Average, > 2 miles (offsite)	13.9 ± 1.1	14.3 ± 1.3	14.5 ± 1.2	13.8 ± 1.7	57

(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

Map Location Number	TLD Station Number	(1) NRC Station No.	Direction, Degrees	Approx Distance, Miles	Environmental Radiation Levels mR/quarter 1st Qtr Jan - Mar 1996	2nd Qtr Apr - Jun 1996	3rd Qtr Jul - Sep 1996	4th Qtr Oct - Dec 1996	Annual Exposure, mR/year
7	N-1		348	1.0	18.3	17.9	18.4	17.5	72.0
38	N-2		1	5.0	13.2	13.2	13.4	12.7	52.5
8	NNE-1		12	0.9	16.2	16.5	17.5	15.4	65.5
39	NNE-2		31	0.7	17.0	17.6	17.5	16.5	68.6
40	NNE-3		19	5.2	13.7	14.9	14.6	13.4	56.6
41	NE-1		51	0.8	17.2	17.9	17.7	16.5	69.3
42	NE-2		49	5.0	15.9	16.4	16.4	15.1	63.8
2	NE-3		56	10.9	14.9	15.4	15.0	14.2	59.5
9	ENE-1	22	61	0.9	16.5	17.7	18.0	16.5	68.7
43	ENE-2		62	6.2	14.5	14.9	15.4	14.3	59.1
44	E-1		85	0.8	17.5	18.5	18.0	16.8	70.8
45	E-2		91	5.2	15.2	15.0	15.2	14.4	59.8
6	E-3		90	24.2	14.4	14.9	15.8	14.4	59.5
46	ESE-1		110	0.9	14.9	14.9	15.5	15.1	60.4
47	ESE-2	21	112	3.0	15.5	16.5	16.4	14.3	62.6
48	SE-1		130	0.5	15.8	16.4	16.5	16.0	64.6
49	SE-2	2	135	5.4	11.6	10.7	11.0	10.0	43.3
50	SSE-1		163	5.1	14.8	15.6	14.6	14.3	59.3
3	SSE-2	37	165	7.5	15.1	14.9	15.6	14.5	60.0
51	S-1		185	3.1	14.6	15.2	14.9	14.0	58.8
52	S-2		182	4.8	12.6	13.2	13.3	12.4	51.3

Table H - 2

DIRECT RADIATION LEVELS

Individual Stations

Map Location Number	TLD Station Number	(1) NRC Station No.	Direction, Degrees	Approx Distance, Miles	Environmental Radiation Levels mR/quarter 1st Qtr Jan - Mar 1996	2nd Qtr Apr - Jun 1996	3rd Qtr Jul - Sep 1996	4th Qtr Oct - Dec 1996	Annual Exposure, mR/year
53	SSW-1	15	203	3.0	12.1	12.3	12.8	11.6	48.7
54	SSW-2		199	4.4	13.4	14.4	14.4	13.6	55.9
55	SW-1	13	228	1.9	14.1	(2)	14.0	13.2	55.1
56	SW-2		219	4.7	14.2	14.4	14.3	13.6	56.5
57	SW-3		224	6.0	12.6	14.5	14.3	16.1	57.5
58	WSW-1	12	244	2.7	12.6	12.6	13.5	12.4	51.1
59	WSW-2		251	5.1	14.2	14.8	15.0	13.7	57.6
60	WSW-3		257	10.5	12.9	12.6	13.4	12.8	51.7
61	W-1		275	1.9	14.3	14.5	15.0	14.0	57.7
62	W-2	7	268	4.7	13.5	13.5	13.5	12.8	53.3
5	W-3		275	31.3	12.9	13.3	13.3	12.8	52.3
63	W-4		265	32.1	14.6	14.9	15.0	14.3	58.8
64	WNW-1		291	3.3	13.6	13.9	14.3	13.4	55.2
65	WNW-2	10	293	4.4	13.9	13.9	14.4	13.2	55.4
66	NW-1		326	2.2	(2)	15.7	15.8	20.5	69.4
67	NW-2		321	5.3	15.1	15.1	15.5	14.6	60.4
1	NW-3		310	13.8	14.0	14.0	14.2	13.0	55.2
68	NNW-1		331	1.0	16.4	16.9	16.9	18.9	69.1
10	NNW-2		331	1.7	16.8	16.2	17.3	18.7	68.9
69	NNW-3		339	5.2	14.9	14.4	15.4	14.4	59.2

(1) Locations with TVA and NRC stations co-located

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

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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA						
569						
	2.00E-03	2.03E-02(465/ 465)	LM3 BF NORTHEAST	2.07E-02(51/ 51)	2.08E-02(104/ 104)	
		9.07E-03- 3.47E-02	1.0 MILE ENE	1.28E-02- 3.39E-02	1.09E-02- 3.27E-02	
GAMMA SCAN (GELI)						
143						
BE-7	2.00E-02	1.06E-01(117/ 117)	LM3 BF NORTHEAST	1.13E-01(13/ 13)	1.09E-01(26/ 26)	
		5.53E-02- 1.69E-01	1.0 MILE ENE	7.27E-02- 1.69E-01	6.78E-02- 1.41E-01	
BI-214	5.00E-03	1.22E-02(72/ 117)	LM4 BF TRAILER P	1.69E-02(7/ 13)	1.17E-02(14/ 26)	
		5.00E-03- 3.12E-02	1.7 MILES NNW	7.20E-03- 2.85E-02	5.00E-03- 2.94E-02	
PB-214	5.00E-03	1.31E-02(69/ 117)	LM4 BF TRAILER P	1.78E-02(7/ 13)	1.39E-02(13/ 26)	
		5.30E-03- 3.39E-02	1.7 MILES NNW	6.20E-03- 3.12E-02	6.20E-03- 3.19E-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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI) 569						
BI-214	5.00E-02	6.23E-02(16/ 465)	LM3 BF NORTHEAST	7.50E-02(1/ 51)	6.21E-02(5/ 104)	
		5.14E-02- 7.77E-02	1.0 MILE ENE	7.50E-02- 7.50E-02	5.35E-02- 7.79E-02	
K-40	3.00E-01	3.48E-01(43/ 465)	LM1 BF NORTHWEST	3.89E-01(2/ 51)	3.37E-01(12/ 104)	
		3.01E-01- 4.58E-01	1.0 MILE N	3.23E-01- 4.56E-01	3.01E-01- 3.98E-01	
PB-214	7.00E-02	9.28E-02(5/ 465)	LM4 BF TRAILER P	1.17E-01(1/ 52)	8.03E-02(2/ 104)	
		8.05E-02- 1.17E-01	1.7 MILES NNW	1.17E-01- 1.17E-01	7.28E-02- 8.79E-02	
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/m^3.

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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131						
100	4.00E-01	52 VALUES < LLD			48 VALUES < LLD	
GAMMA SCAN (GELI)						
100						
BI-214	2.00E+01	4.54E+01(1/ 52)	BROOKS FARM 6.8 MILE	4.54E+01(1/ 26)	2.20E+01(3/ 48)	
		4.54E+01- 4.54E+01	S NNW	4.54E+01- 4.54E+01	2.08E+01- 2.37E+01	
K-40	1.00E+02	1.32E+03(52/ 52)	BROOKS FARM 6.8 MILE	1.34E+03(26/ 26)	1.35E+03(48/ 48)	
		1.00E+03- 1.55E+03	S NNW	1.06E+03- 1.44E+03	9.97E+02- 1.47E+03	
PB-214	2.00E+01	3.91E+01(1/ 52)	BROOKS FARM 6.8 MILE	3.91E+01(1/ 26)	48 VALUES < LLD	
		3.91E+01- 3.91E+01	S NNW	3.91E+01- 3.91E+01		
SR 89						
50	3.50E+00	26 VALUES < LLD			24 VALUES < LLD	
SR 90						
50	2.00E+00	2.28E+00(4/ 26)	BROOKS FARM 6.8 MILE	2.30E+00(1/ 13)	2.76E+00(2/ 24)	
		2.03E+00- 2.48E+00	S NNW	2.30E+00- 2.30E+00	2.00E+00- 3.52E+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 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: 1996

