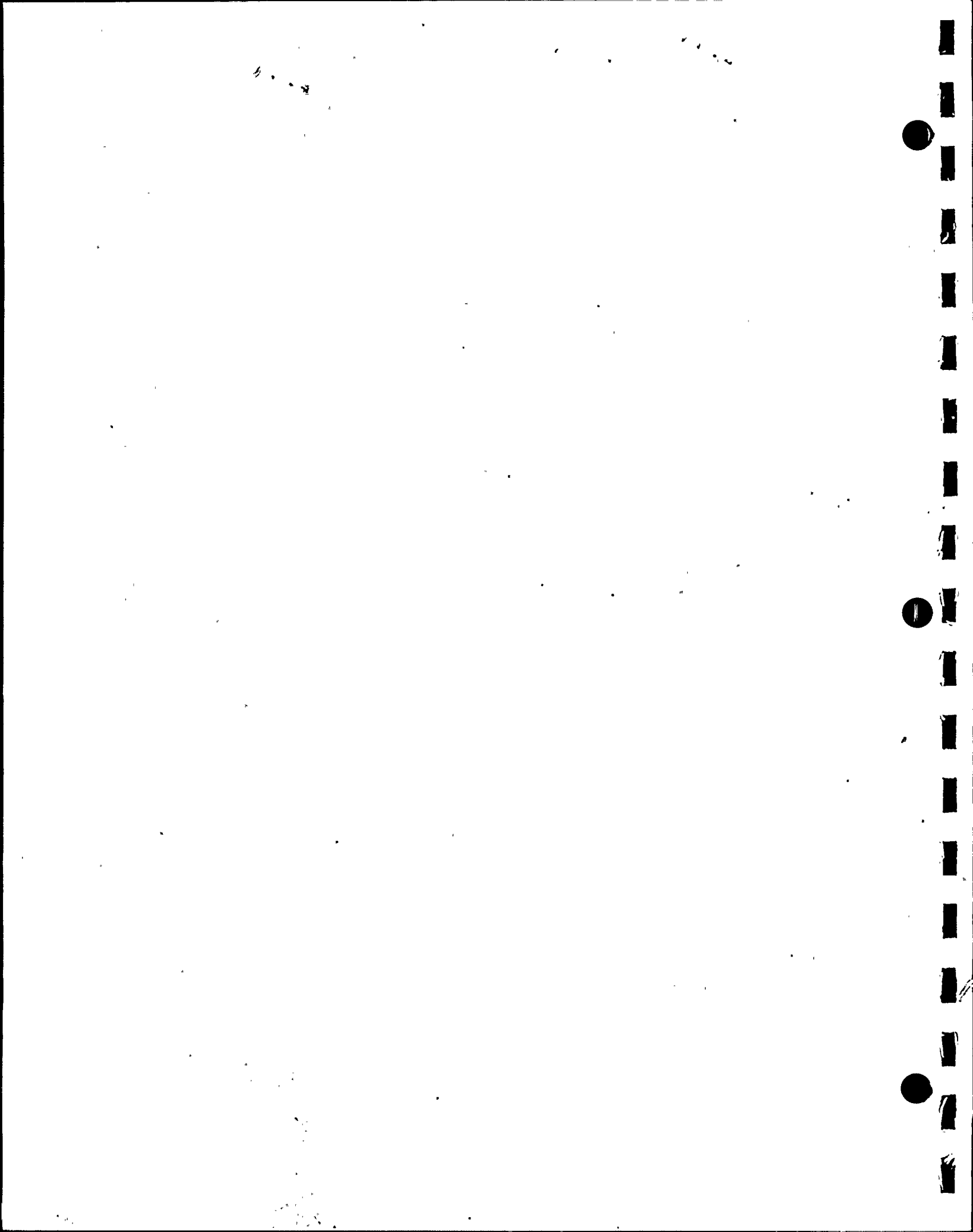


# Annual Radiological Environmental Operating Report

Browns Ferry  
Nuclear Plant  
1995



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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 1995. 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. Material sampled includes air, water, milk, foods, vegetation, soil, fish, sediment, and 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-134 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. Some of the data presented are prescribed by specific requirements while other data are included which may be useful or interesting to 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 information in the following table 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	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 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	$\leq 10$ mrad/year
Beta radiation	$\leq 20$ mrad/year

Particulates: -

Any organ	$\leq 15$ mrem/year
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The Environmental Protection Agency (EPA) limits for the total dose to the public in the vicinity of a nuclear power plant, established in the Environmental Dose Standard of 40 CFR 190, are as follows:

Total body	25 mrem/year
Thyroid	75 mrem/year
Any other organ	25 mrem/year

Appendix B to 10 CFR 20 presents annual average limits for the concentrations of radioactive materials released in gaseous and liquid effluents at the boundary of the unrestricted areas.

Table 1 of this report presents the annual average concentration limits for the principal radionuclides associated with nuclear power plant effluents. This table also presents (1) the concentrations of radioactive materials in the environment which would require a special report to the NRC and (2) the detection limits for the listed radionuclides. It should be noted that the levels of radioactive materials measured in the environment are typically below or only slightly above the lower limit of detection. The data presented in this report indicate compliance with the regulation.



## 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. 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 the center of Decatur, Alabama (Figure 1). 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 15,000, while approximately 45,000 people live in the city of Decatur. The largest city in the area with approximately 145,000 people is Huntsville, Alabama, located about 24 miles east of the site.

Area recreation facilities are being developed along the Tennessee River. The nearest facilities are two county parks located about 8 miles west-northwest of the site and a commercial boat dock across the river 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 taken out of service in March 1985. Unit 2 was restarted May 24, 1991 and unit 3 restarted on November 19, 1995.





## 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 identification system is used for all tables and figures given in the appendices.) lists the sampling stations and the types of samples collected from each. Modifications made to the



program in 1995 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 Department 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 generally quite 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 special 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 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 1995 were consistent with levels from previous years and with levels measured at other locations in the region.

### Measurement Techniques

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

From 1968 through 1989, TVA used a Victoreen dosimeter consisting of a manganese activated calcium fluoride ( $\text{Ca}_2\text{F:Mn}$ ) TLD material encased in a glass bulb. In 1989, TVA began the process of changing from the Victoreen dosimeter to the Panasonic Model UD-814 dosimeter, and completely changed to the Panasonic dosimeter in 1990. This dosimeter contains four elements consisting of one lithium borate and three calcium sulfate phosphors. The calcium sulfate phosphors are shielded by approximately  $1000 \text{ mg/cm}^2$  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 three 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 than the lithium borate, the measured exposure is taken as the median of the results obtained from the nine calcium sulfate phosphors in three detectors. 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 Watts Bar Nuclear Plant (WBN) environmental radiological monitoring program are referenced. Prior to January, 1996, WBN was a non-operating plant under construction near Spring City, Tennessee.

The quarterly gamma radiation levels determined from the TLDs deployed around BFN in 1995 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 and reported in millirem per standard quarter. For purposes of this report, one milliroentgen and one millirem (mrem) are assumed to be equivalent. The rounded average annual exposures are shown below.

	Annual Average Direct Radiation Levels mR/year	
	<u>BFN</u>	<u>WBN</u>
Onsite Stations	63	64
Offsite Stations	54	58

The data in Table H-1 indicate that the average quarterly radiation levels at the BFN onsite stations are approximately 2 mR/quarter higher than levels at the offsite stations. This difference has also been noted at the stations at WBN and other nonoperating nuclear power plant construction sites where the average levels onsite are generally 2-6 mR/quarter higher than 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 construction site.

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 1995. 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 of TVA's WBN to the present. Note that the data follow a similar pattern to the BFN data and that, as discussed above, the levels reported at onsite stations are similarly higher than the levels at offsite stations.

All results reported in 1995 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 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. 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-3. 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 Hollingsworth and Vose LB5211 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.

On March 27, 1989, two monitors, one local and one remote, were equipped with a second





sampler. The filters from these samplers are analyzed weekly for gross alpha and composited quarterly for analysis of transuranic isotopes and for Sr-89,90.

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 collected 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 1995.

### Results

The results from the analysis of air particulate samples are summarized in Table H-3. Gross beta activity in 1995 was consistent with levels reported in previous years. The average level at indicator stations was 0.021 pCi/m<sup>3</sup> while the average at control stations was 0.022 pCi/m<sup>3</sup>. The annual averages of the gross beta activity in air particulate filters at these stations for the years 1968-1995 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 nonoperating nuclear power plant construction sites.



Only natural radioactive materials were identified by the monthly gamma spectral analysis of the air particulate samples. No fission or activation products or transuranic isotopes 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 1995.

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 3 miles of the plant. The results of the 1995 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. Analyses for transuranic isotopes are also performed on samples from the two monitoring stations with the second air samplers.

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 1995 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 0.2 pCi/liter. Strontium-90 was identified in two of the samples. 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 average Sr-90 concentration reported from indicator locations was 3.3 pCi/liter while the concentration from control stations were all below the lower limit of detection (LLD) of 2.0 pCi/liter. These levels are consistent with concentrations measured in samples collected prior to plant operation and with concentrations reported in milk as a result of fallout from atmospheric nuclear weapons tests (Reference 1). Strontium-89 in concentrations slightly greater than the LLD of 2.0 pCi/liter was identified in one indicator and one control station. With a half-life of approximately 60 days, this isotope cannot be present in the environment as a result of the last atmospheric nuclear weapons tests conducted about 15 years ago. The apparent identification of Sr-89 is an artifact of the calculational process and the low concentrations the laboratory is attempting to detect. By far the predominant isotope reported in milk samples was the





naturally occurring K-40. An average of approximately 1300 pCi/liter of K-40 was identified in all milk samples.

Similar results were reported for vegetation samples (Table H-6). All I-131 and Cs-137 values were less than the nominal LLD. Strontium-90 was identified in one indicator and one control sample at concentrations of 28.1 and 35.1 pCi/Kg, respectively. 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 of was approximately 0.8 pCi/g in a sample from one of the control stations. These concentrations are 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.

Analyses for transuranic isotopes (Am-241; Pu-238; Pu-239,240; Cm-242; and Cm-244) in soil have been performed since 1989. The results have generally agreed with the concentrations reported by the Electric Power Research Institute (EPRI) in Reference 4. The EPRI report concludes that essentially all of the radionuclides in soils from around the nuclear power plants participating in the study (including BFN) were of fallout origin and that the variations in concentrations were a function of soil texture, soil permeability, and/or disturbances of the soil surface. The concentrations measured in 1995 are included in Table H-7.

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 clams, 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, 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 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 significantly 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 two downstream stations 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.

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 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.

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. Most of the fish are filleted, but one group is processed whole for analysis. After drying and grinding, the samples are analyzed by gamma spectroscopy.

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 LLD 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 1995 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 2.6 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.

Concentrations of fission and activation products in groundwater samples were all below the LLDs. Only naturally occurring radon decay products (Bi-214 and Pb-214) were identified in these samples. Results from the analysis of groundwater samples are presented in Table H-16.

Cesium-137 was identified in four fish samples. The downstream samples had an average concentration of 0.04 pCi/g while the average concentration in the upstream samples was 0.05 pCi/g. The only other radioisotope found in fish were naturally occurring. Concentrations of K-40 ranged from 5.8 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 probably a 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 0.49 pCi/g in downstream samples and 0.14 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 0.07 pCi/g, while concentrations in upstream samples were below the LLD. The maximum concentration downstream was 0.09 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 "maximally 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 or meat 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 maximally exposed individual due to radioactivity released from BFN in 1995 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 0.058 mrem/year, or 1.9 percent of the limit. The maximum organ dose equivalent from gaseous effluents is 0.006 mrem/year. This represents 0.04 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 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 undetectably small 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 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. Merrill Eisenbud, Environmental Radioactivity, Academic Press, Inc., New York, NY, 1987.
2. National Council on Radiation Protection and Measurements, Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," September 1987.
3. United States Nuclear Regulatory Commission, Regulatory Guide 8.29, "Instruction Concerning Risks From Occupational Radiation Exposure," July 1981.
4. Electric Power Research Institute, Report No. EPRI EA-2045, Project 1059, "Transuranium and Other Long-Lived Radionuclides in the Terrestrial Environs of Nuclear Power Plants," September 1981.



Table 1

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

	<u>Concentrations in Water, pCi/Liter</u>			<u>Concentrations in Air, pCi/Cubic Meter</u>		
	<u>Effluent Concentration<sup>1</sup></u>	<u>Reporting Level<sup>2</sup></u>	<u>Lower Limit of Detection<sup>3</sup></u>	<u>Effluent Concentration<sup>1</sup></u>	<u>Reporting Level<sup>2</sup></u>	<u>Lower Limit of Detection<sup>3</sup></u>
H-3	1,000,000	20,000	250	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		3	1,000		0.0006
Sr-90	500		1.4	6		0.0003
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	1	200	0.9	0.02
Cs-134	900	30	5	200	10	0.005
Cs-137	1,000	50	5	200	20	0.005
Ce-144	3,000		33	40		0.01
Ba-140	8,000	200	25	2,000		0.01
La-140	9,000	200	8	2,000		0.005

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

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

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

2 Source: 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

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

- Notes:
1. The calculated exposure is the "known" exposure determined the testing agency.
  2. See Figure 3.



Table 3

Maximum Dose due to Radioactive Effluent Releases  
 Browns Ferry Nuclear Plant  
 1995  
 mrem/year

Liquid Effluents

<u>Type</u>	<u>1995 Dose</u>	<u>NRC Limit</u>	<u>Percent of NRC Limit</u>	<u>EPA Limit</u>	<u>Percent of EPA Limit</u>
Total Body	5.8E-2	3	1.9	25	0.2
Any Organ	8.6E-2	10	0.9	25	0.3

Gaseous Effluents

<u>Type</u>	<u>1995 Dose</u>	<u>NRC Limit</u>	<u>Percent of NRC Limit</u>	<u>EPA Limit</u>	<u>Percent of EPA Limit</u>
Noble Gas (Gamma)	4.0E-5	10	0.0004	25	0.0002
Noble Gas (Beta)	2.2E-5	20	0.0001	25	0.0001
Any Organ	5.9E-3	15	0.04	25	0.02





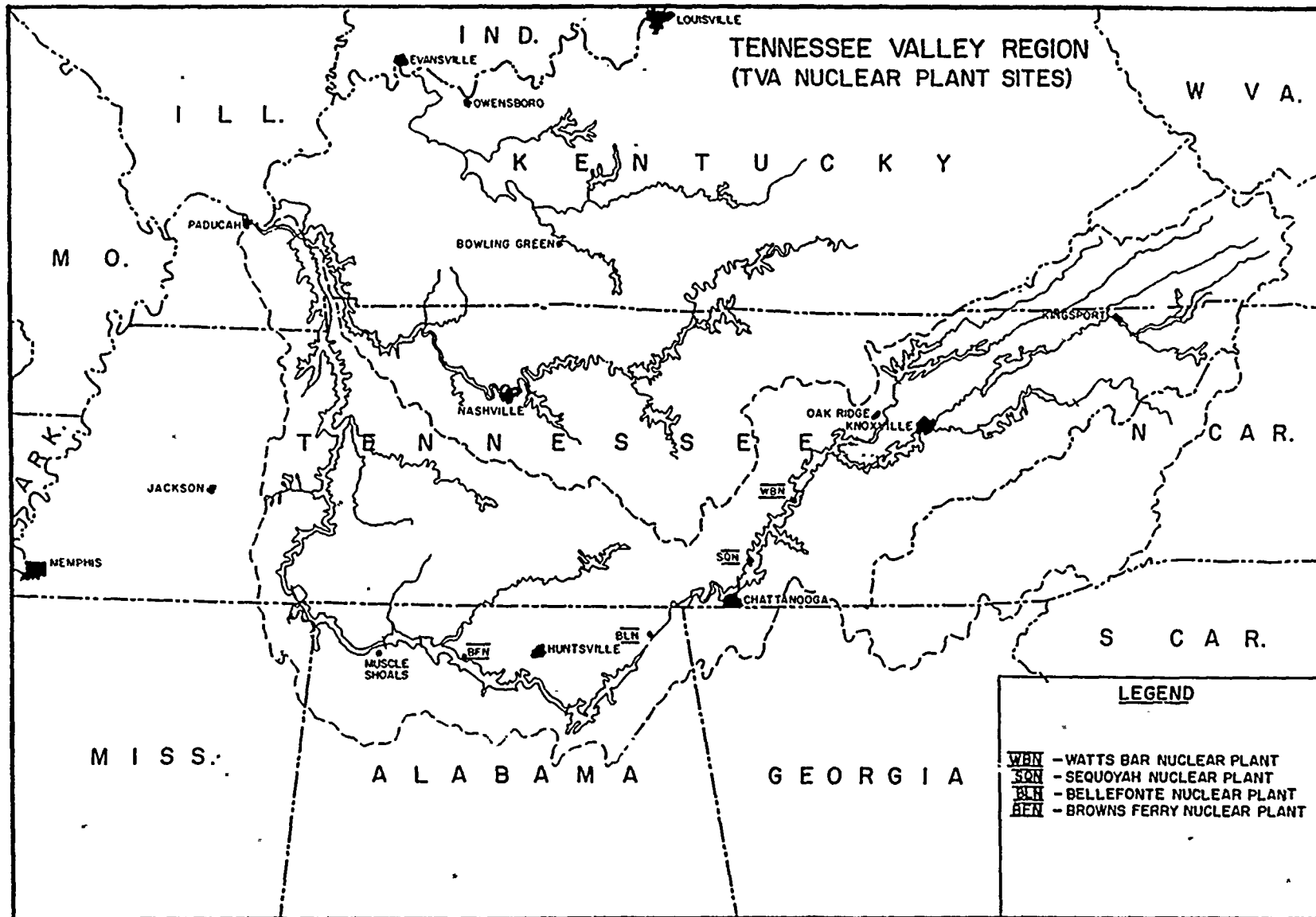
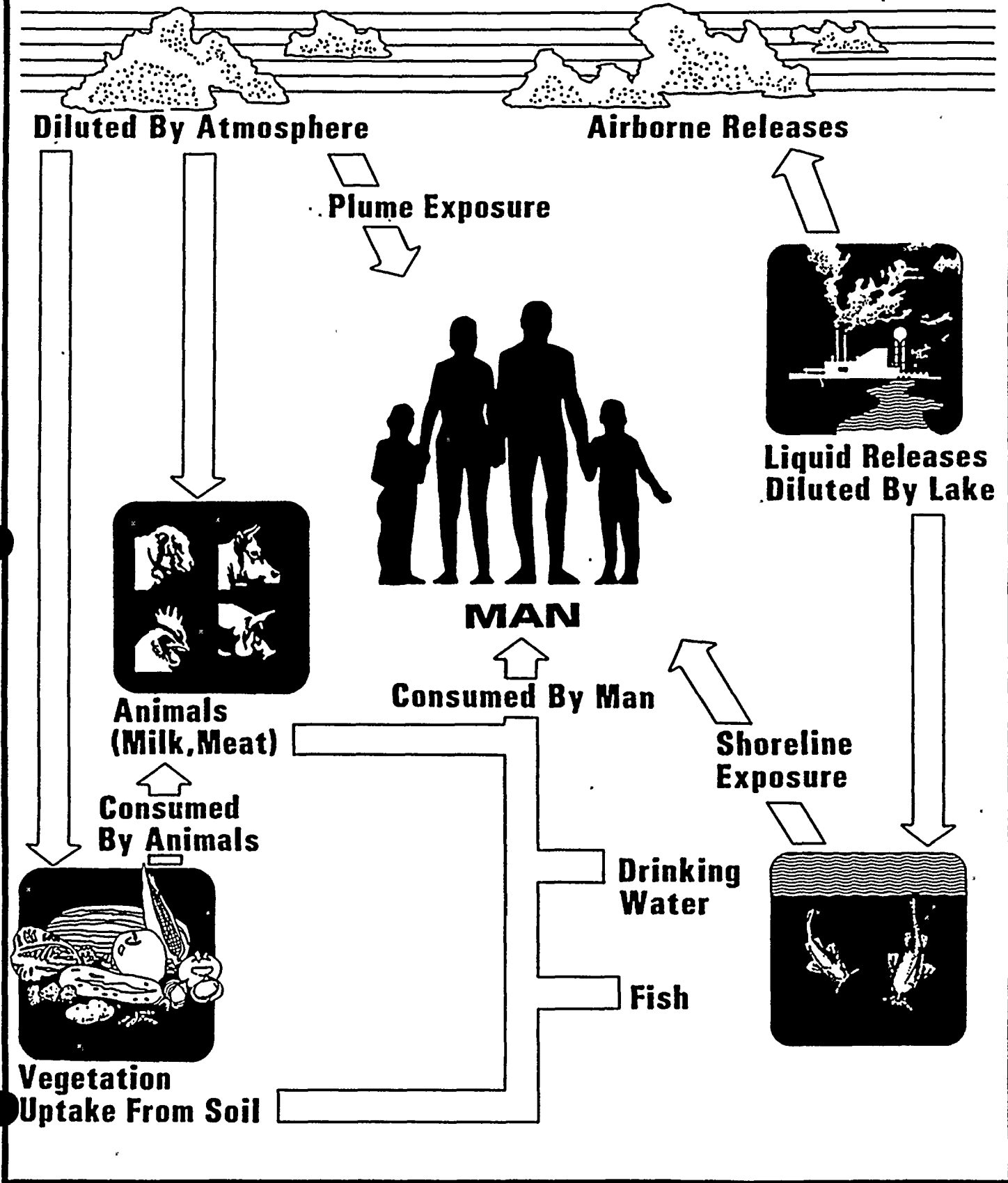