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	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 SCAN (GELI)						
26						
BE-7	2.00E+02	1.27E+03(12/ 13) 2.31E+02- 4.49E+03	TERRY FARM 3.2 MILES WNW	1.27E+03(12/ 13) 2.31E+02- 4.49E+03	1.26E+03(12/ 13) 3.34E+02- 2.68E+03	
BI-214	5.50E+01	9.31E+01(3/ 13) 7.14E+01- 1.05E+02	TERRY FARM 3.2 MILES WNW	9.31E+01(3/ 13) 7.14E+01- 1.05E+02	6.13E+01(2/ 13) 5.93E+01- 6.33E+01	
K-40	4.00E+02	4.60E+03(13/ 13) 2.59E+03- 6.71E+03	TERRY FARM 3.2 MILES WNW	4.60E+03(13/ 13) 2.59E+03- 6.71E+03	5.28E+03(13/ 13) 2.91E+03- 6.78E+03	
PB-214	8.00E+01	1.13E+02(1/ 13) 1.13E+02- 1.13E+02	TERRY FARM 3.2 MILES WNW	1.13E+02(1/ 13) 1.13E+02- 1.13E+02	13 VALUES < LLD	
SR 89						
6	3.10E+01	3 VALUES < LLD			3 VALUES < LLD	
SR 90						
6	1.20E+01	4.58E+01(3/ 3) 1.80E+01- 8.60E+01	TERRY FARM 3.2 MILES WNW	4.58E+01(3/ 3) 1.80E+01- 8.60E+01	1.70E+01(2/ 3) 1.66E+01- 1.73E+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 SOIL
PCI/G - 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
11						
AC-228	2.50E-01	1.16E+00(9/ 9)	LM1 BF NORTHWEST	1.39E+00(1/ 1)	9.56E-01(2/ 2)	
		6.83E-01- 1.39E+00	1.0 MILE N	1.39E+00- 1.39E+00	7.54E-01- 1.16E+00	
BI-212	4.50E-01	1.14E+00(9/ 9)	LM1 BF NORTHWEST	1.34E+00(1/ 1)	9.21E-01(2/ 2)	
		7.08E-01- 1.34E+00	1.0 MILE N	1.34E+00- 1.34E+00	6.57E-01- 1.19E+00	
BI-214	1.50E-01	9.10E-01(9/ 9)	LM2 BF NORTH	1.22E+00(1/ 1)	6.94E-01(2/ 2)	
		6.60E-01- 1.22E+00	0.9 MILE NNE	1.22E+00- 1.22E+00	6.66E-01- 7.23E-01	
CS-137	3.00E-02	3.03E-01(9/ 9)	LM-6BF BAKER BOTTOM	6.21E-01(1/ 1)	3.96E-01(2/ 2)	
		7.32E-02- 6.21E-01	3.0 MILES SSW	6.21E-01- 6.21E-01	7.48E-02- 7.17E-01	
K-40	7.50E-01	5.09E+00(9/ 9)	LM1 BF NORTHWEST	7.34E+00(1/ 1)	3.61E+00(2/ 2)	
		2.77E+00- 7.34E+00	1.0 MILE N	7.34E+00- 7.34E+00	3.31E+00- 3.92E+00	
PB-212	1.00E-01	1.12E+00(9/ 9)	LM4 BF TRAILER P	1.29E+00(1/ 1)	8.94E-01(2/ 2)	
		6.38E-01- 1.29E+00	1.7 MILES NNW	1.29E+00- 1.29E+00	6.99E-01- 1.09E+00	
PB-214	1.50E-01	1.07E+00(9/ 9)	LM2 BF NORTH	1.29E+00(1/ 1)	8.40E-01(2/ 2)	
		7.99E-01- 1.29E+00	0.9 MILE NNE	1.29E+00- 1.29E+00	8.16E-01- 8.63E-01	
RA-224	7.50E-01	1.31E+00(5/ 9)	LM1 BF NORTHWEST	1.64E+00(1/ 1)	2 VALUES < LLD	
		8.97E-01- 1.64E+00	1.0 MILE N	1.64E+00- 1.64E+00		
RA-226	1.50E-01	9.10E-01(9/ 9)	LM2 BF NORTH	1.22E+00(1/ 1)	6.94E-01(2/ 2)	
		6.60E-01- 1.22E+00	0.9 MILE NNE	1.22E+00- 1.22E+00	6.66E-01- 7.23E-01	
TL-208	6.00E-02	3.46E-01(9/ 9)	LM2 BF NORTH	4.13E-01(1/ 1)	2.86E-01(2/ 2)	
		2.12E-01- 4.13E-01	0.9 MILE NNE	4.13E-01- 4.13E-01	2.34E-01- 3.39E-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).

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

RADIOACTIVITY IN APPLES
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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
2						
K-40	2.50E+02	9.43E+02(1/ 1)	7 MILES NNW	9.43E+02(1/ 1)	8.44E+02(1/ 1)	
		9.43E+02- 9.43E+02		9.43E+02- 9.43E+02	8.44E+02- 8.44E+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 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
K-40	2.50E+02	1.84E+03(1/ 1) 1.84E+03- 1.84E+03	7 MILES NNW	1.84E+03(1/ 1) 1.84E+03- 1.84E+03	1.28E+03(1/ 1) 1.28E+03- 1.28E+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 PARENTHESES (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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
K-40 2	2.50E+02	2.03E+03(1/ 1) 2.03E+03- 2.03E+03	7 MILES NNW	2.03E+03(1/ 1) 2.03E+03- 2.03E+03	1.90E+03(1/ 1) 1.90E+03- 1.90E+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 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
BI-214	4.00E+01	8.04E+01(1/ 1) 8.04E+01- 8.04E+01	7 MILES NNW	8.04E+01(1/ 1) 8.04E+01- 8.04E+01	1 VALUES < LLD	
K-40	2.50E+02	2.48E+03(1/ 1) 2.48E+03- 2.48E+03	7 MILES NNW	2.48E+03(1/ 1) 2.48E+03- 2.48E+03	1.02E+03(1/ 1) 1.02E+03- 1.02E+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 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI) 2						
K-40	2.50E+02	3.39E+03(1/ 1) 3.39E+03- 3.39E+03	7 MILES NNW	3.39E+03(1/ 1) 3.39E+03- 3.39E+03	3.43E+03(1/ 1) 3.43E+03- 3.43E+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 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
K-40	2.50E+02	2.35E+03(1/ 1) 2.35E+03- 2.35E+03	7 MILES NNW	2.35E+03(1/ 1) 2.35E+03- 2.35E+03	2.30E+03(1/ 1) 2.30E+03- 2.30E+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 PARENTHESES (F).

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ENVIRONMENTAL RADIOLOGICAL MONITORING AND INSTRUMENTATION
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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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA						
26	1.90E+00	2.91E+00(13/ 13) 2.32E+00- 4.60E+00	TRM 293.5	2.91E+00(13/ 13) 2.32E+00- 4.60E+00	2.91E+00(13/ 13) 2.02E+00- 4.29E+00	
GAMMA SCAN (GELI)						
26						
BI-214	2.00E+01	2.25E+01(3/ 13) 2.10E+01- 2.48E+01	TRM 293.5	2.25E+01(3/ 13) 2.10E+01- 2.48E+01	3.15E+01(1/ 13) 3.15E+01- 3.15E+01	
PB-214	2.00E+01	2.08E+01(1/ 13) 2.08E+01- 2.08E+01	TRM 293.5	2.08E+01(1/ 13) 2.08E+01- 2.08E+01	13 VALUES < LLD	
SR 89						
6	5.00E+00	3 VALUES < LLD			3 VALUES < LLD	
SR 90						
6	2.00E+00	3 VALUES < LLD			3 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA						
87	1.90E+00	2.72E+00(53/ 61)	W MOR-E LAWR WAT ATH	3.01E+00(9/ 9)	2.84E+00(22/ 26)	
		1.91E+00- 4.69E+00	TRM 286.5	2.01E+00- 3.80E+00	1.98E+00- 4.29E+00	
GAMMA SCAN (GELI)						
87						
BI-214	2.00E+01	4.01E+01(6/ 61)	MUSCLE SHOALS AREA	1.04E+02(1/ 13)	3.06E+01(4/ 26)	
		2.38E+01- 1.04E+02	TRM 259.5	1.04E+02- 1.04E+02	2.16E+01- 3.48E+01	
PB-214	2.00E+01	4.66E+01(2/ 61)	MUSCLE SHOALS AREA	6.37E+01(1/ 13)	3.07E+01(1/ 26)	
		2.95E+01- 6.37E+01	TRM 259.5	6.37E+01- 6.37E+01	3.07E+01- 3.07E+01	
SR 89						
20	5.00E+00	14 VALUES < LLD			6 VALUES < LLD	
SR 90						
20	2.00E+00	14 VALUES < LLD			6 VALUES < LLD	
TRITIUM						
27	3.00E+02	19 VALUES < LLD			8 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
26						
BI-214	2.00E+01	5.29E+01(5/ 13)	BFN WELL #6	5.29E+01(5/ 13)	3.44E+02(12/ 13)	
		2.18E+01- 8.79E+01	0.02 MILES W	2.18E+01- 8.79E+01	2.15E+02- 7.24E+02	
PB-214	2.00E+01	5.59E+01(4/ 13)	BFN WELL #6	5.59E+01(4/ 13)	3.46E+02(12/ 13)	
		3.90E+01- 8.08E+01	0.02 MILES W	3.90E+01- 8.08E+01	1.97E+02- 7.41E+02	
SR 89						
6						
	5.00E+00	3 VALUES < LLD			3 VALUES < LLD	
SR 90						
6						
	2.00E+00	3 VALUES < LLD			3 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).

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RADIOACTIVITY IN CRAPPIE FLESH
PCI/G - 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI) 4						
BI-214	1.00E-01	1.03E-01(1/ 2)	WHEELER RES	1.03E-01(1/ 2)	2 VALUES < LLD	
		1.03E-01- 1.03E-01	TRM 275-349	1.03E-01- 1.03E-01		
CS-137	3.00E-02	5.56E-02(1/ 2)	WHEELER RES	5.56E-02(1/ 2)	5.31E-02(2/ 2)	
		5.56E-02- 5.56E-02	TRM 275-349	5.56E-02- 5.56E-02	3.93E-02- 6.70E-02	
K-40	4.00E-01	1.36E+01(2/ 2)	WHEELER RES	1.36E+01(2/ 2)	1.38E+01(2/ 2)	
		1.30E+01- 1.43E+01	TRM 275-349	1.30E+01- 1.43E+01	1.34E+01- 1.43E+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).

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RADIOACTIVITY IN SMALLMOUTH BUFFALO FLESH
PCI/G - 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: 1996

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 SCAN (GELI) 4						
BI-214	1.00E-01	2 VALUES < LLD	WHEELER RES TRM 275-349	2 VALUES < LLD	1.94E-01(2/ 2) 1.63E-01- 2.26E-01	
K-40	4.00E-01	9.81E+00(2/ 2) 8.17E+00- 1.15E+01	WHEELER RES TRM 275-349	9.81E+00(2/ 2) 8.17E+00- 1.15E+01	1.01E+01(2/ 2) 9.68E+00- 1.05E+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 SMALLMOUTH BUFFALO WHOLE
PCI/G - 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
K-40	4.00E-01	6.74E+00(1/ 1) 6.74E+00- 6.74E+00	WHEELER RES TRM 275-349	6.74E+00(1/ 1) 6.74E+00- 6.74E+00	8.99E+00(1/ 1) 8.99E+00- 8.99E+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).