Figure 1



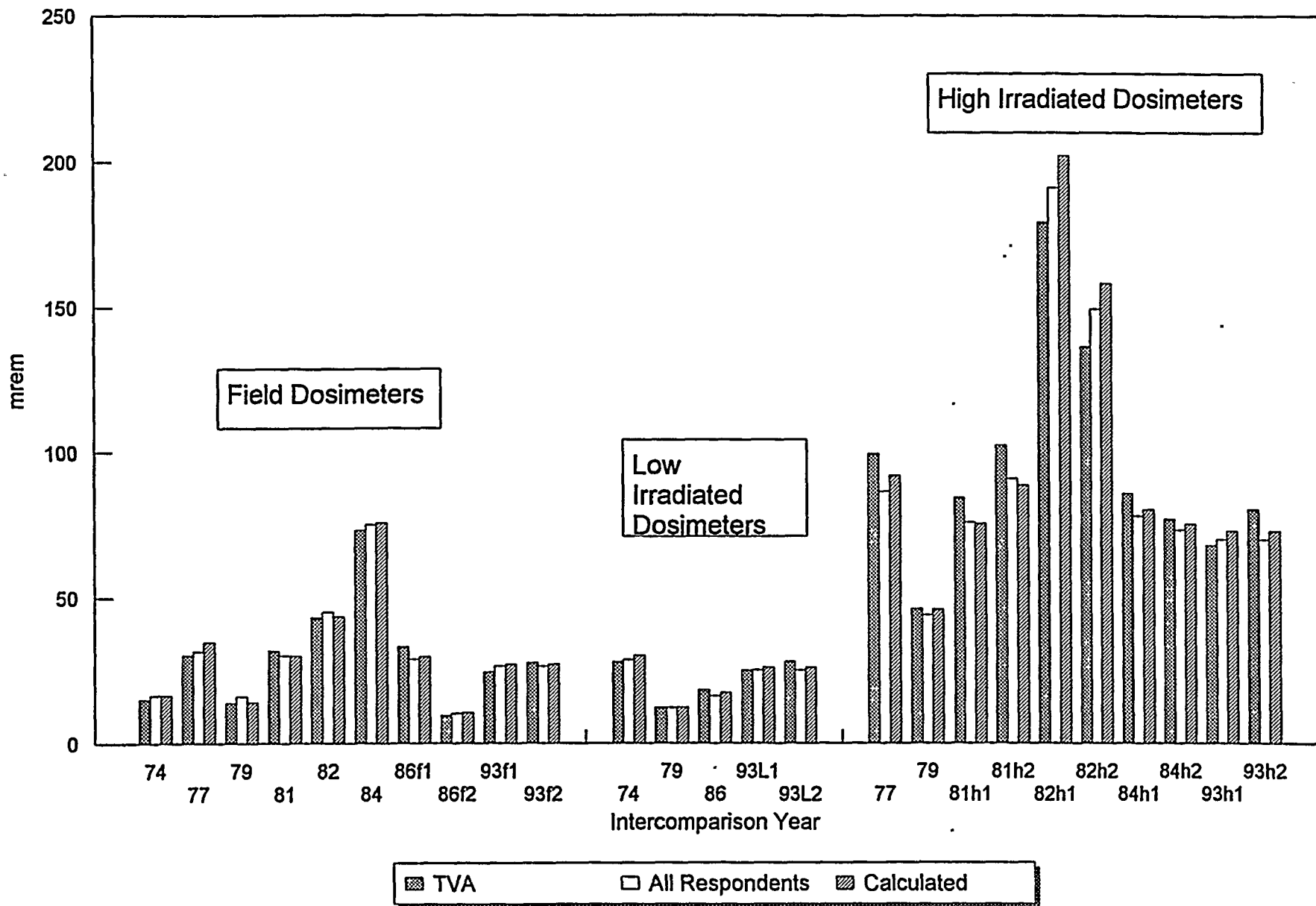
FIGURE 2

**ENVIRONMENTAL EXPOSURE PATHWAYS OF MAN  
DUE TO RELEASES OF RADIOACTIVE MATERIAL  
TO THE ATMOSPHERE AND LAKE.**





# Intercomparison of Environmental Dosimeters





APPENDIX A

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM AND  
SAMPLING LOCATIONS





Table A-1

**BROWNS FERRY NUCLEAR PLANT  
Environmental Radiological Monitoring Program<sup>a</sup>**

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
AIRBORNE Particulates	Six samples from locations (in different sectors) at or near boundary site (LM-1, LM-2, LM-3, LM-4, LM-6, and LM-7)	Continuous sampler operation with sample collection as required by dust loading but at least once per 7 days	Particulate sampler. 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.
	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)		
Radioiodine	Same locations as air particulates	Continuous sampler operation with charcoal canister collection at least once per 7 days	I-131 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<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
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		
<b>WATERBORNE</b>			
Surface Water	One sample upstream (TRM 305.0) One sample immediately downstream of discharge (TRM 293.5) One sample downstream from plant (TRM 285.2)	Collected by automatic sequential-type sampler with composite sample taken at least once per 7 days <sup>c</sup>	Gross beta and gamma scan on 4-week composite. Composite for Sr-89, Sr-90, and tritium at least once per 92 days



Table A-1

**BROWNS FERRY NUCLEAR PLANT**  
**Environmental Radiological Monitoring Program<sup>a</sup>**

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
Drinking Water	One sample at the first potable surface water supply downstream from the plant (TRM 282.6)	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days <sup>c</sup>	Gross beta and gamma scan on 4-week composite. Composite for Sr-89, Sr-90, and tritium at least once per 92 days
	Two additional samples of potable surface water downstream from the plant (TRM 274.9 and TRM 259.5)	Grab sample taken at least once per 31 days	Gross beta and gamma scan on each sample. Composite for Sr-89, Sr-90, and tritium at least once per 92 days
	One sample at a control location (TRM 306)		
	One additional sample at a control location <sup>d</sup> (TRM 305)	Collected by automatic sequential-type sampler with composite sample taken at least once per 7 days <sup>c</sup>	
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 Sr-89, Sr-90, and tritium 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 Sr-89, Sr-90, and tritium at least once per 92 days



Table A-1

BROWNS FERRY NUCLEAR PLANT  
Environmental Radiological Monitoring Program<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
<b>AQUATIC</b>			
Sediment	Two samples upstream from discharge point (TRM 297.0 and 307.52)	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)	At least once per 184 days	Gamma scan, Sr-89 and Sr-90 analyses
	Two additional samples downstream from the plant (TRM 288.78 and 277.98)		
<b>INGESTION</b>			
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<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
Fish	Three samples representing commercial and game species in Guntersville Reservoir above the plant  Three samples representing commercial and game species in Wheeler Reservoir near the plant.	At least once per 184 days	Gamma scan at least once per 184 days on edible portions
Clams	One sample downstream from the discharge  One sample upstream from the plant  (No permanent stations established; depends on location of clams)	At least once per 184 days	Gamma scan on flesh only



Table A-1

BROWNS FERRY NUCLEAR PLANT  
Environmental Radiological Monitoring Program<sup>a</sup>

<u>Exposure Pathway and/or Sample</u>	<u>Number of Samples and Locations<sup>b</sup></u>	<u>Sampling and Collection Frequency</u>	<u>Type and Frequency of Analysis</u>
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 1995.
- 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 <sup>a</sup>	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected <sup>b</sup>
1	PM-1	NW	13.8	I	AP,CF,R,S
2	PM-2	NE	10.9	I	AP,CF,R,S
3	PM-3	SSE	8.2	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
18	Farm GL	WSW	35.0	C	M,V <sup>f</sup>
19	Farm R	SW	12.5	C	M,V <sup>f</sup>
22	Well No. 6	NW	0.02	I	W
23	TRM <sup>c</sup> 282.6	-	11.4 <sup>d</sup>	I	PW
24	TRM 306.0	-	12.0 <sup>d</sup>	C	PW
25	TRM 259.6	W	34.4 <sup>d</sup>	I	PW
26	TRM 274.9	-	19.1 <sup>d</sup>	I	PW
27	TRM 285.2	-	8.8 <sup>d</sup>	I	SW
28	TRM 293.5	-	0.5 <sup>d</sup>	I	SW
29	TRM 305.0	-	11.0 <sup>d</sup>	C <sup>e</sup>	SW
30	TRM 307.52	-	13.52 <sup>d</sup>	C	SD
31	TRM 293.7	-	0.3 <sup>d</sup>	I	SD
32	TRM 288.78	-	5.22 <sup>d</sup>	I	SD
33	TRM 277.98	-	16.02 <sup>d</sup>	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
	Wheeler 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

F = Fish

R = Rainwater

SW = Surface water

CF = Charcoal filter (Iodine)

M = Milk

S = Soil

V = Vegetation

CL = Clams

PW = Public drinking water

SD = Sediment

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 G1 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

<u>Map Location Number<sup>a</sup></u>	<u>Station</u>	<u>Sector</u>	<u>Approximate Distance (miles)</u>	<u>Onsite (On)<sup>b</sup> or Offsite (Off)</u>
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

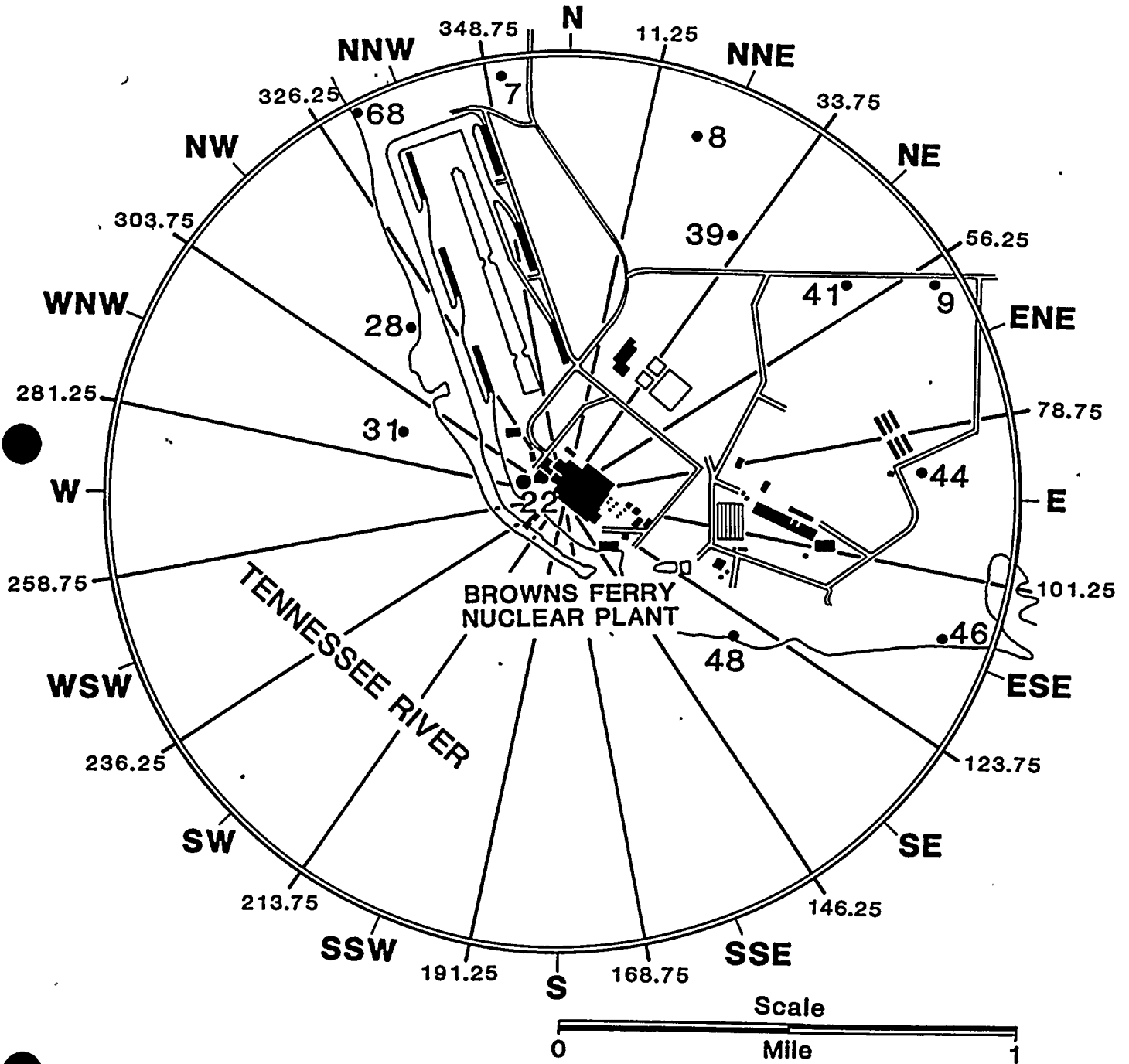




Figure A-2

# Environmental Radiological Sampling Locations

## From 1 to 5 Miles From the Plant

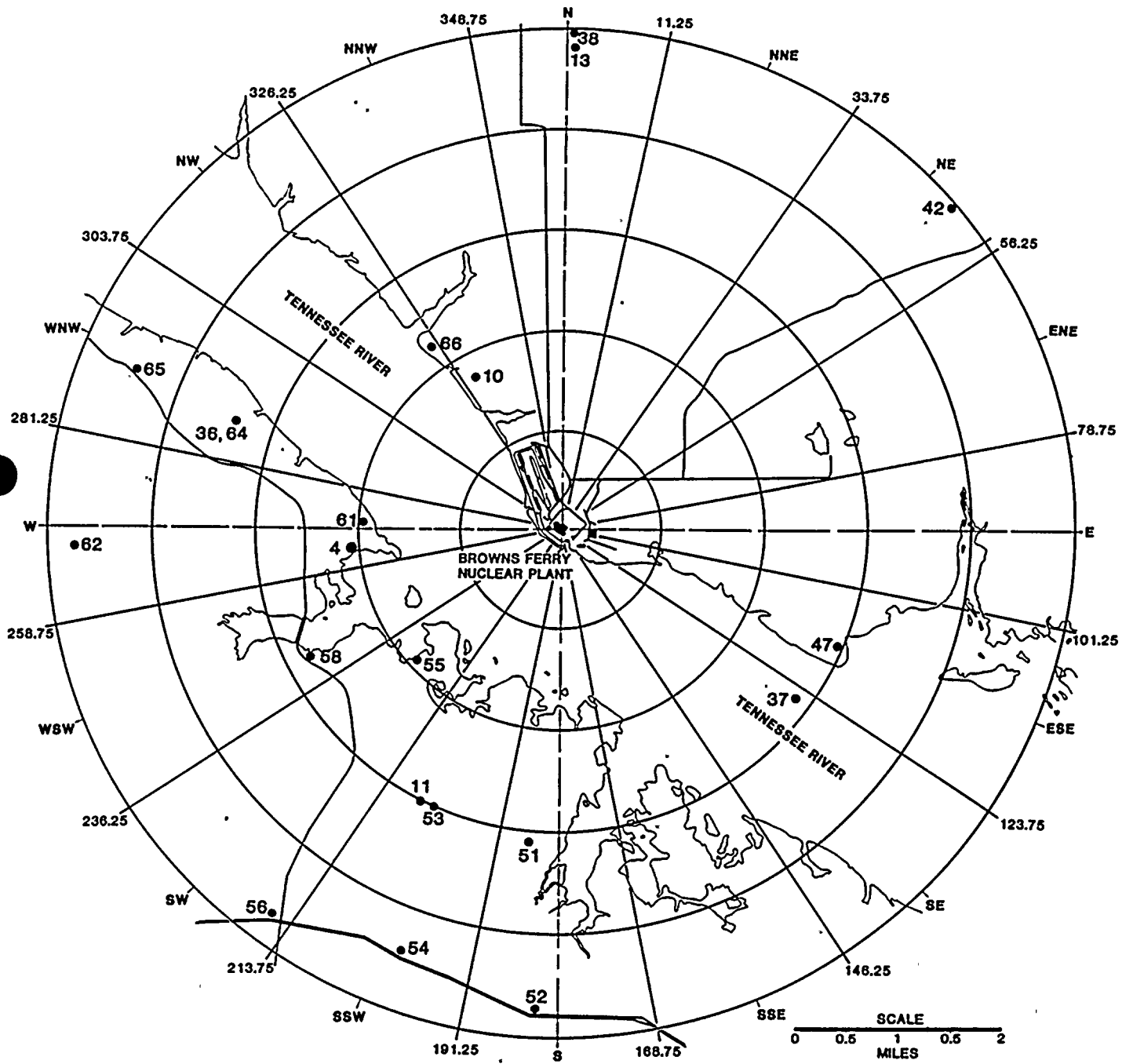
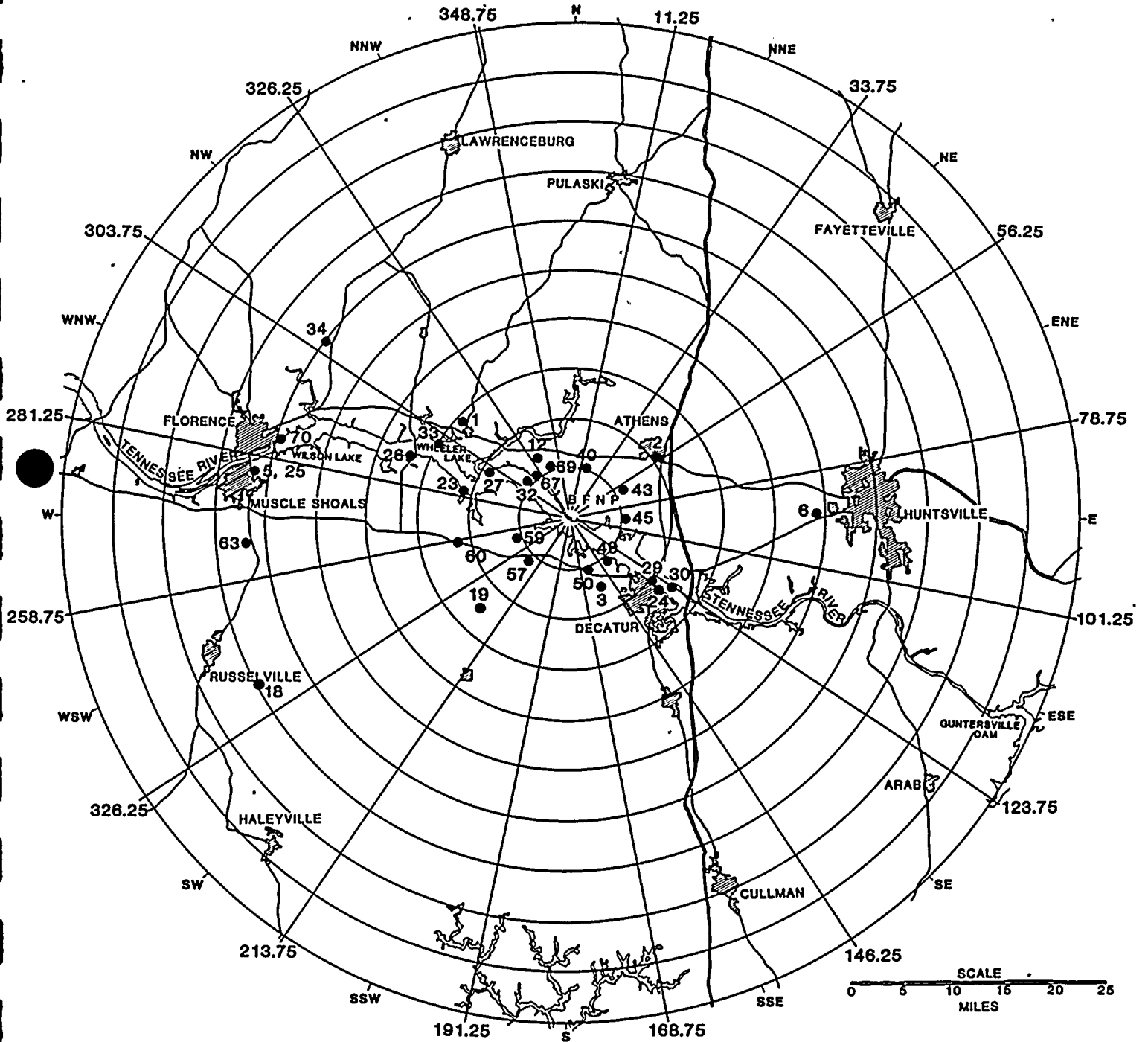




Figure A-3

# Environmental Radiological Sampling Locations

## Greater Than 5 Miles From the Plant





APPENDIX B

1995 PROGRAM MODIFICATIONS





## APPENDIX B

### Environmental Radiological Monitoring Program Modifications

During 1995, only one modification was made in the environmental monitoring program. The control dairy farm located 35 miles WSW from the plant discontinued dairy operations and was replaced in the monitoring program by a farm 12.5 miles SW from the plant.

The following table details the changes made in the REMP in 1995.



Table B-1

Environmental Radiological Monitoring Program Modifications

<u>Date</u>	<u>Station</u>	<u>Location</u>	<u>Remarks</u>
4/24/95	Farm G1	35 miles WSW	Milk sampling was discontinued from this farm in April 1995 when it went out of the dairy business. Vegetation sampling was also discontinued at this farm.
5/8/95	Farm R	12.5 miles SW	The farm was added to the program to replace Farm G1. Milk and vegetation sampling was initiated at this farm to provide control samples for these media.



APPENDIX C

PROGRAM DEVIATIONS



## Appendix C

### Program Deviations

During 1995 a small number of samples were not collected. Those occurrences resulted in deviations from the scheduled program but not from the minimum program required in the Offsite Dose Calculation Manual. Table C-1 lists these occurrences. A general description follows.

Two air particulate and charcoal filter sample sets were missed as a result of a malfunction in the sampling equipment. The motors were replaced and subsequent samples collected as scheduled.

One public water sample was not collected as a result of a short in the electrical system.

All other samples were collected as scheduled.





Table C-1

Environmental Radiological Monitoring Program Deviations

<u>Date</u>	<u>Station</u>	<u>Location</u>	<u>Remarks</u>
1/9/95	PM-3 BF	8.2 miles SSE	Air particulate filter and charcoal filter samples were not collected as a result of the malfunction of the sampling motor. The motor was replaced and subsequent samples collected.
12/11/95	PM-1 BF	13.8 miles NW	Air particulate filter and charcoal filter samples were not collected as a result of the malfunction of the sampling motor. The motor was replaced and subsequent samples collected.



APPENDIX D

ANALYTICAL PROCEDURES



## APPENDIX D

### Analytical Procedures

Analyses of environmental samples are performed by the radioanalytical laboratory located at the Western Area Radiological Laboratory facility in Muscle Shoals. 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.

The analysis of transuranic isotopes in soil and air filters is performed by leaching the sample with acid and then separating the isotopes of interest from the acid leach by an ion exchange technique. The ion exchange technique separates the samples into two fractions, one containing plutonium and the other containing both americium and curium. The Pu fraction and the Am/Cm fractions are electroplated onto separate stainless steel discs, and counted for 1200 minutes on an alpha spectrometer employing a surface barrier detector.





APPENDIX E

NOMINAL LOWER LIMITS OF DETECTION (LLD)



## Appendix E

### Nominal Lower Limits of Detection

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

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

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



A number of factors influence the LLD, including sample size, count time, 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

	<u>Air Filters</u> <u>(pCi/m<sup>3</sup>)</u>	<u>Water</u> <u>(pCi/L)</u>	<u>Milk</u> <u>(pCi/L)</u>	<u>Fish</u> <u>(pCi/g dry)</u>	<u>Wet Vegetation</u> <u>(pCi/Kg wet)</u>	<u>Sediment</u> <u>and Soil</u> <u>(pCi/g dry)</u>
Gross Beta	0.002	1.9				
Tritium		300				
Iodine-131		0.4	0.4		6.0	
Strontium-89	0.0011	5.0	2.0	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 <u>pCi/m3</u>	Water and Milk <u>pCi/L</u>	Vegetation and Grain <u>pCi/g, dry</u>	Wet Vegetation <u>pCi/kg, wet</u>	Soil and Sediment <u>pCi/g, dry</u>	Fish <u>pCi/g, dry</u>	Foods, Clam Flesh <u>pCi/g, dry</u>	Tomatoes Potatoes, etc. <u>pCi/kg, wet</u>	Meat and Poultry <u>pCi/kg, wet</u>
Ce-141	.005	10	.07	28	.02	.07	.15	10	25
Ce-144	.01	33	.25	100	.06	.25	.50	33	50
Cr-51	.02	45	.45	180	.10	.45	.94	45	90
I-131	.005	10	.09	36	.02	.09	.18	10	20
Ru-103	.005	5	.05	20	.01	.05	.11	5	15
Ru-106	.02	40	.48	190	.09	.48	.95	40	95
Cs-134	.005	5	.07	28	.01	.07	.11	5	15
Cs-137	.005	5	.06	24	.01	.06	.10	5	15
Zr-95	.005	10	.11	44	.02	.11	.19	10	25
Nb-95	.005	5	.06	24	.01	.06	.11	5	15
Co-58	.005	5	.05	20	.01	.05	.10	5	15
Mn-54	.005	5	.05	20	.01	.05	.10	5	15
Zn-65	.005	10	.11	44	.01	.11	.21	10	25
Co-60	.005	5	.07	28	.01	.07	.11	5	15
K-40	.04	150	1.00	400	.20	1.00	2.00	150	300
Ba-140	.01	25	.23	92	.05	.23	.47	25	50
La-140	.005	8	.11	44	.02	.11	.17	8	20
Fe-59	.005	5	.10	40	.01	.10	.13	5	15
Be-7	.02	45	.50	200	.10	.50	.90	45	100
Pb-212	.005	20	.10	40	.02	.10	.25	20	40
Pb-214	.005	20	.20	80	.02	.20	.25	20	40
Bi-214	.005	20	.12	48	.04	.12	.25	20	40
Bi-212		53	.40	40	.25	.40		53	
Tl-208	.001	7	.03	26	.02	.03	.35	7	
Ra-224					.30				
Ra-226					.05				
Ac-228	.014	25	.10	80	.10	.10	1.00	22	22
Pa-234m		700			3.00				



Table E-2

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

<u>Analysis</u>	<u>Water pCi/L</u>	<u>Airborne Particulate or Gases pCi/m<sup>3</sup></u>	<u>Fish pCi/Kg.wet</u>	<u>Milk pCi/L</u>	<u>Food Products pci/kg.wet</u>	<u>Sediment pCi/Kg.dry</u>
gross beta	4	$1 \times 10^{-2}$	N.A.	N.A.	N.A.	N.A.
H-3	2000	N.A.	N.A.	N.A.	N.A.	N.A.
Mn-54	15	N.A.	130	N.A.	N.A.	N.A.
Fe-59	30	N.A.	260	N.A.	N.A.	N.A.
Co-58,60	15	N.A.	130	N.A.	N.A.	N.A.
Zn-65	30	N.A.	260	N.A.	N.A.	N.A.
Zr-95	30	N.A.	N.A.	N.A.	N.A.	N.A.
Nb-95	15	N.A.	N.A.	N.A.	N.A.	N.A.
I-131	1 <sup>a</sup>	$7 \times 10^{-2}$	N.A.	1	60	N.A.
Cs-134	15	$5 \times 10^{-2}$	130	15	60	150
Cs-137	18	$6 \times 10^{-2}$	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. LLD for analysis of drinking water and surface water samples shall be performed by gamma spectroscopy at approximately 15 pCi/liter. If levels greater than 15 pCi/liter are identified in surface water samples downstream from the plant, or in the event of an unanticipated release of I-131, drinking water samples will be analyzed at an LLD of 1.0 pCi/liter for I-131.