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RADIOACTIVITY IN SEDIMENT
PCI/G - 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI)						
8						
AC-228	2.50E-01	1.31E+00(5/ 5)	TRM 293.7	1.43E+00(2/ 2)	9.48E-01(3/ 3)	
		1.07E+00- 1.51E+00	BFN DISCHARGE	1.34E+00- 1.51E+00	8.30E-01- 1.06E+00	
BE-7	2.50E-01	4.53E-01(1/ 5)	TRM 293.7	4.53E-01(1/ 2)	4.72E-01(2/ 3)	
		4.53E-01- 4.53E-01	BFN DISCHARGE	4.53E-01- 4.53E-01	2.50E-01- 6.94E-01	
BI-212	4.50E-01	1.39E+00(5/ 5)	TRM 293.7	1.54E+00(2/ 2)	1.04E+00(3/ 3)	
		1.17E+00- 1.58E+00	BFN DISCHARGE	1.51E+00- 1.58E+00	8.64E-01- 1.27E+00	
BI-214	1.50E-01	9.80E-01(5/ 5)	TRM 293.7	1.04E+00(2/ 2)	7.41E-01(3/ 3)	
		7.80E-01- 1.07E+00	BFN DISCHARGE	1.01E+00- 1.07E+00	6.65E-01- 8.83E-01	
CO-60	3.00E-02	5.88E-02(4/ 5)	TRM 293.7	6.07E-02(2/ 2)	3 VALUES < LLD	
		5.46E-02- 6.24E-02	BFN DISCHARGE	5.90E-02- 6.24E-02		
CS-137	3.00E-02	5.93E-01(5/ 5)	TRM 288.78	8.28E-01(2/ 2)	1.29E-01(3/ 3)	
		3.55E-01- 1.03E+00		6.26E-01- 1.03E+00	7.97E-02- 1.80E-01	
K-40	7.50E-01	1.12E+01(5/ 5)	TRM 288.78	1.25E+01(2/ 2)	1.18E+01(3/ 3)	
		7.40E+00- 1.25E+01		1.25E+01- 1.25E+01	1.11E+01- 1.31E+01	
PB-212	1.00E-01	1.28E+00(5/ 5)	TRM 293.7	1.38E+00(2/ 2)	9.79E-01(3/ 3)	
		1.03E+00- 1.47E+00	BFN DISCHARGE	1.29E+00- 1.47E+00	8.48E-01- 1.14E+00	
PB-214	1.50E-01	1.11E+00(5/ 5)	TRM 293.7	1.17E+00(2/ 2)	8.38E-01(3/ 3)	
		8.92E-01- 1.19E+00	BFN DISCHARGE	1.17E+00- 1.18E+00	7.58E-01- 9.42E-01	
RA-224	7.50E-01	1.38E+00(5/ 5)	TRM 288.78	1.49E+00(2/ 2)	9.30E-01(2/ 3)	
		9.84E-01- 1.55E+00		1.46E+00- 1.52E+00	7.60E-01- 1.10E+00	
RA-226	1.50E-01	9.80E-01(5/ 5)	TRM 293.7	1.04E+00(2/ 2)	7.41E-01(3/ 3)	
		7.80E-01- 1.07E+00	BFN DISCHARGE	1.01E+00- 1.07E+00	6.65E-01- 8.83E-01	
TL-208	6.00E-02	3.99E-01(5/ 5)	TRM 293.7	4.41E-01(2/ 2)	3.13E-01(3/ 3)	
		3.32E-01- 4.62E-01	BFN DISCHARGE	4.20E-01- 4.62E-01	2.84E-01- 3.60E-01	
SR 89						
8						
	1.60E+00	5 VALUES < LLD			3 VALUES < LLD	
SR 90						
8						
	4.00E-01	5 VALUES < LLD			3 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
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RADIOACTIVITY IN CLAM FLESH
PCI/G - 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: 1996

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	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA SCAN (GELI) 4						
BI-214	5.00E-01	2.35E+00(2/ 2) 2.27E+00- 2.43E+00	DOWNSTREAM LOCATION DOWNSTREAM	2.35E+00(2/ 2) 2.27E+00- 2.43E+00	2.40E+00(1/ 2) 2.40E+00- 2.40E+00	
PB-214	1.00E-01	2.40E+00(2/ 2) 1.96E+00- 2.83E+00	DOWNSTREAM LOCATION DOWNSTREAM	2.40E+00(2/ 2) 1.96E+00- 2.83E+00	2.13E+00(1/ 2) 2.13E+00- 2.13E+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).

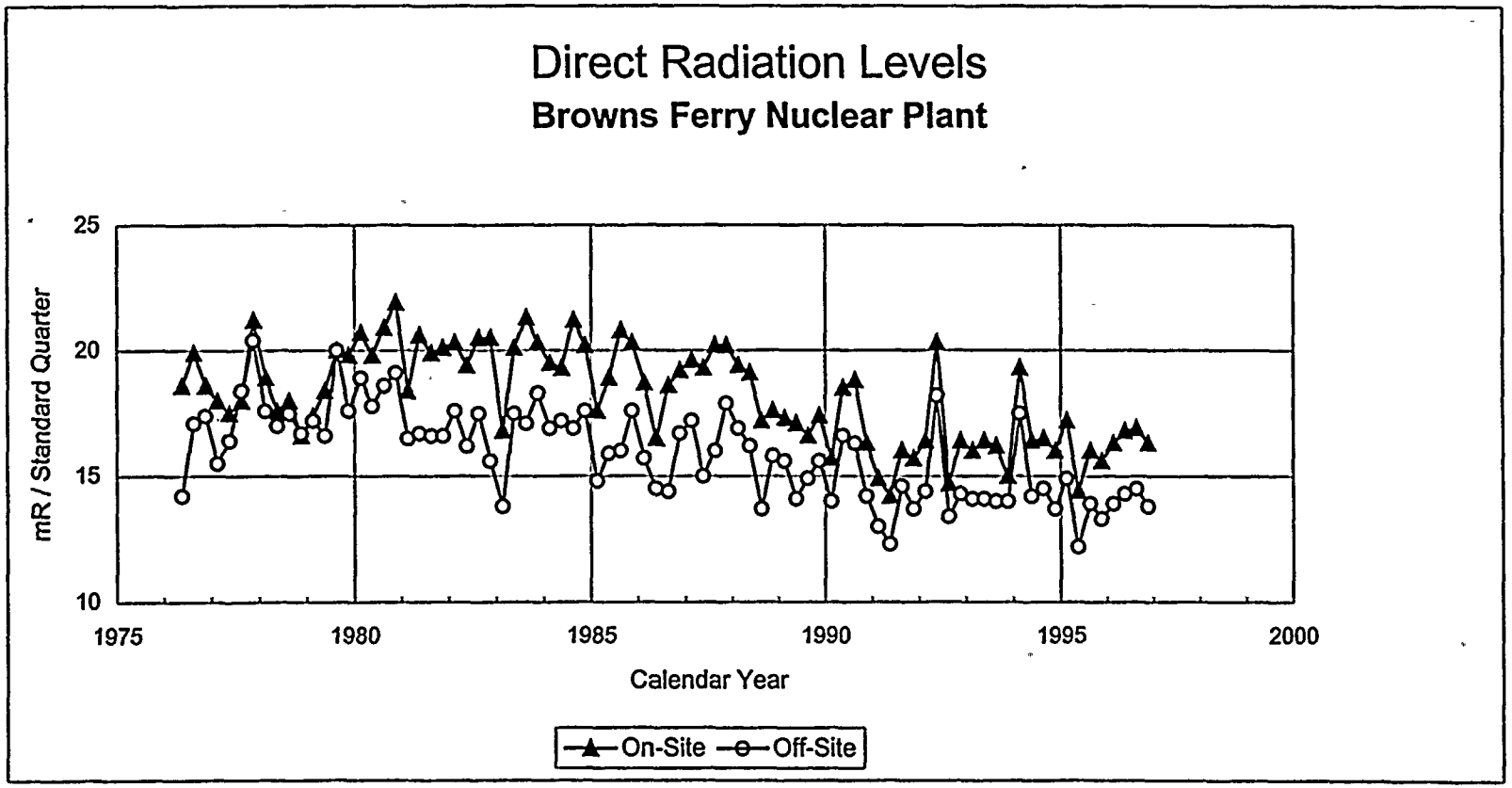
Direct Radiation Levels
Browns Ferry Nuclear Plant
mR / Standard Quarter
25
20
15
10
1975
1980
1985
1990
1995
2000
Calendar Year
On-Site
Off-Site

Figure H-1

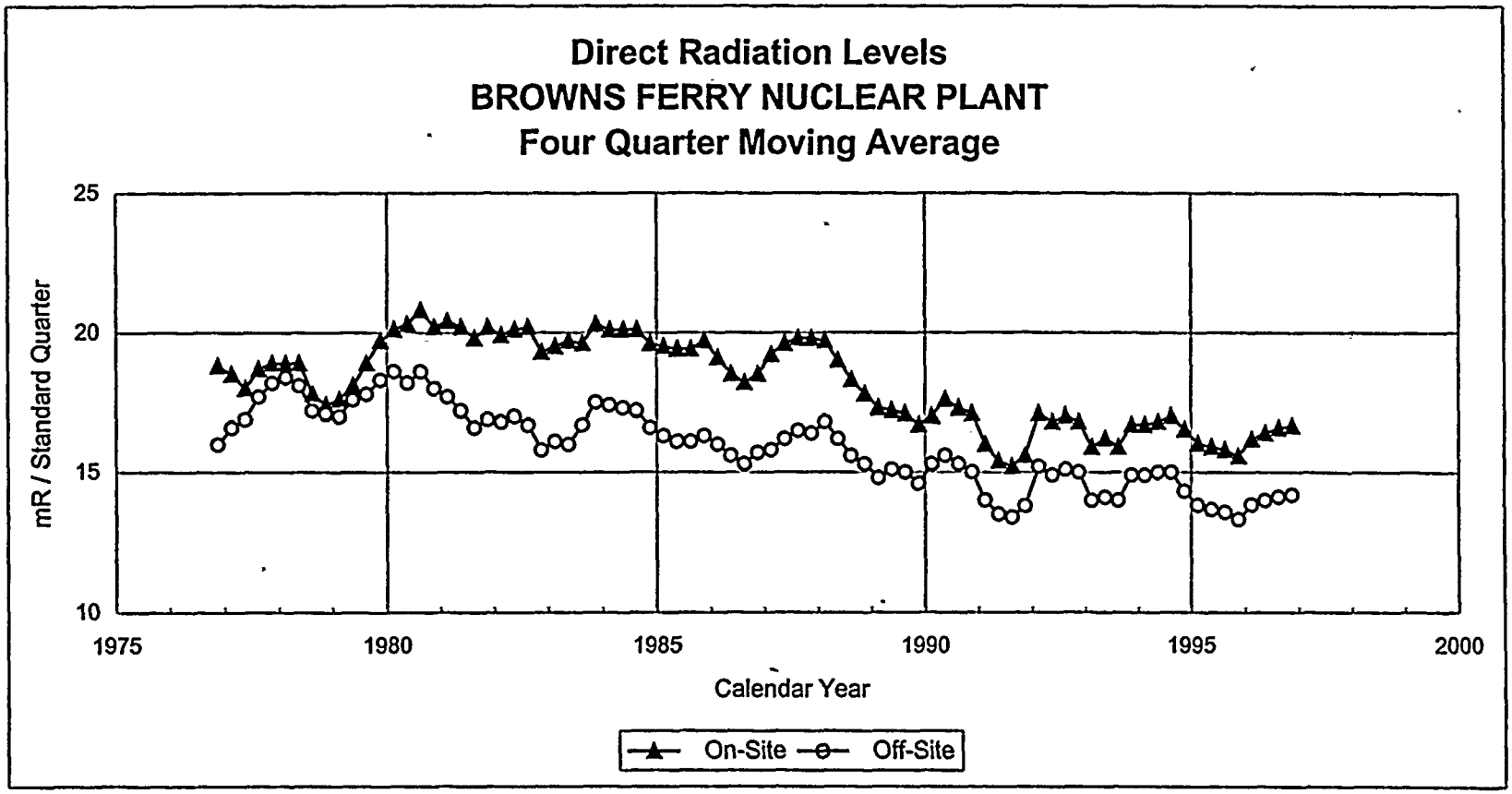
Direct Radiation Levels
BROWNS FERRY NUCLEAR PLANT
Four Quarter Moving Average
mR / Standard Quarter
25
20
15
10
1975
1980
1985
1990
1995
2000
Calendar Year
On-Site
Off-Site