APPENDIX F

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM



## Appendix F

### Quality Assurance/Quality Control Program

A thorough quality assurance program is employed by the laboratory to ensure that the environmental monitoring data are reliable. This program includes the use of written, approved procedures in performing the work, a nonconformance and corrective action tracking system, systematic internal audits, a complete training and retraining system, 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 special 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 are examined very closely by laboratory supervisory and quality control personnel. They 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 1995, all EPA cross-check sample concentrations measured by TVA's laboratory were within  $\pm 3$ -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. Air Filter (pCi/Filter)

Date	<u>Gross Alpha</u>		<u>Gross Beta</u>		<u>Strontium-90</u>		<u>Cesium-137</u>	
	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>
8/95	25±11	29	87±17	90	30±9	29	25±9	23

## B. Radiochemical Analysis of Water (pCi/L)

Date	<u>Gross Beta</u>		<u>Strontium-89</u>		<u>Strontium-90</u>		<u>Tritium</u>		<u>Iodine-131</u>		<u>Plutonium-239</u>	
	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>	<u>EPA Value</u> <u>(±3 sigma)</u>	<u>TVA</u> <u>Avg.</u>
1/95	5±9	7	20±9	21	15±9	15						
2/95									100±17	93		
3/95							7435± 1289	7172			11± 2	10
4/95 <sup>a</sup>			20±9	20	15±9	15						
7/95	19±9	22	20±9	21	8±9	9						
8/95							4872± 844	4747				
10/95	25±9	28							148± 26	148		
10/95 <sup>a</sup>			20±9	22	10±9	8						





Table F-1

## RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM (Continued)

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

Date	<u>Barium-133</u>		<u>Cobalt-60</u>		<u>Zinc-65</u>		<u>Cesium-134</u>		<u>Cesium-137</u>	
	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.
4/95 <sup>a</sup>			29 $\pm$ 9	29			20 $\pm$ 9	19	11 $\pm$ 9	12
6/95	79 $\pm$ 14	76	40 $\pm$ 9	40	76 $\pm$ 14	71	50 $\pm$ 9	44	35 $\pm$ 9	34
10/95 <sup>a</sup>			49 $\pm$ 9	50			40 $\pm$ 9	38	30 $\pm$ 9	30
11/95	99 $\pm$ 17	100	60 $\pm$ 9	60	125 $\pm$ 23	129	40 $\pm$ 9	37	49 $\pm$ 9	50

## D. Milk (pCi/L)

Date	<u>Strontium-89</u>		<u>Strontium-90</u>		<u>Iodine-131</u>		<u>Cesium-137</u>		<u>Potassium-40<sup>b</sup></u>	
	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.	EPA Value ( $\pm 3$ sigma)	TVA Avg.
9/95	20 $\pm$ 9	19	15 $\pm$ 9	16	99 $\pm$ 17	100	50 $\pm$ 9	50	1654 $\pm$ 144	1675

a. Performance Evaluation Intercomparison Study.

b. Units are milligrams of total potassium per liter rather than picocuries of K-40 per liter.



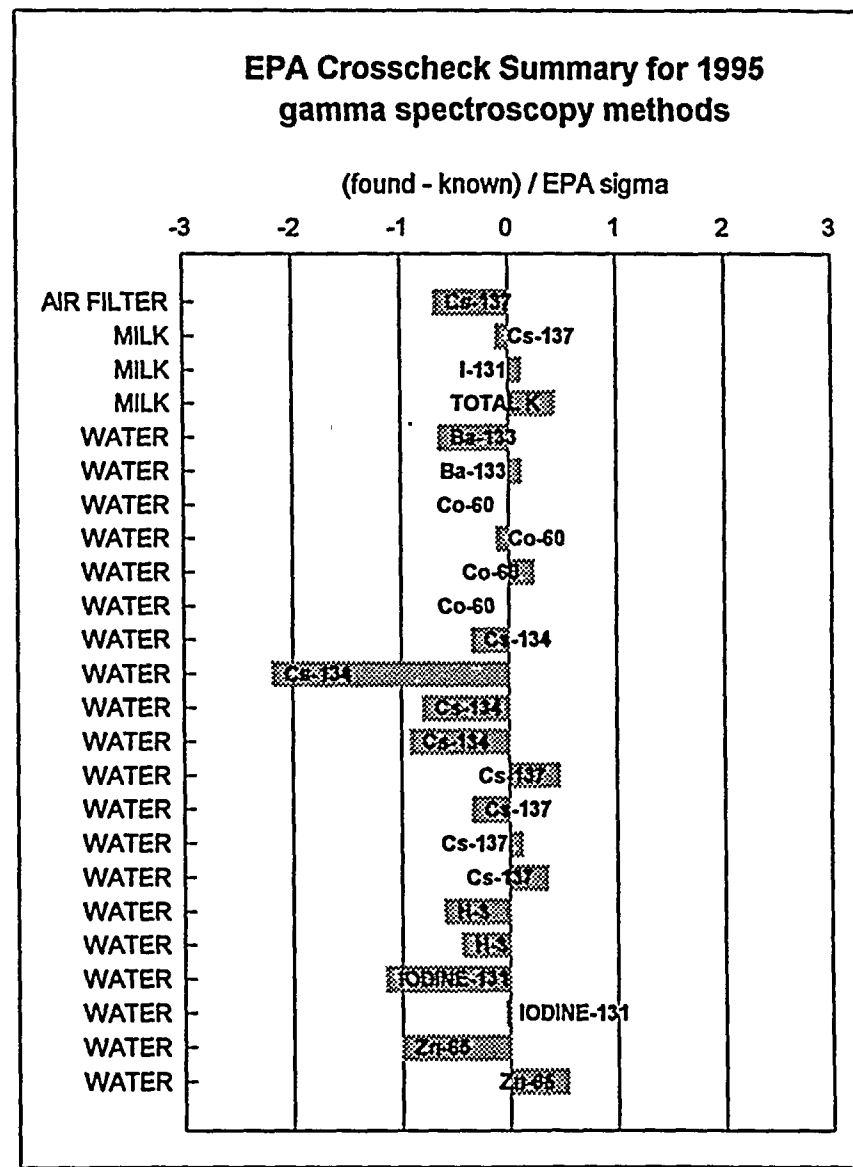
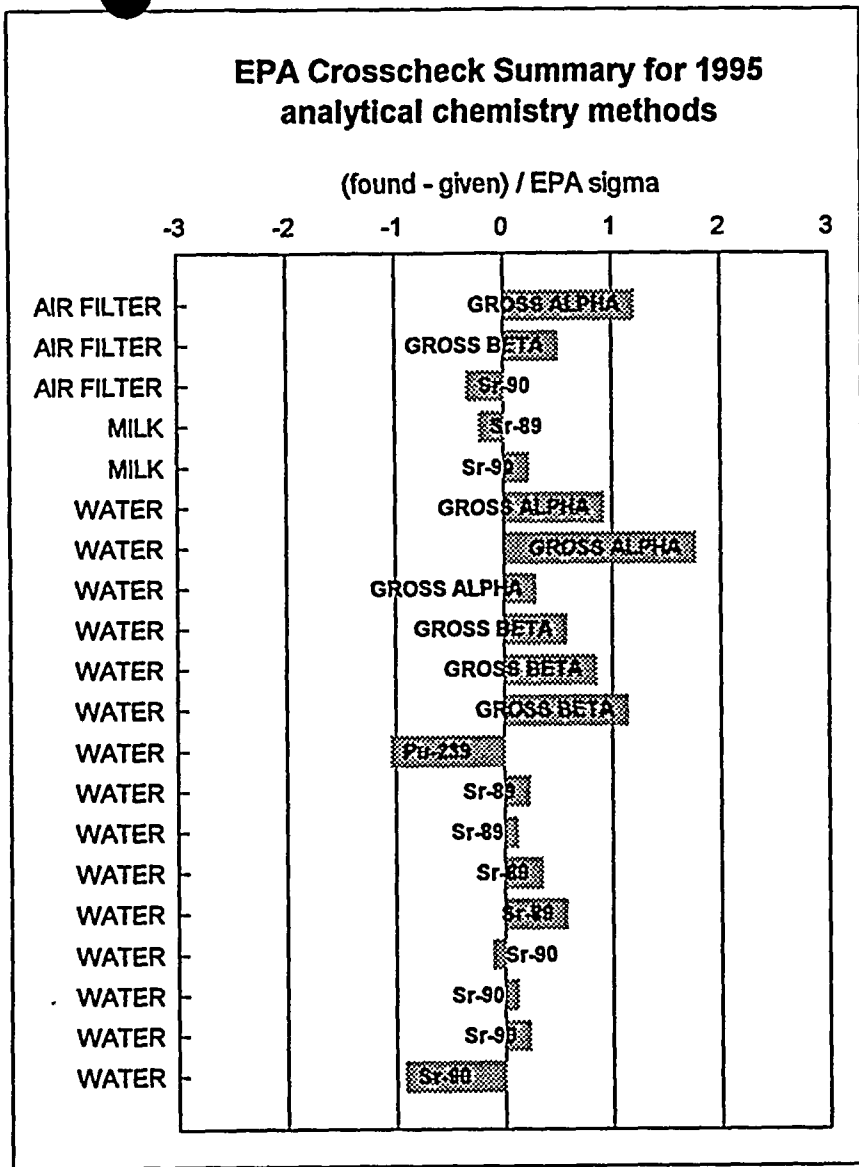


FIGURE F-1

Laboratory objective:  $abs[(found - given)/EPA\ sigma] < 3$



APPENDIX G

LAND USE SURVEY



## 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 same locations as in 1994, with the resulting values similar to those calculated for 1994. 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 1995

For milk ingestion, projected annual doses were almost identical to those calculated for 1994. Only two locations with milk producing animals were identified. Samples are being taken from both of these farms.

Tables G-1, G-2, and G-3 show the comparative calculated doses for 1994 and 1995.



Table G-1

## BROWNS FERRY NUCLEAR PLANT

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

Sector	1994 Survey		1995 Survey	
	Approximate Distance (Miles)	Annual Dose	Approximate Distance (Miles)	Annual Dose
N	1.23	0.22	1.23	0.33
NNE	1.61	0.08	1.61	0.10
NE	2.56	0.10	2.34	0.10
ENE	1.42	0.10	1.42	0.14
E	2.56	0.08	2.37	0.09
ESE	1.33	0.07	1.33	0.11
SE	5.03	0.06	5.03	0.06
SSE	4.17	0.06	4.26	0.07
S	2.82	0.10	2.82	0.12
SSW	2.60	0.12	2.60	0.14
SW	3.15	0.07	3.15	0.08
WSW	2.70	0.05	2.56	0.06
W	1.63	0.11	1.52	0.17
WNW	2.75	0.09	2.84	0.09
NW	2.27	0.22	2.27	0.23
NNW	0.95	0.42	0.95	0.57



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

<u>Sector</u>	<u>1994 Survey</u>		<u>1995 Survey</u>		<u>Number of Gardens Within 3 Miles (1995)</u>
	<u>Approximate Distance (Miles)</u>	<u>Annual Dose</u>	<u>Approximate Distance (Miles)</u>	<u>Annual Dose</u>	
N	1.23	8.22	1.23	8.21	2
NNE	3.41	1.01	2.56	1.54	1
NE	2.75	1.23	2.37	1.49	1
ENE	1.70	2.44	1.70	2.44	2
E	2.56	1.89	2.27	2.23	2
ESE	2.46	2.19	2.46	2.19	1
SE	a	—	a	—	0
SSE	4.17	0.97	4.36	0.97	0
S	2.82	2.25	2.75	2.33	1
SSW	2.84	2.35	2.56	2.74	2
SW	3.41	0.69	3.88	0.68	0
WSW	2.70	0.60	2.70	0.60	1
W	1.70	1.26	1.61	1.34	1
WNW	a	—	a	—	0
NW	a	—	a	—	0
NNW	1.04	10.60	1.04	10.60	4

a. Garden not identified in this sector.



Table G-3

BROWNS FERRY NUCLEAR PLANT

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

<u>Location</u>	<u>Sector</u>	<u>Approximate Distance (Miles)</u>	<u>Annual Dose</u>		<u>X/Q s/m<sup>3</sup></u>
			<u>1994</u>	<u>1995</u>	
Farm Bn <sup>a</sup>	N	4.9	0.008	0.008	1.28 E -8
Farm B <sup>a</sup>	NNW	6.8	0.019	0.016	1.32 E -8

a. Milk being sampled at these locations.





APPENDIX H

DATA TABLES



Table H-1

DIRECT RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from  
 Browns Ferry Nuclear Plant for Each Quarter - 1995  
 mR/Quarter<sup>a</sup>

<u>Distance Miles</u>	<u>Average External Gamma Radiation Levels<sup>b</sup></u>			
	<u>1st Quarter</u>	<u>2nd Quarter</u>	<u>3rd Quarter</u>	<u>4th Quarter</u>
0-1	17.7 ± 0.9	14.7 ± 1.0	16.5 ± 1.1	16.0 ± 0.7
1-2	15.2 ± 0.6	13.4 ± 1.6	14.2 ± 0.1	14.4 ± 1.0
2-4	15.0 ± 1.3	12.3 ± 1.4	13.9 ± 1.5	13.1 ± 1.4
4-6	14.8 ± 1.0	12.1 ± 1.0	14.0 ± 1.1	13.3 ± 1.0
> 6	14.8 ± 0.8	12.3 ± 0.9	13.7 ± 1.2	13.3 ± 0.9
Average, 0-2 miles (onsite)	17.2 ± 1.3	14.4 ± 1.3	16.0 ± 1.3	15.6 ± 1.1
Average, > 2 miles (offsite)	14.9 ± 1.0	12.2 ± 1.1	13.9 ± 1.2	13.3 ± 1.1

a. Data normalized to one quarter (2190 hours).

b. Averages 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	NRC Station No.	Direction, Degrees	Approx. Distance, Miles	Environmental Radiation Levels mrem/Quarter				Annual Exposure, mrem/Year
					1st Quarter January - March 1995	2nd Quarter April - June 1995	3rd Quarter July - Sept. 1995	4th Quarter October - Dec. 1995	
7	N-1		348	1.0	19.1	16.5	18.3	12.6	66.5
38	N-2		1	5.0	13.8	11.6	12.6	11.8	49.8
8	NNE-1		12	0.9	17.0	14.2	16.3	14.8	62.3
39	NNE-2		31	0.7	17.7	14.5	17.6	16.0	65.8
40	NNE-3		19	5.2	13.7	11.3	13.4	12.4	50.8
41	NE-1		51	0.8	17.9	14.8	16.9	15.9	65.5
42	NE-2		49	5.0	16.6	13.6	15.9	14.7	60.8
2	NE-3		56	10.9	15.3	12.9	14.9	13.6	56.7
9	ENE-1	22	61	0.9	17.7	15.0	16.2	16.7	65.6
43	ENE-2		62	6.2	15.7	13.1	15.9	13.5	58.2
44	E-1		85	0.8	17.9	15.5	16.9	16.5	66.8
45	E-2		91	5.2	15.5	12.8	14.9	13.7	56.9
6	E-3		90	24.2	15.2	12.9	15.4	13.8	57.3
46	ESE-1		110	0.9	**	13.1	14.9	**	56.0
47	ESE-2	21	112	3.0	16.4	14.0	15.7	14.9	61.0
48	SE-1		130	0.5	16.0	13.4	15.0	15.1	59.5
49	SE-2	2	135	5.4	14.1	10.6	14.2	12.5	51.4
50	SSE-1		163	5.1	14.5	11.9	15.0	13.7	55.1
3	SSE-2	37	165	7.5	15.1	12.2	14.7	14.1	56.1
51	S-1		185	3.1	14.8	12.3	15.1	13.9	56.1
52	S-2		182	4.8	13.0	10.1	12.6	12.0	47.7

\* Locations with TVA and NRC stations co-located.

\*\* Sum of available quarterly data normalized to 1 year for the annual exposure.



Table H - 2

## DIRECT RADIATION LEVELS

## Individual Stations

Map Location Number	TLD Station Number	NRC Station No.	Direction, Degrees	Approx. Distance, Miles	Environmental Radiation Levels mrem/Quarter				Annual Exposure, mrem/Year
					1st Quarter January - March 1995	2nd Quarter April - June 1995	3rd Quarter July - Sept. 1995	4th Quarter October - Dec. 1995	
53	SSW-1	15	203	3.0	13.5	10.3	11.9	11.5	47.2
54	SSW-2		199	4.4	14.5	11.8	14.4	13.0	53.7
55	SW-1	13	228	1.9	14.6	11.8	14.3	13.8	54.5
56	SW-2		219	4.7	15.0	12.2	13.5	13.3	54.0
57	SW-3		224	6.0	13.4	11.2	13.0	12.2	49.8
58	WSW-1	12	244	2.7	13.2	10.7	12.1	11.2	47.2
59	WSW-2		251	5.1	15.6	12.8	14.5	12.8	55.7
60	WSW-3		257	10.5	14.0	10.7	12.0	12.0	48.7
61	W-1		275	1.9	15.8	12.8	14.1	13.6	56.3
62	W-2	7	268	4.7	14.2	11.6	12.2	**	50.7
5	W-3		275	31.3	14.2	11.5	12.4	11.9	50.0
63	W-4		265	32.1	15.9	13.5	14.4	14.8	58.6
64	WNW-1		291	3.3	15.6	12.7	13.6	12.7	54.6
65	WNW-2	10	293	4.4	15.0	12.3	13.1	14.1	54.5
66	NW-1		326	2.2	16.7	13.9	15.3	14.6	60.5
67	NW-2		321	5.3	16.0	13.8	15.3	14.5	59.6
1	NW-3		310	13.8	14.6	12.6	12.9	13.5	53.6
68	NNW-1		331	1.0	18.2	15.4	15.9	16.6	66.1
10	NNW-2		331	1.7	**	15.6	**	15.8	62.8
69	NNW-3		339	5.2	16.1	12.5	14.0	14.6	57.2

\* Locations with TVA and NRC stations co-located.

\*\* Sum of available quarterly data normalized to 1 year for the annual exposure.





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: 1995

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA	104	9.00E-04	1.09E-03( 15/ 52) LM-1 BF 9.01E-04- 1.41E-03 1.0 MILES N	1.09E-03( 15/ 52) 9.01E-04- 1.41E-03	1.11E-03( 12/ 52) 9.13E-04- 1.57E-03	
GROSS BETA	570	2.00E-03	2.13E-02( 466/ 466) LM3 BF NORTHEAST 9.62E-03- 4.30E-02 1.0 MILE ENE	2.20E-02( 52/ 52) 1.18E-02- 4.16E-02	2.18E-02( 104/ 104) 1.29E-02- 4.40E-02	
GAMMA SCAN (GELI)	143					
BE-7		2.00E-02	1.06E-01( 117/ 117) PH-2 BF ATHENS AL 7.18E-02- 1.46E-01 10.9 MILES NE	1.10E-01( 13/ 13) 9.25E-02- 1.46E-01	1.06E-01( 26/ 26) 7.86E-02- 1.41E-01	
BI-214		5.00E-03	9.09E-03( 22/ 117) LM-7BF LAKEVIEW 5.00E-03- 1.91E-02 2.1 MILES WEST	1.22E-02( 3/ 13) 5.20E-03- 1.91E-02	1.21E-02( 3/ 26) 7.50E-03- 1.72E-02	
PB-214		5.00E-03	1.03E-02( 20/ 117) LM2 BF NORTH 5.40E-03- 1.80E-02 0.9 MILE WNE	1.26E-02( 2/ 13) 9.40E-03- 1.59E-02	1.20E-02( 4/ 26) 5.90E-03- 1.96E-02	
SR 89	8	1.10E-03	4 VALUES < LLD		4 VALUES < LLD	
SR 90	8	4.00E-04	4 VALUES < LLD		4 VALUES < LLD	
AM 241	8	2.50E-05	4 VALUES < LLD		4 VALUES < LLD	
CH 242	8	2.50E-05	4 VALUES < LLD		4 VALUES < LLD	
CH 244	8	2.50E-05	4 VALUES < LLD		4 VALUES < LLD	
PU 239,240	8	2.50E-05	4 VALUES < LLD		4 VALUES < LLD	
PU 238	8	2.50E-05	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).

TABLE H-3



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: 1995

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)						
	570					
BI-214	5.00E-02	8.81E-02( 2/ 466) 5.13E-02- 1.25E-01	LM-7BF LAKEVIEW 2.1 MILES WEST	1.25E-01( 1/ 52) 1.25E-01- 1.25E-01	104 VALUES < LLD	
K-40	3.00E-01	3.36E-01( 17/ 466) 3.01E-01- 3.95E-01	LM-7BF LAKEVIEW 2.1 MILES WEST	3.70E-01( 2/ 52) 3.45E-01- 3.95E-01	3.57E-01( 5/ 104) 3.22E-01- 4.17E-01	
PB-214	7.00E-02	7.44E-02( 2/ 466) 7.00E-02- 7.88E-02	PH-1 ROGERSVILLE AL 13.8 MILES NW	7.88E-02( 1/ 51) 7.88E-02- 7.88E-02	104 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 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: 1995

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
IOOINE-131	104	4.00E-01	52 VALUES < LLD		52 VALUES < LLD	
GAMMA SCAN (GELI)	104					
BI-214	2.00E+01	2.50E+01( 1/ 52)	BROOKS FARM 6.8 MILE	2.50E+01( 1/ 26)	2.53E+01( 3/ 52)	
K-40	1.00E+02	2.50E+01- 2.50E+01	S NNW	2.50E+01- 2.50E+01	2.52E+01- 2.53E+01	
		1.29E+03( 52/ 52)	SMITH/BENNETT FARM	1.31E+03( 26/ 26)	1.37E+03( 52/ 52)	
		1.02E+03- 1.46E+03	5.0 MILES N	1.05E+03- 1.46E+03	6.96E+02- 4.80E+03	
PB-214	2.00E+01	52 VALUES < LLD	SMITH/BENNETT FARM	26 VALUES < LLD	2.18E+01( 3/ 52)	
			5.0 MILES N		2.13E+01- 2.26E+01	
SR 89	52	2.00E+00	2.73E+00( 1/ 26)	BROOKS FARM 6.8 MILE	2.73E+00( 1/ 13)	2.09E+00( 1/ 26)
		2.73E+00- 2.73E+00	S NNW	2.73E+00- 2.73E+00	2.09E+00- 2.09E+00	
SR 90	52	2.00E+00	3.28E+00( 2/ 26)	SMITH/BENNETT FARM	3.28E+00( 2/ 13)	26 VALUES < LLD
		2.29E+00- 4.27E+00	5.0 MILES N	2.29E+00- 4.27E+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: 1995