Figure H-2

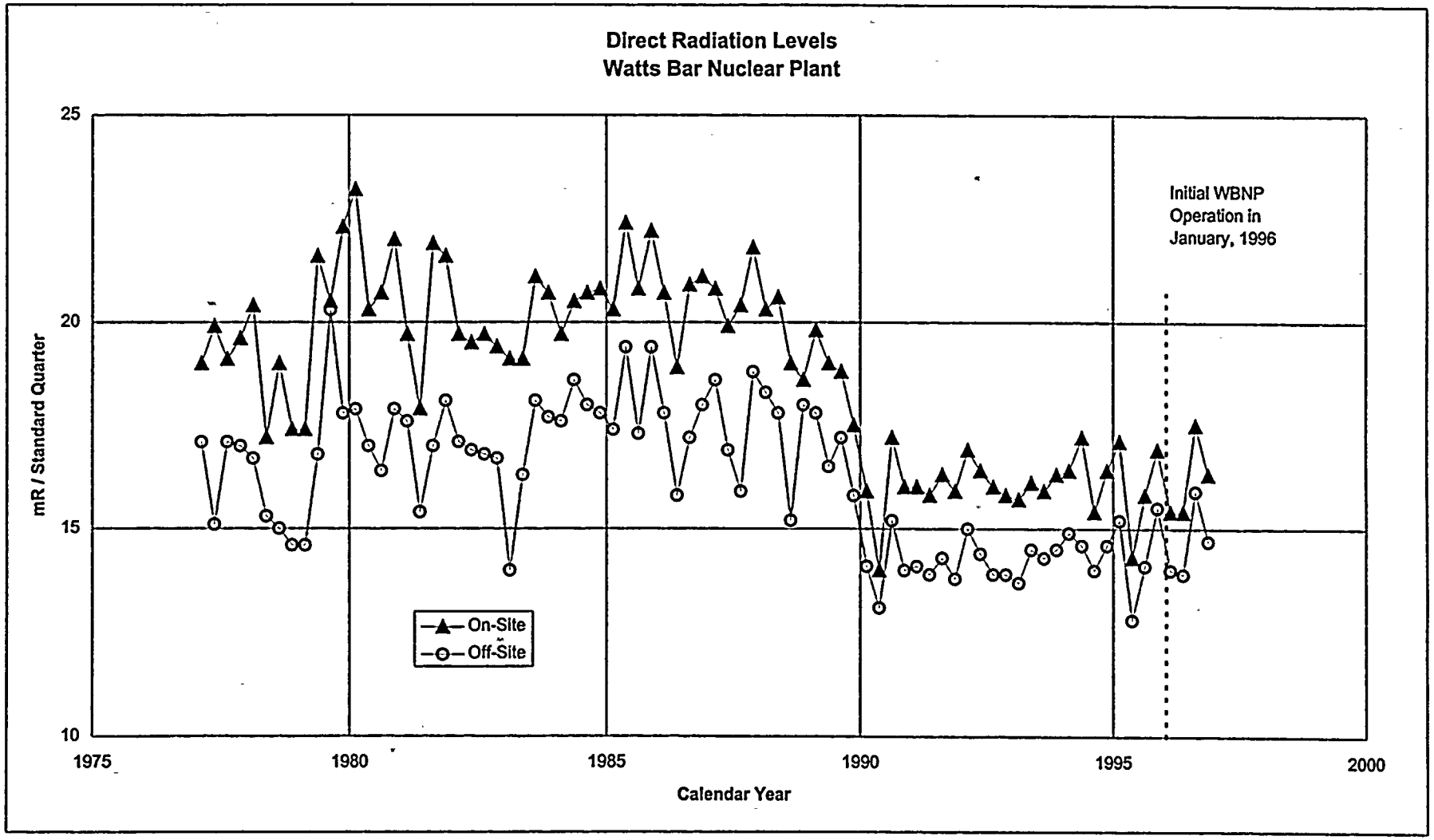
Direct Radiation Levels
Watts Bar Nuclear Plant
mR / Standard Quarter
25
20
15
10
1975
1980
1985
1990
1995
2000
Calendar Year
Initial WBNP
Operation in
January, 1996
On-Site
Off-Site

Figure H-3

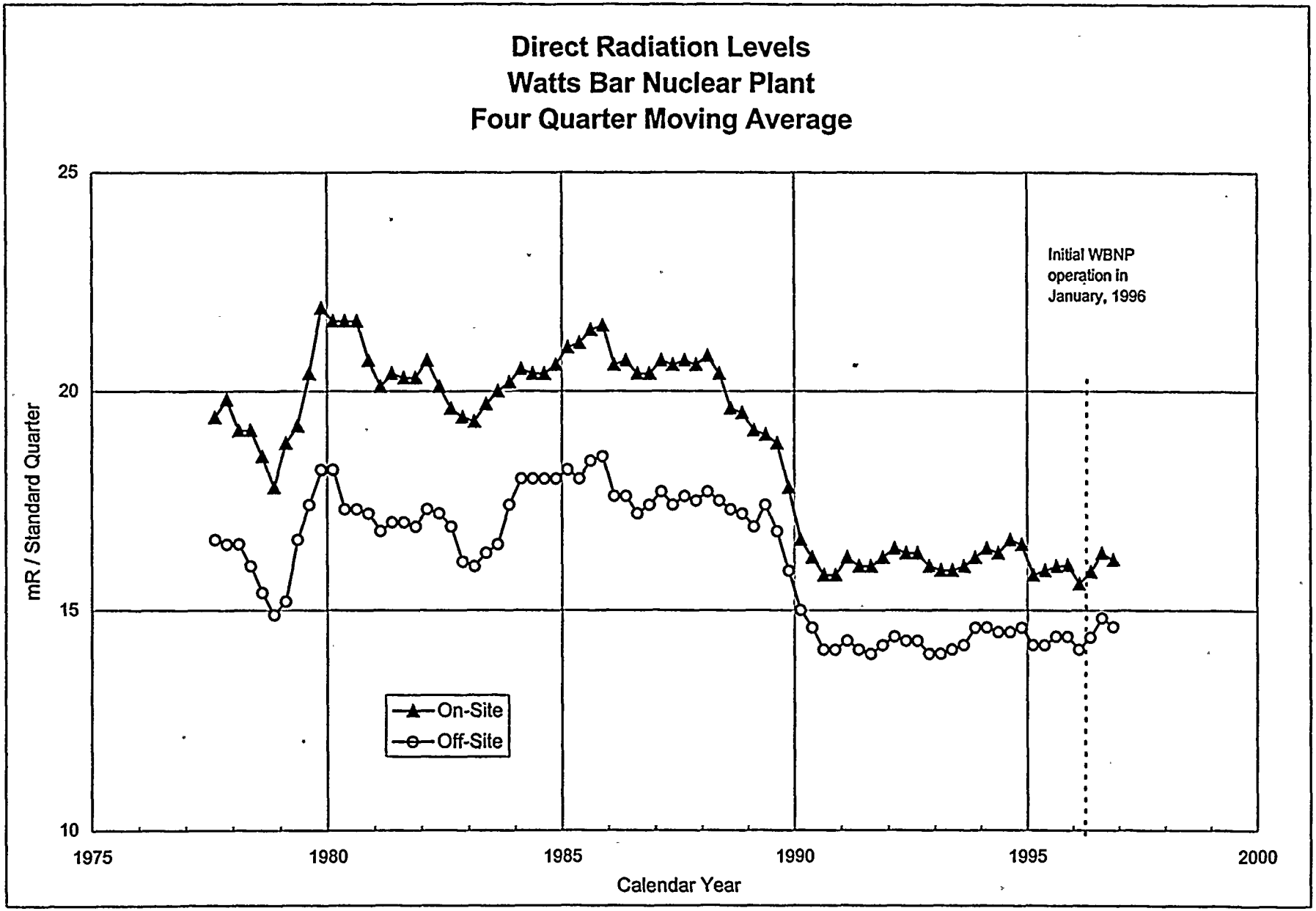
Direct Radiation Levels
Watts Bar Nuclear Plant
Four Quarter Moving Average
25
20
15
10
mR / Standard Quarter
1975
1980
1985
1990
1995
2000
Calendar Year
Initial WBNP
operation in
January, 1996
On-Site
Off-Site