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131						
	26					
	6.00E+00	13 VALUES < LLD			13 VALUES < LLD	
GAMMA SCAN (GELI)						
	26					
BE-7	2.00E+02	1.06E+03( 12/ 13) 2.13E+02- 2.19E+03	TERRY FARM 3.2 MILES WNW	1.06E+03( 12/ 13) 2.13E+02- 2.19E+03	1.03E+03( 13/ 13) 2.14E+02- 2.42E+03	
BI-214	5.50E+01	4.32E+02( 1/ 13) 4.32E+02- 4.32E+02	TERRY FARM 3.2 MILES WNW	4.32E+02( 1/ 13) 4.32E+02- 4.32E+02	8.91E+01( 2/ 13) 5.87E+01- 1.20E+02	
K-40	4.00E+02	5.56E+03( 13/ 13) 3.53E+03- 8.60E+03	TERRY FARM 3.2 MILES WNW	5.56E+03( 13/ 13) 3.53E+03- 8.60E+03	5.79E+03( 13/ 13) 3.78E+03- 8.16E+03	
PB-212	4.00E+01	7.44E+01( 1/ 13) 7.44E+01- 7.44E+01	TERRY FARM 3.2 MILES WNW	7.44E+01( 1/ 13) 7.44E+01- 7.44E+01	4.25E+01( 1/ 13) 4.25E+01- 4.25E+01	
PB-214	8.00E+01	2.48E+02( 1/ 13) 2.48E+02- 2.48E+02	TERRY FARM 3.2 MILES WNW	2.48E+02( 1/ 13) 2.48E+02- 2.48E+02	1.09E+02( 1/ 13) 1.09E+02- 1.09E+02	
SR 89						
	8					
	3.10E+01	4 VALUES < LLD			4 VALUES < LLD	
SR 90						
	8					
	1.20E+01	2.81E+01( 1/ 4) 2.81E+01- 2.81E+01	TERRY FARM 3.2 MILES WNW	2.81E+01( 1/ 4) 2.81E+01- 2.81E+01	3.51E+01( 1/ 4) 3.51E+01- 3.51E+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/GM - 0.037 BQ/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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 MEAN (F) NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA	2	NOT ESTAB	3.53E+00( 1/ 1) LM1 BF NORTHWEST 3.53E+00- 3.53E+00 1.0 MILE N	3.53E+00( 1/ 1) 3.53E+00- 3.53E+00	2.13E+00( 1/ 1) 2.13E+00- 2.13E+00	
GAMMA SCAN (GELI)	11					
AC-228	2.50E-01	1.16E+00( 9/ 9) 5.19E-01- 1.42E+00	PH-3 BF DECATUR AL 8.2 MILES SSE	1.42E+00( 1/ 1) 1.42E+00- 1.42E+00	8.16E-01( 2/ 2) 6.55E-01- 9.77E-01	
BI-212	4.50E-01	1.22E+00( 9/ 9) 7.23E-01- 1.54E+00	PH-3 BF DECATUR AL 8.2 MILES SSE	1.54E+00( 1/ 1) 1.54E+00- 1.54E+00	9.00E-01( 2/ 2) 7.62E-01- 1.04E+00	
BI-214	1.50E-01	9.08E-01( 9/ 9) 5.87E-01- 1.04E+00	LM1 BF NORTHWEST 1.0 MILE N	1.04E+00( 1/ 1) 1.04E+00- 1.04E+00	7.21E-01( 2/ 2) 6.89E-01- 7.53E-01	
CS-137	3.00E-02	2.74E-01( 9/ 9) 6.43E-02- 4.82E-01	LM-68F BAKER BOTTOM 3.0 MILES SSW	4.82E-01( 1/ 1) 4.82E-01- 4.82E-01	4.47E-01( 2/ 2) 1.27E-01- 7.68E-01	
K-40	7.50E-01	5.43E+00( 9/ 9) 2.79E+00- 7.45E+00	LM1 BF NORTHWEST 1.0 MILE N	7.45E+00( 1/ 1) 7.45E+00- 7.45E+00	4.34E+00( 2/ 2) 3.75E+00- 4.93E+00	
PB-212	1.00E-01	1.13E+00( 9/ 9) 6.03E-01- 1.45E+00	PH-3 BF DECATUR AL 8.2 MILES SSE	1.45E+00( 1/ 1) 1.45E+00- 1.45E+00	8.45E-01( 2/ 2) 6.39E-01- 1.05E+00	
PB-214	1.50E-01	9.90E-01( 9/ 9) 6.10E-01- 1.14E+00	LM2 BF NORTH 0.9 MILE NNE	1.14E+00( 1/ 1) 1.14E+00- 1.14E+00	7.82E-01( 2/ 2) 7.38E-01- 8.25E-01	
RA-224	7.50E-01	1.25E+00( 7/ 9) 7.96E-01- 1.49E+00	PH-3 BF DECATUR AL 8.2 MILES SSE	1.49E+00( 1/ 1) 1.49E+00- 1.49E+00	1.21E+00( 1/ 2) 1.21E+00- 1.21E+00	
RA-226	1.50E-01	9.08E-01( 9/ 9) 5.87E-01- 1.04E+00	LM1 BF NORTHWEST 1.0 MILE N	1.04E+00( 1/ 1) 1.04E+00- 1.04E+00	7.21E-01( 2/ 2) 6.89E-01- 7.53E-01	
TL-208	6.00E-02	3.83E-01( 9/ 9) 1.92E-01- 4.78E-01	PH-3 BF DECATUR AL 8.2 MILES SSE	4.78E-01( 1/ 1) 4.78E-01- 4.78E-01	2.75E-01( 2/ 2) 2.22E-01- 3.28E-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	
AH 241	2	NOT ESTAB	5.02E-03( 1/ 1) LM1 BF NORTHWEST 5.02E-03- 5.02E-03 1.0 MILE N	5.02E-03( 1/ 1) 5.02E-03- 5.02E-03	7.85E-03( 1/ 1) 7.85E-03- 7.85E-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

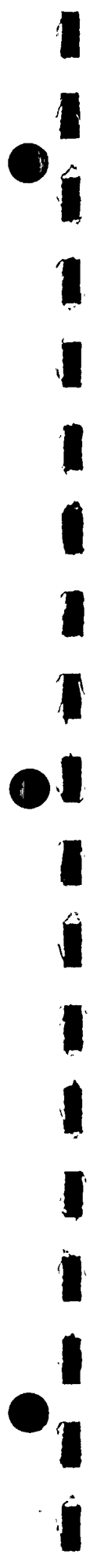
RADIOACTIVITY IN SOIL  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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
CH 244	2	NOT ESTAB	1 VALUES < LLD	LM1 BF NORTHWEST 1.0 MILE N	1 VALUES < LLD	2.51E-03( 1/ 1) 2.51E-03- 2.51E-03
CH 242	2	NOT ESTAB	1 VALUES < LLD	LM1 BF NORTHWEST 1.0 MILE N	1 VALUES < LLD	1 VALUES < LLD
PU 238	2	NOT ESTAB	1.14E-03( 1/ 1) 1.14E-03- 1.14E-03	LM1 BF NORTHWEST 1.0 MILE N	1.14E-03( 1/ 1) 1.14E-03- 1.14E-03	1 VALUES < LLD
PU 239,240	2	NOT ESTAB	5.50E-03( 1/ 1) 5.50E-03- 5.50E-03	LM1 BF NORTHWEST 1.0 MILE N	5.50E-03( 1/ 1) 5.50E-03- 5.50E-03	2.01E-02( 1/ 1) 2.01E-02- 2.01E-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).



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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: 1995

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)						
K-40	2.50E+02	8.32E+02( 1/ 1) 8.32E+02- 8.32E+02	7 MILES NNW	8.32E+02( 1/ 1) 8.32E+02- 8.32E+02	1.56E+03( 1/ 1) 1.56E+03- 1.56E+03	2

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



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 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: 1995

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)						
K-40	2.50E+02	1.12E+03( 1/ 1) 1.12E+03- 1.12E+03	7 MILES NNW	1.12E+03( 1/ 1) 1.12E+03- 1.12E+03	1.78E+03( 1/ 1) 1.78E+03- 1.78E+03	2

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





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 WESTERN AREA RADIOLOGICAL LABORATORY

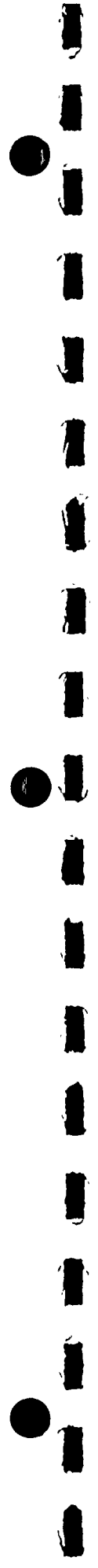
RADIOACTIVITY IN CORN  
 PCI/KG - 0.037 BQ/KG (WET WT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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)						
K-40	2	2.50E+02	2.56E+03( 1/ 1) 7 MILES NNW 2.56E+03- 2.56E+03	2.56E+03( 1/ 1) 2.56E+03- 2.56E+03	2.26E+03( 1/ 1) 2.26E+03- 2.26E+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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RADIOACTIVITY IN GREEN BEANS  
 PCI/KG - 0.037 Bq/KG (WET WT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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) <sup>2</sup>						
K-40	2.50E+02	2.60E+03( 1/ 1) 2.60E+03- 2.60E+03	7 MILES NNW	2.60E+03( 1/ 1) 2.60E+03- 2.60E+03	2.01E+03( 1/ 1) 2.01E+03- 2.01E+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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 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: 1995

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)						
K-40	2.50E+02	3.46E+03( 1/ 1) 3.46E+03- 3.46E+03	7 MILES NNW	3.46E+03( 1/ 1) 3.46E+03- 3.46E+03	3.74E+03( 1/ 1) 3.74E+03- 3.74E+03	2

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



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 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: 1995

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)						
K-40	2.50E+02	1.77E+03( 1/ 1) 1.77E+03- 1.77E+03	7 MILES NNW	1.77E+03( 1/ 1) 1.77E+03- 1.77E+03	2.28E+03( 1/ 1) 2.28E+03- 2.28E+03	2

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





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RADIOACTIVITY IN SURFACE WATER(Total)  
 PC1/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: 1995

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST NAME DISTANCE AND DIRECTION	ANNUAL MEAN MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA						
	39	1.90E+00	2.88E+00( 24/ 26) TRM 285.2 2.14E+00- 3.99E+00	2.95E+00( 13/ 13) 2.25E+00- 3.93E+00	2.89E+00( 12/ 13) 1.95E+00- 3.83E+00	
GAMMA SCAN (GELI)						
	39					
BI-214		2.00E+01	2.53E+01( 1/ 26) TRM 285.2 2.53E+01- 2.53E+01	2.53E+01( 1/ 13) 2.53E+01- 2.53E+01	2.07E+01( 1/ 13) 2.07E+01- 2.07E+01	
SR 89	12	5.00E+00	8 VALUES < LLD		4 VALUES < LLD	
SR 90	12	2.00E+00	8 VALUES < LLD		4 VALUES < LLD	
TRITIUM	12	3.00E+02	8 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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 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: 1995

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 MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA					
	77	1.90E+00	2.73E+00( 41/ 51) WHEELER DAM, AL 1.99E+00- 4.10E+00 TRM 274.9	2.91E+00( 11/ 13) 2.63E+00( 21/ 26) 2.06E+00- 3.53E+00 1.94E+00- 3.83E+00	
GAMMA SCAN (GELI)					
	77				
BI-214	2.00E+01	3.45E+02( 1/ 51) CHAMPION PAPER 3.45E+02- 3.45E+02 TRM 282.6	3.45E+02( 1/ 12) 3.45E+02- 3.45E+02	2.07E+01( 1/ 26) 2.07E+01- 2.07E+01	
PB-214	2.00E+01	1.94E+02( 2/ 51) CHAMPION PAPER 2.29E+01- 3.65E+02 TRM 282.6	3.65E+02( 1/ 12) 3.65E+02- 3.65E+02	26 VALUES < LLD	
SR 89	24	5.00E+00	16 VALUES < LLD	8 VALUES < LLD	
SR 90	24	2.00E+00	16 VALUES < LLD	8 VALUES < LLD	
TRITIUM					
	24	3.00E+02	16 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).



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 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: 1995

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)						
	26					
BI-214	2.00E+01	5.31E+01( 5/ 13) 2.80E+01- 8.60E+01	BFH WELL #6 0.02 MILES W	5.31E+01( 5/ 13) 2.80E+01- 8.60E+01	3.38E+02( 12/ 13) 2.31E+02- 5.19E+02	
PB-214	2.00E+01	3.90E+01( 5/ 13) 2.30E+01- 7.23E+01	BFH WELL #6 0.02 MILES W	3.90E+01( 5/ 13) 2.30E+01- 7.23E+01	3.43E+02( 12/ 13) 2.54E+02- 5.13E+02	
SR 89	8					
	8	5.00E+00	4 VALUES < LLD		4 VALUES < LLD	
SR 90	8					
	8	2.00E+00	4 VALUES < LLD		4 VALUES < LLD	
TRITIUM	8					
	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/GM - 0.037 BQ/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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)						
B1-214	1.00E-01	2 VALUES < LLD	WHEELER RES TRM 275-349	2 VALUES < LLD	1.05E-01( 1/ 2) 1.05E-01- 1.05E-01	
CS-137	3.00E-02	4.40E-02( 2/ 2) 3.54E-02- 5.26E-02	WHEELER RES TRM 275-349	4.40E-02( 2/ 2) 3.54E-02- 5.26E-02	5.04E-02( 2/ 2) 4.31E-02- 5.77E-02	
K-40	4.00E-01	1.36E+01( 2/ 2) 1.29E+01- 1.43E+01	WHEELER RES TRM 275-349	1.36E+01( 2/ 2) 1.29E+01- 1.43E+01	1.26E+01( 2/ 2) 1.23E+01- 1.29E+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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 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN SMALLMOUTH BUFFALO FLESH  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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)						
K-40	4.00E-01	9.06E+00( 2/ 2) 6.37E+00- 1.17E+01	WHEELER RES TRM 275-349	9.06E+00( 2/ 2) 6.37E+00- 1.17E+01	1.02E+01( 2/ 2) 8.40E+00- 1.20E+01	4

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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 WESTERN AREA RADIOLOGICAL LABORATORY

RADIOACTIVITY IN SMALLMOUTH BUFFALO WHOLE  
 PC1/GM - 0.037 BQ/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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)						
K-40	4.00E-01	7.02E+00( 2/ 2) 5.81E+00- 8.24E+00	WHEELER RES TRM 275-349	7.02E+00( 2/ 2) 5.81E+00- 8.24E+00	7.65E+00( 2/ 2) 7.64E+00- 7.66E+00	4