Figure H-4

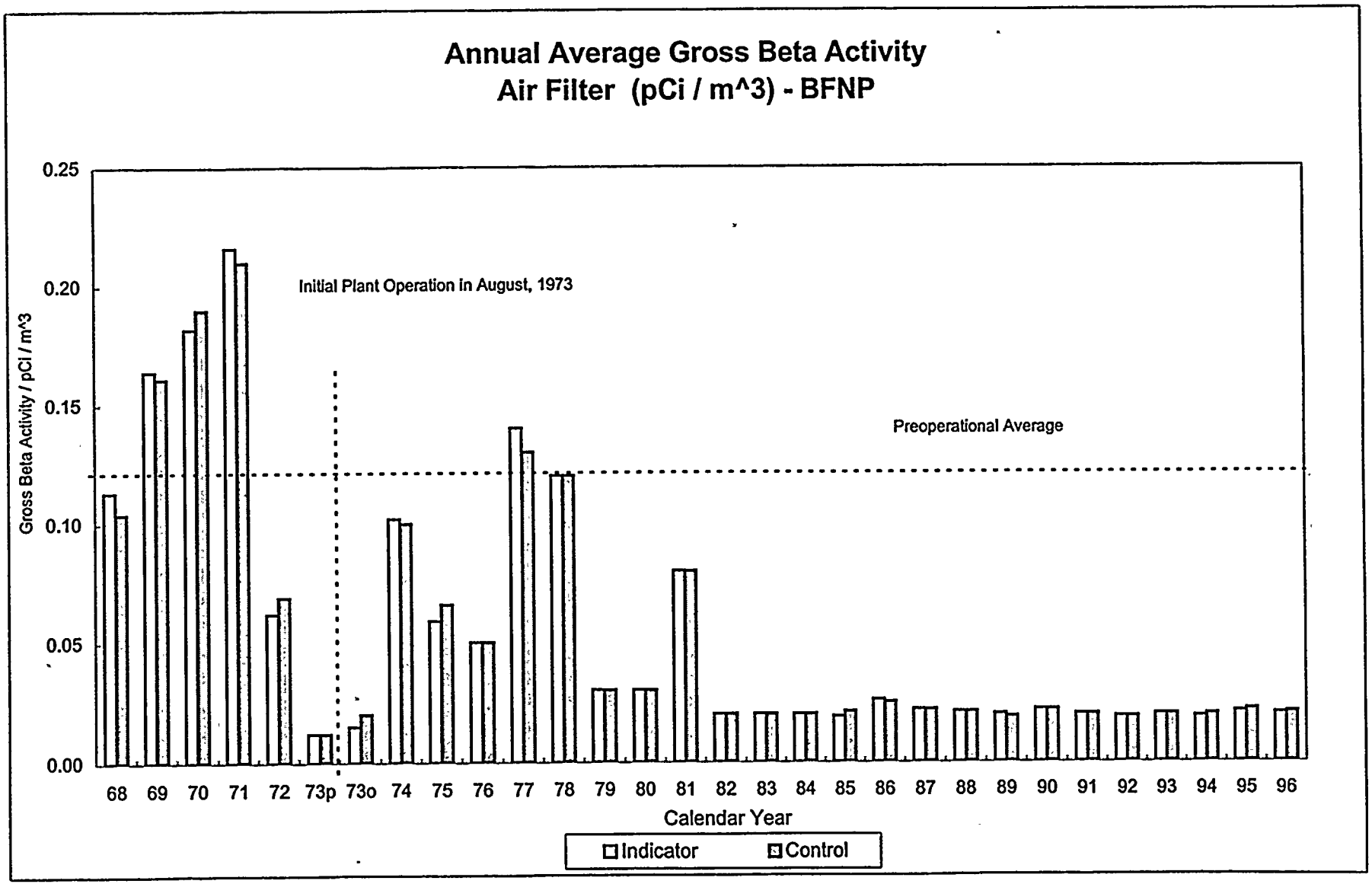
Annual Average Gross Beta Activity
Air Filter (pCi / m^3) - BFNP
Gross Beta Activity / pCi / m^3
0.25
0.20
0.15
0.10
0.05
0.00
Initial Plant Operation in August, 1973
Preoperational Average
68 69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year
Indicator
Control

Figure H-5

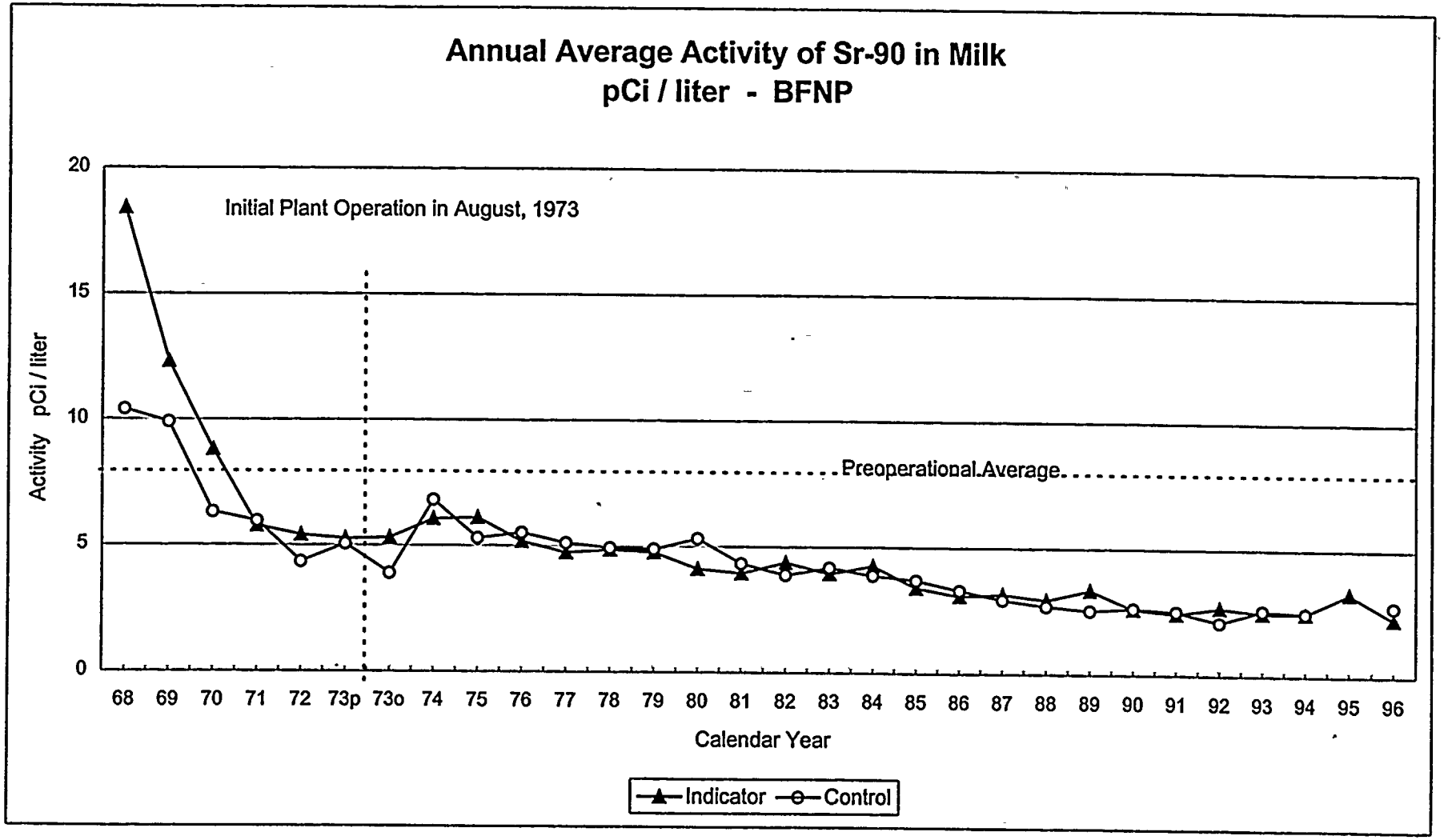
Annual Average Activity of Sr-90 in Milk
pCi / liter - BFNP
Initial Plant Operation in August, 1973
Preoperational Average
Activity pCi / liter
20
15
10
5
0
68 69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year
Indicator
Control

Figure H-6

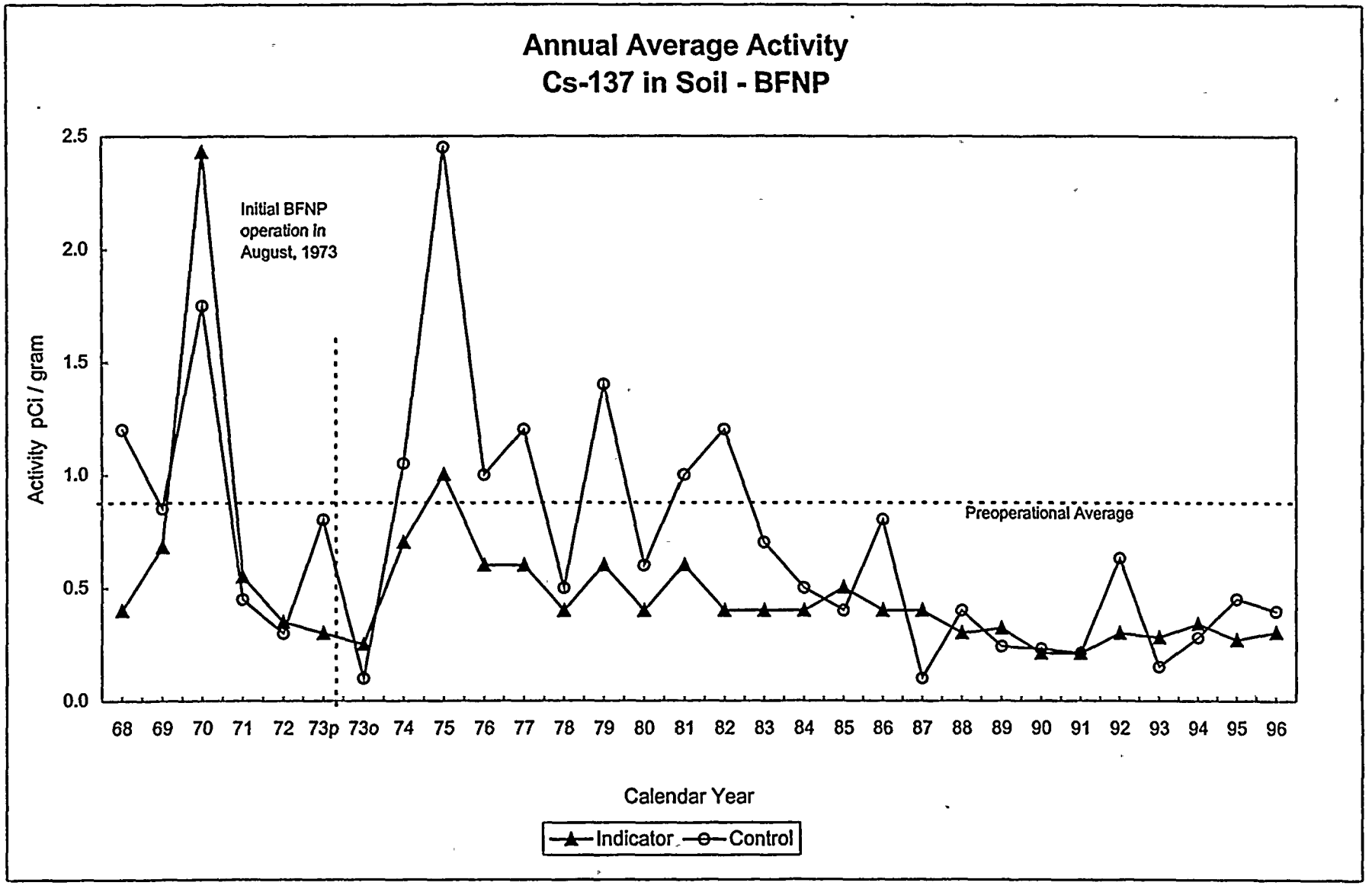
Annual Average Activity
Cs-137 in Soil - BFNP
Activity pCi / gram
2.5
2.0
1.5
1.0
0.5
0.0
Initial BFNP operation in August, 1973
Preoperational Average
68 69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year
Indicator
Control

Figure H-7

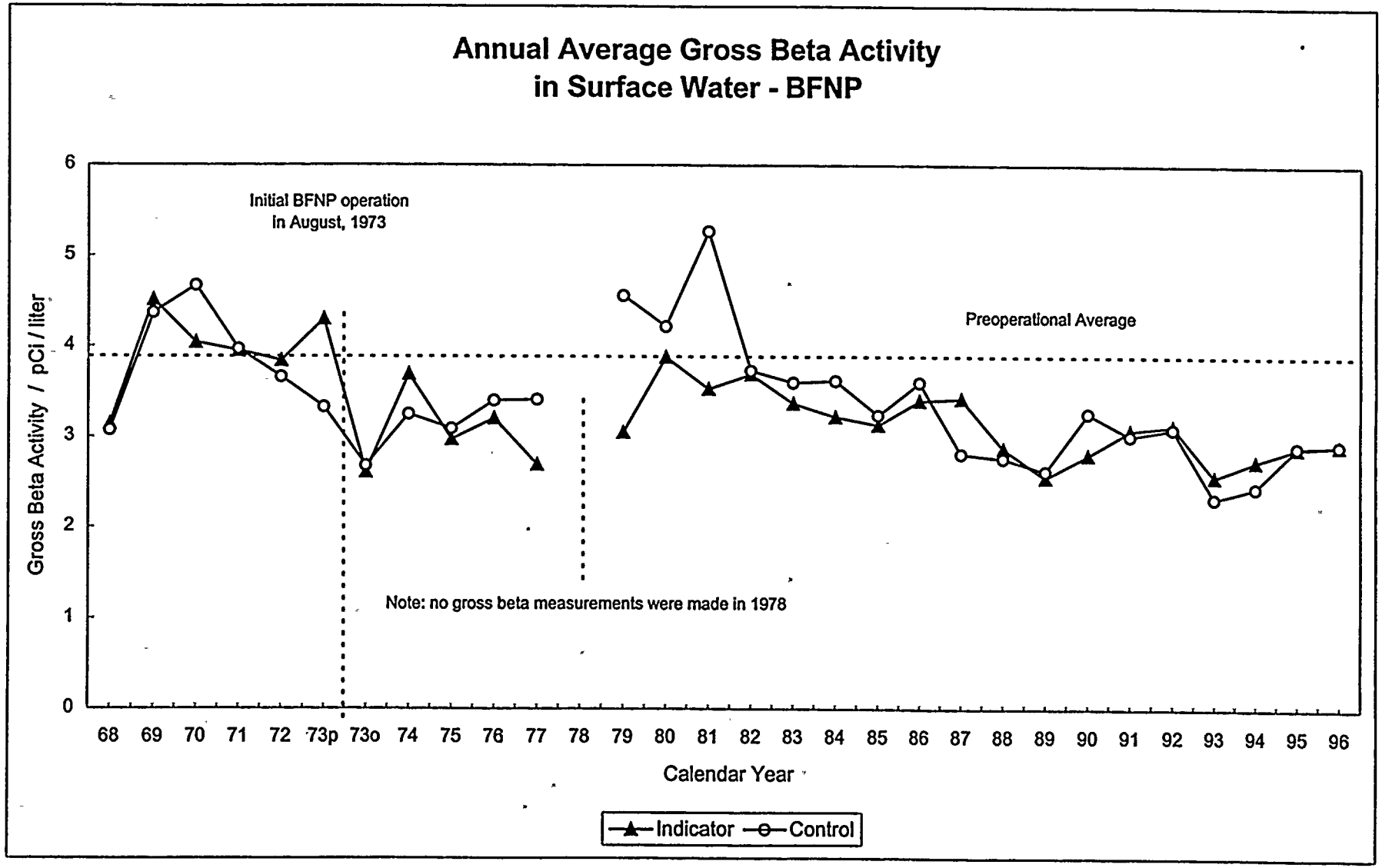
Annual Average Gross Beta Activity
in Surface Water - BFNP
Initial BFNP operation
in August, 1973
Preoperational Average
Note: no gross beta measurements were made in 1978
Gross Beta Activity / pCi / liter
0
1
2
3
4
5
6
68 69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year
Indicator
Control

Figure H-8

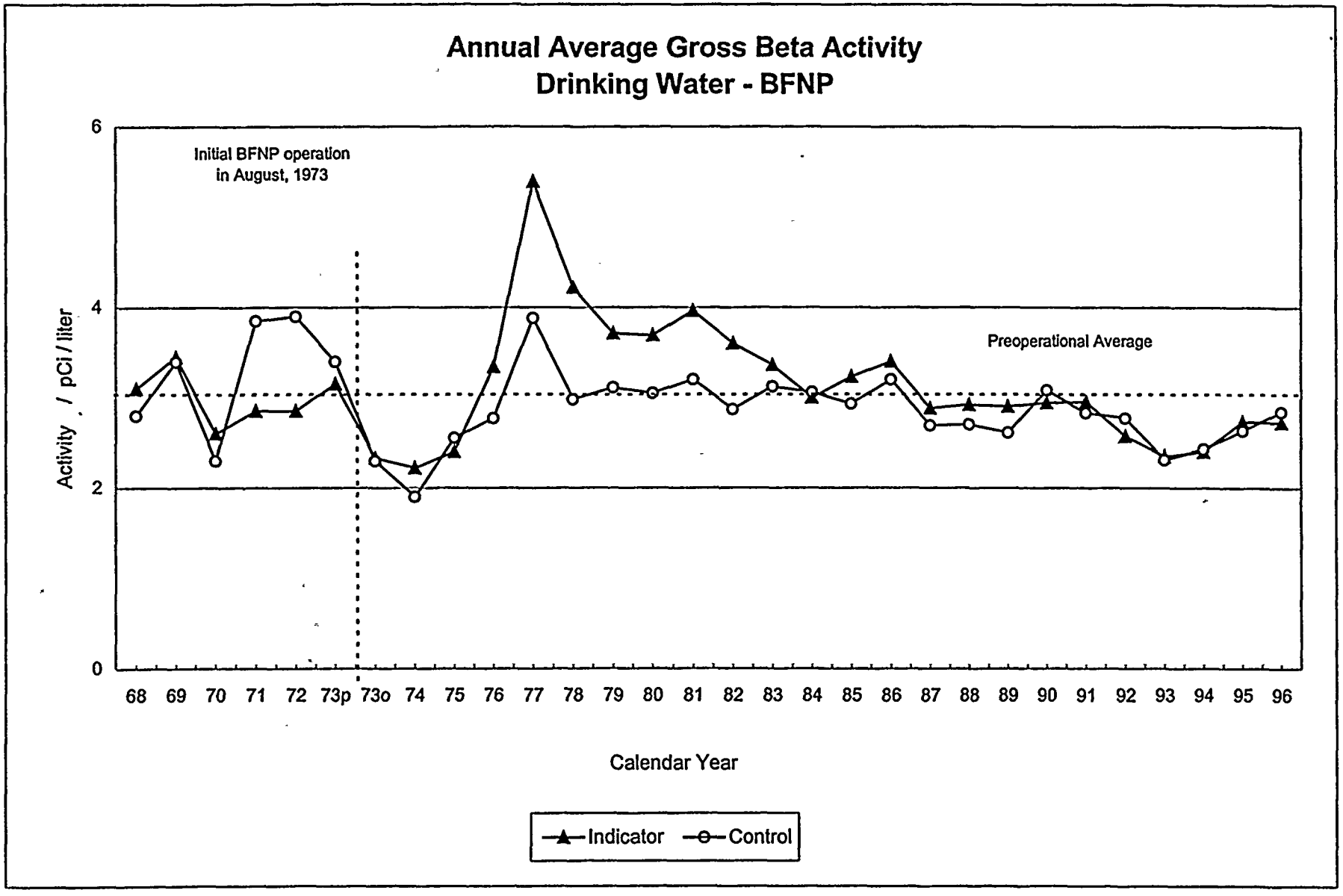
Annual Average Gross Beta Activity
Drinking Water - BFNP
Initial BFNP operation
in August, 1973
Preoperational Average
Activity / pCi / liter
6
4
2
0
68 69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year
Indicator
Control

Figure H-9

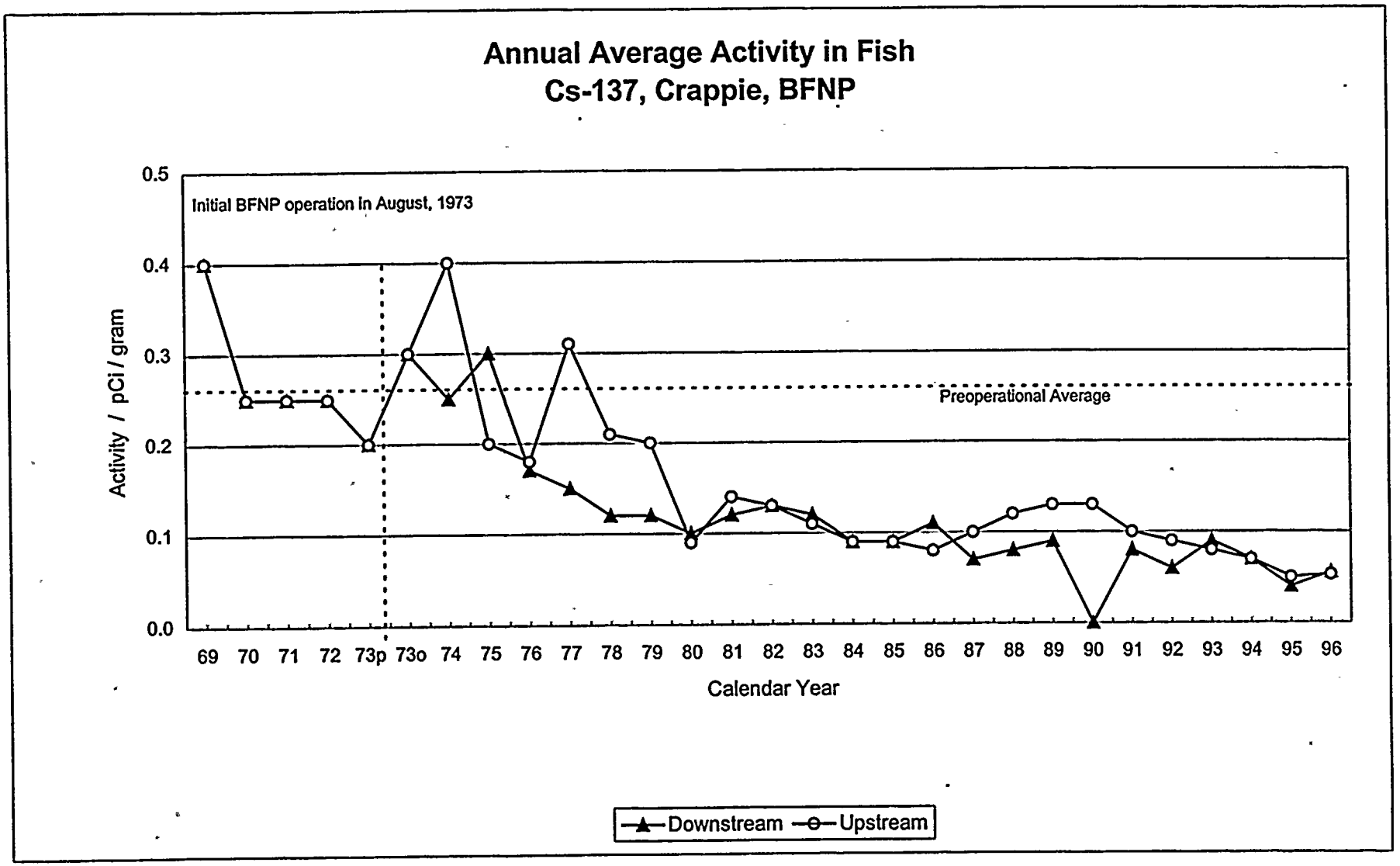
Annual Average Activity in Fish
Cs-137, Crappie, BFNP
Initial BFNP operation in August, 1973
Preoperational Average
Activity / pCi / gram
0.5
0.4
0.3
0.2
0.1
0.0
69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year
Downstream
Upstream

Figure H-10

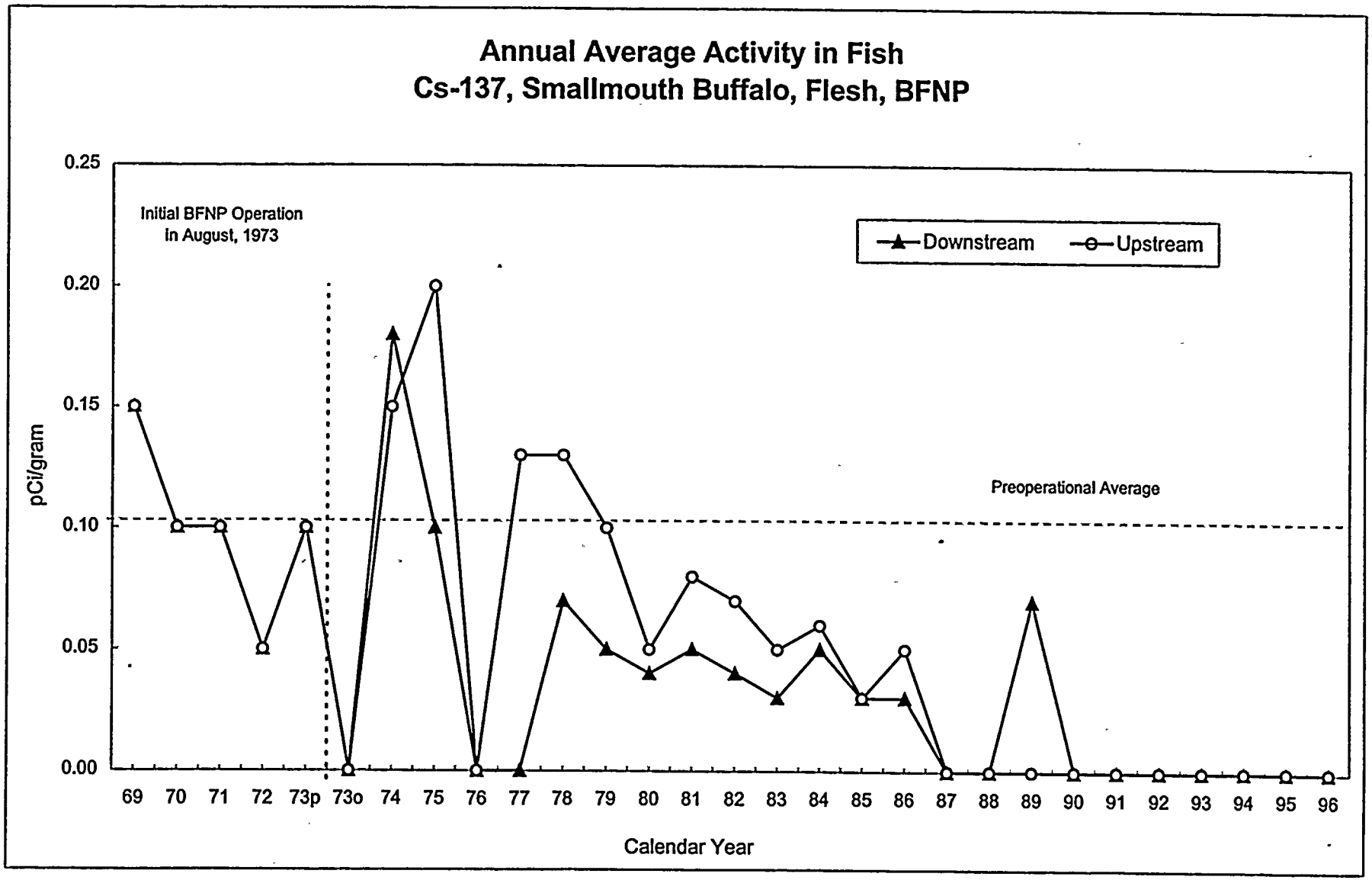
Annual Average Activity in Fish
Cs-137, Smallmouth Buffalo, Flesh, BFNP
Initial BFNP Operation
in August, 1973
Downstream
Upstream
Preoperational Average
pCi/gram
0.25
0.20
0.15
0.10
0.05
0.00
69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year

Figure H-11

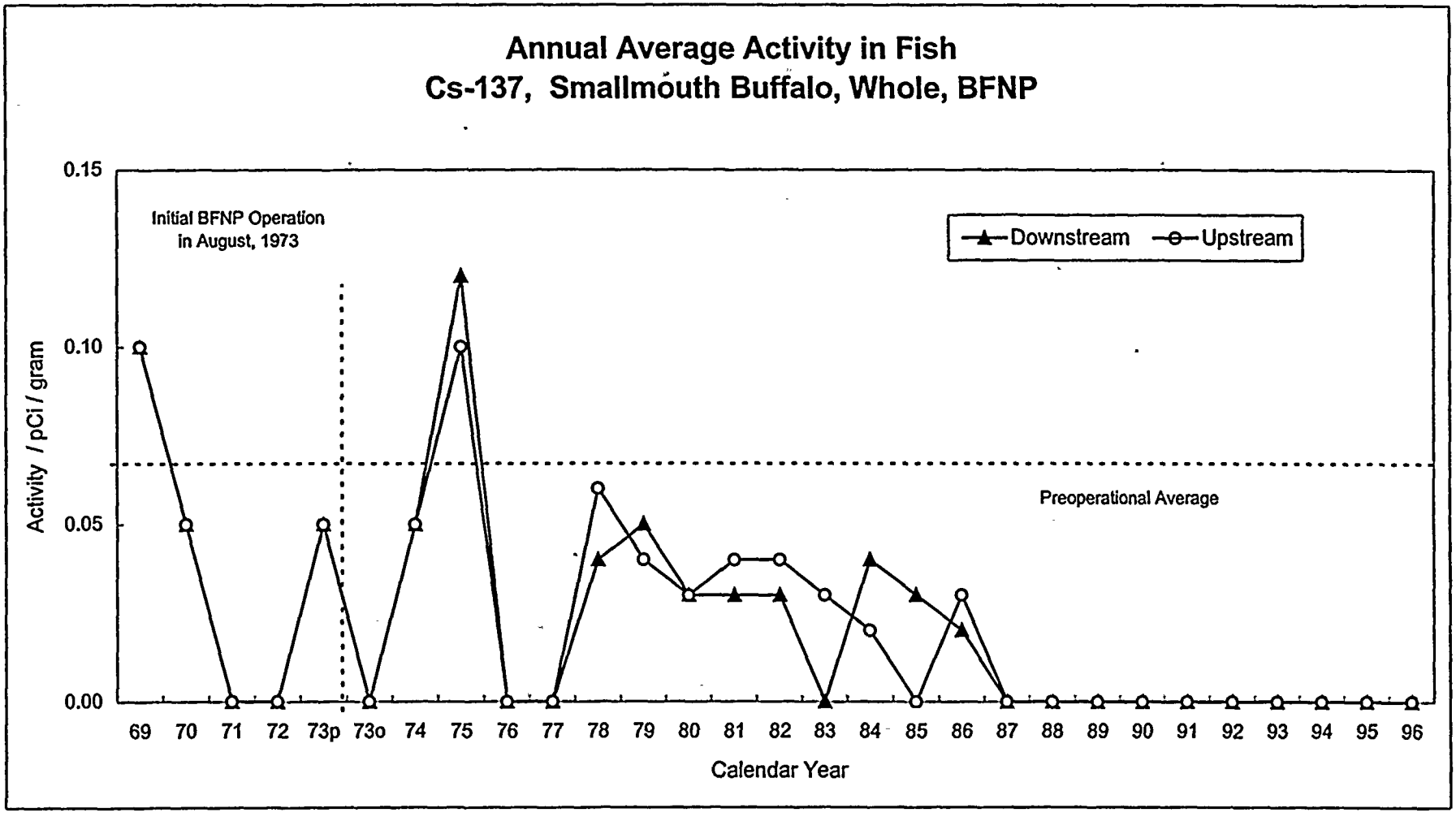
Annual Average Activity in Fish
Cs-137, Smallmouth Buffalo, Whole, BFNP
Initial BFNP Operation
in August, 1973
Downstream
Upstream
Preoperational Average
Activity / pCi / gram
0.15
0.10
0.05
0.00
69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year

Figure H-12

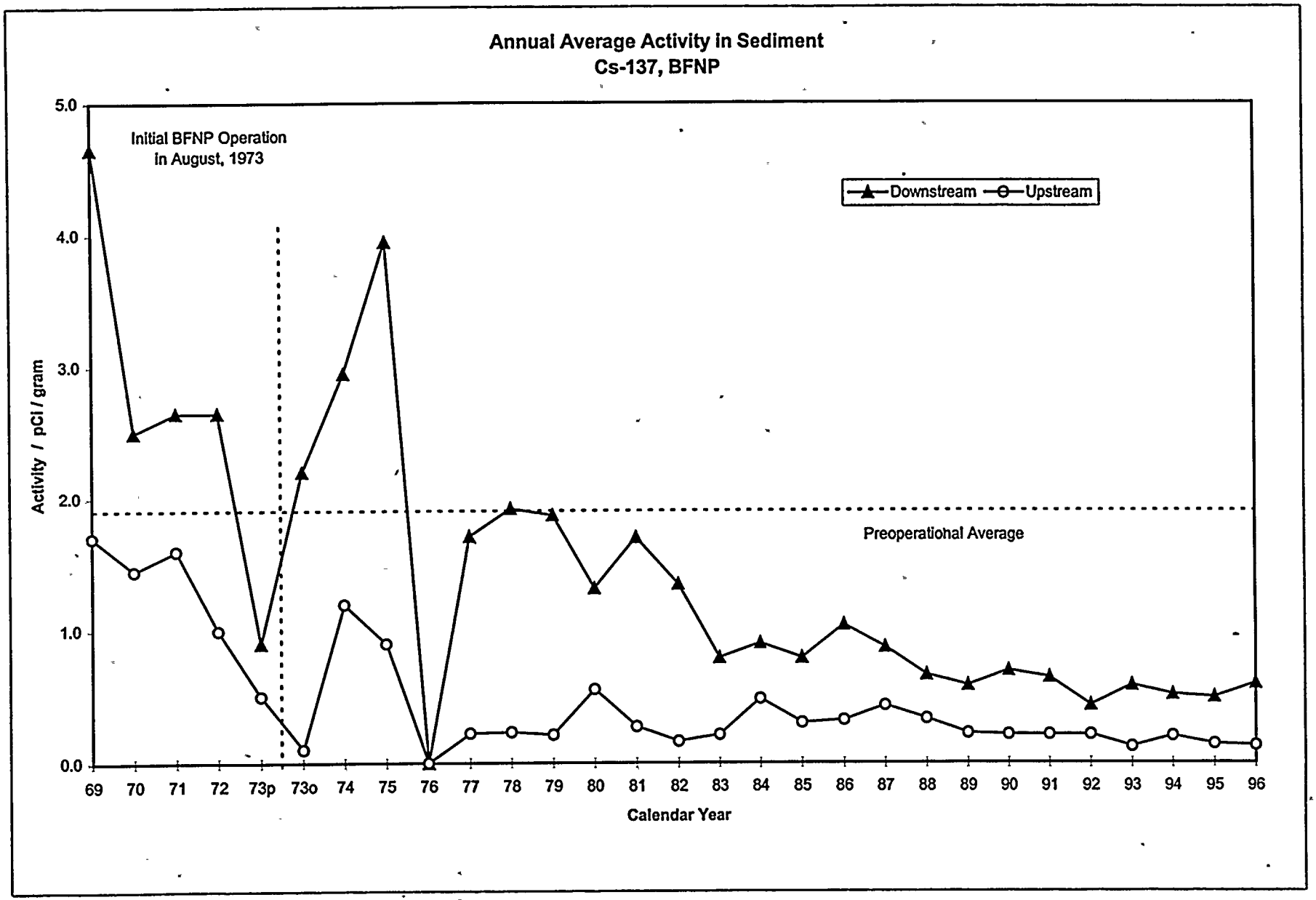
Annual Average Activity in Sediment
Cs-137, BFNP
Initial BFNP Operation
in August, 1973
Downstream
Upstream
Preoperational Average
Activity / pCi / gram
5.0
4.0
3.0
2.0
1.0
0.0
69
70
71
72
73p
73o
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
Calendar Year

Figure H-13

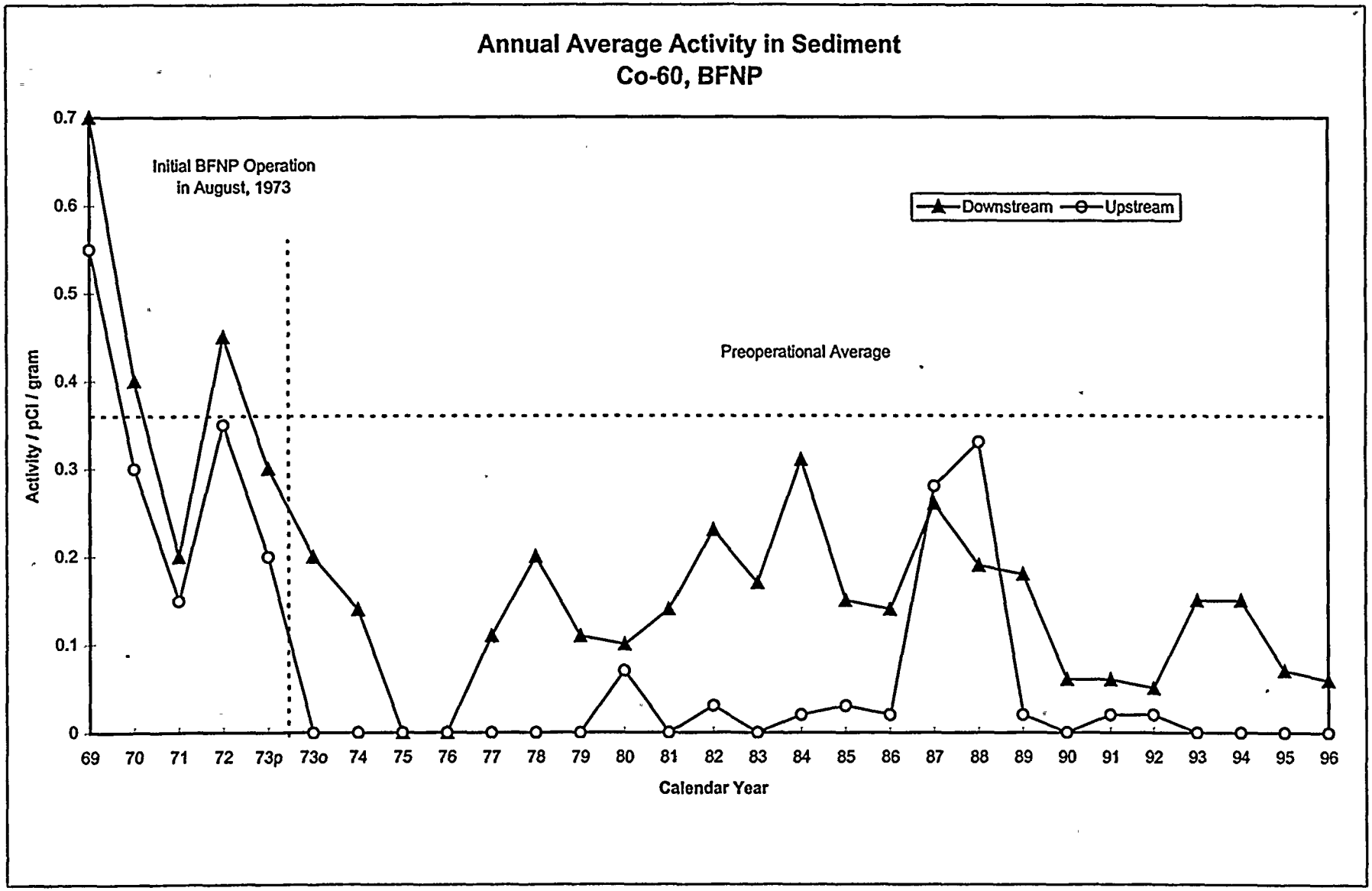
Annual Average Activity in Sediment
Co-60, BFNP
Initial BFNP Operation
in August, 1973
Downstream
Upstream
Preoperational Average
Activity / pCi / gram
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
69 70 71 72 73p 73o 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96
Calendar Year

Figure H-14