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/GM - 0.037 BO/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
REPORTING PERIOD: 1995

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)						
	10					
AC-228	2.50E-01	1.24E+00( 6/ 6)	TRM 293.7	1.37E+00( 2/ 2)	9.79E-01( 4/ 4)	
		8.25E-01- 1.50E+00	BFN DISCHARGE	1.31E+00- 1.42E+00	8.17E-01- 1.23E+00	
BE-7	2.50E-01	3.16E-01( 1/ 6)	TRM 288.78	3.16E-01( 1/ 2)	4.91E-01( 1/ 4)	
		3.16E-01- 3.16E-01		3.16E-01- 3.16E-01	4.91E-01- 4.91E-01	
B1-212	4.50E-01	1.36E+00( 6/ 6)	TRM 293.7	1.54E+00( 2/ 2)	9.50E-01( 4/ 4)	
		7.86E-01- 1.62E+00	BFN DISCHARGE	1.51E+00- 1.57E+00	7.95E-01- 1.15E+00	
B1-214	1.50E-01	9.71E-01( 6/ 6)	TRM 293.7	1.04E+00( 2/ 2)	7.43E-01( 4/ 4)	
		6.63E-01- 1.15E+00	BFN DISCHARGE	9.92E-01- 1.10E+00	6.30E-01- 9.05E-01	
CO-60	3.00E-02	7.47E-02( 5/ 6)	TRM 277.98	8.92E-02( 1/ 2)	4 VALUES < LLD	
		5.22E-02- 9.10E-02		8.92E-02- 8.92E-02		
CS-137	3.00E-02	4.86E-01( 6/ 6)	TRM 293.7	5.27E-01( 2/ 2)	1.45E-01( 4/ 4)	
		2.33E-01- 6.66E-01	BFN DISCHARGE	5.20E-01- 5.34E-01	1.23E-01- 1.71E-01	
K-40	7.50E-01	1.16E+01( 6/ 6)	TRM 293.7	1.29E+01( 2/ 2)	1.14E+01( 4/ 4)	
		9.92E+00- 1.37E+01	BFN DISCHARGE	1.21E+01- 1.37E+01	9.79E+00- 1.26E+01	
PB-212	1.00E-01	1.23E+00( 6/ 6)	TRM 293.7	1.34E+00( 2/ 2)	9.52E-01( 4/ 4)	
		7.53E-01- 1.52E+00	BFN DISCHARGE	1.29E+00- 1.39E+00	7.89E-01- 1.21E+00	
PB-214	1.50E-01	1.07E+00( 6/ 6)	TRM 293.7	1.15E+00( 2/ 2)	8.34E-01( 4/ 4)	
		7.22E-01- 1.29E+00	BFN DISCHARGE	1.11E+00- 1.20E+00	7.21E-01- 1.03E+00	
RA-224	7.50E-01	1.33E+00( 5/ 6)	TRM 277.98	1.39E+00( 1/ 2)	9.25E-01( 1/ 4)	
		9.78E-01- 1.54E+00		1.39E+00- 1.39E+00	9.25E-01- 9.25E-01	
RA-226	1.50E-01	9.71E-01( 6/ 6)	TRM 293.7	1.04E+00( 2/ 2)	7.43E-01( 4/ 4)	
		6.63E-01- 1.15E+00	BFN DISCHARGE	9.92E-01- 1.10E+00	6.30E-01- 9.05E-01	
TL-208	6.00E-02	4.06E-01( 6/ 6)	TRM 293.7	4.54E-01( 2/ 2)	3.10E-01( 4/ 4)	
		2.55E-01- 4.96E-01	BFN DISCHARGE	4.38E-01- 4.71E-01	2.37E-01- 3.81E-01	
SR 89						
	10					
		1.60E+00	6 VALUES < LLD		4 VALUES < LLD	
SR 90						
	10					
		4.00E-01	6 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 CLAM FLESH  
 PCI/GM - 0.037 BQ/G (DRY WEIGHT)

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

DOCKET NO.: 50-259,260,296  
 REPORTING PERIOD: 1995

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	5.00E-01	2.02E+00( 1/ 2) 2.02E+00- 2.02E+00	DOWNSTREAM LOCATION DOWNSTREAM	2.02E+00( 1/ 2) 2.02E+00- 2.02E+00	1.65E+00( 1/ 2) 1.65E+00- 1.65E+00	
PB-214	1.00E-01	2.49E+00( 1/ 2) 2.49E+00- 2.49E+00	DOWNSTREAM LOCATION DOWNSTREAM	2.49E+00( 1/ 2) 2.49E+00- 2.49E+00	1.58E+00( 1/ 2) 1.58E+00- 1.58E+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).





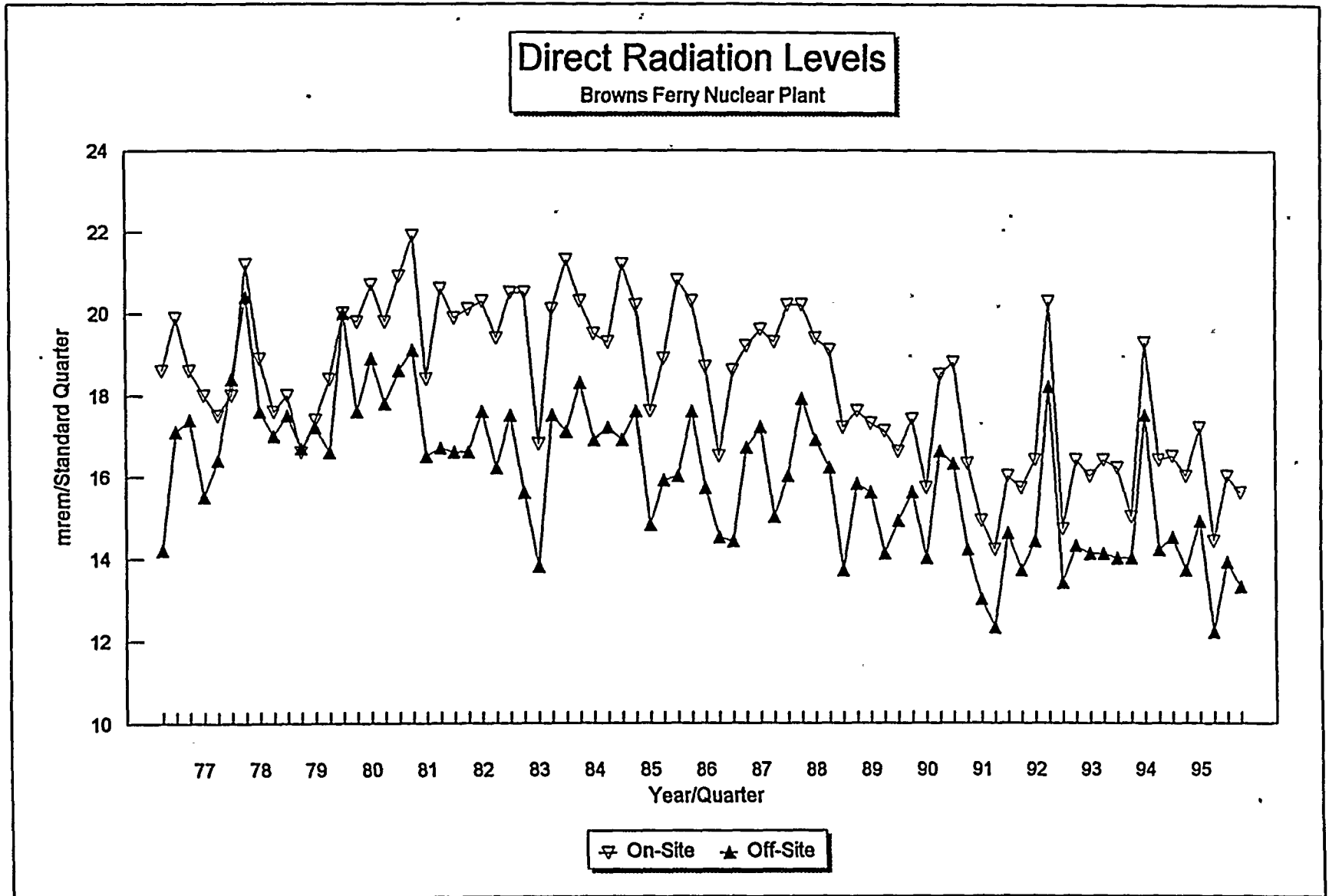
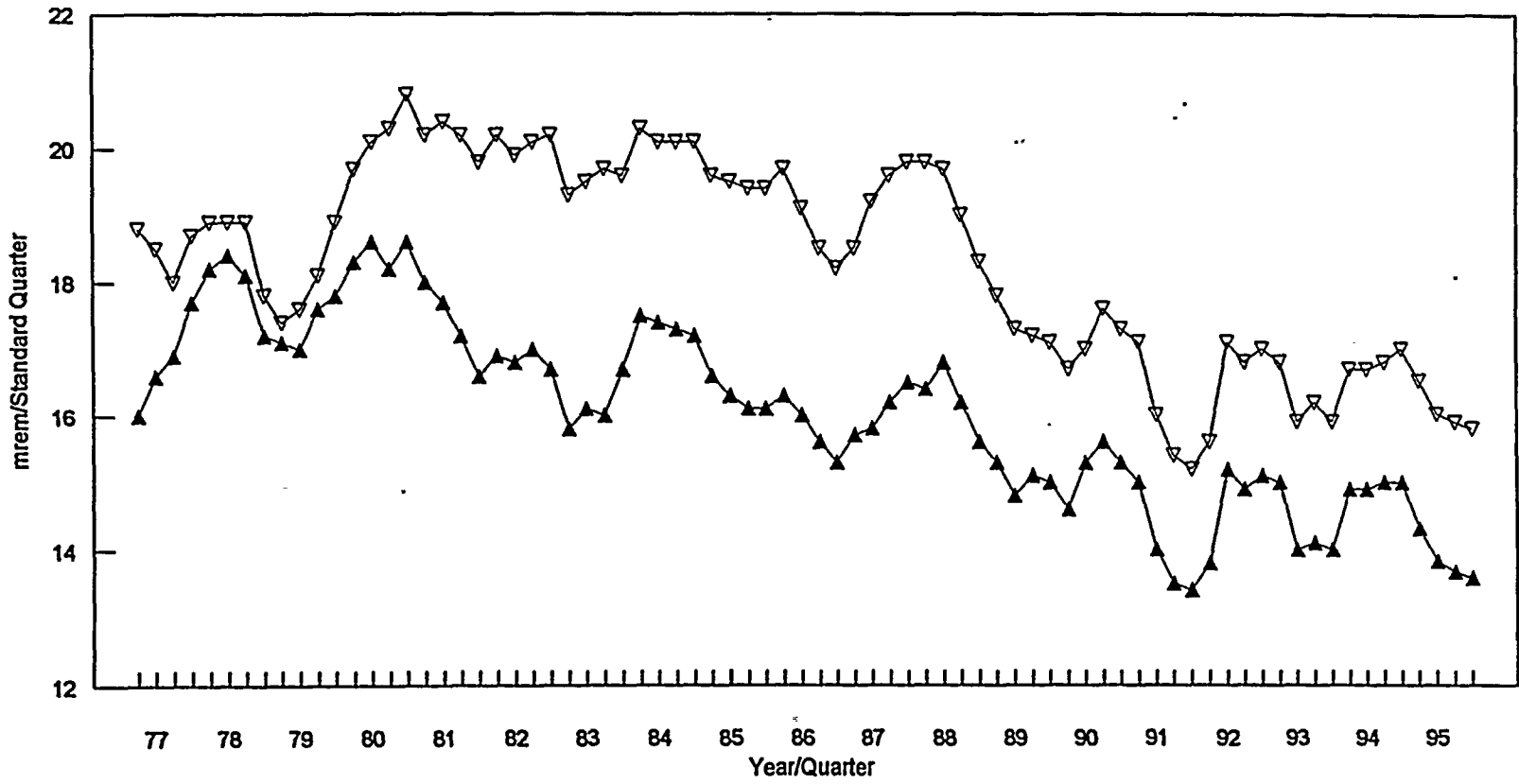


FIGURE H-1



# Direct Radiation Levels

Four Quarter Moving Average



▽ On-Site ▲ Off-Site

Browns Ferry Nuclear Plant



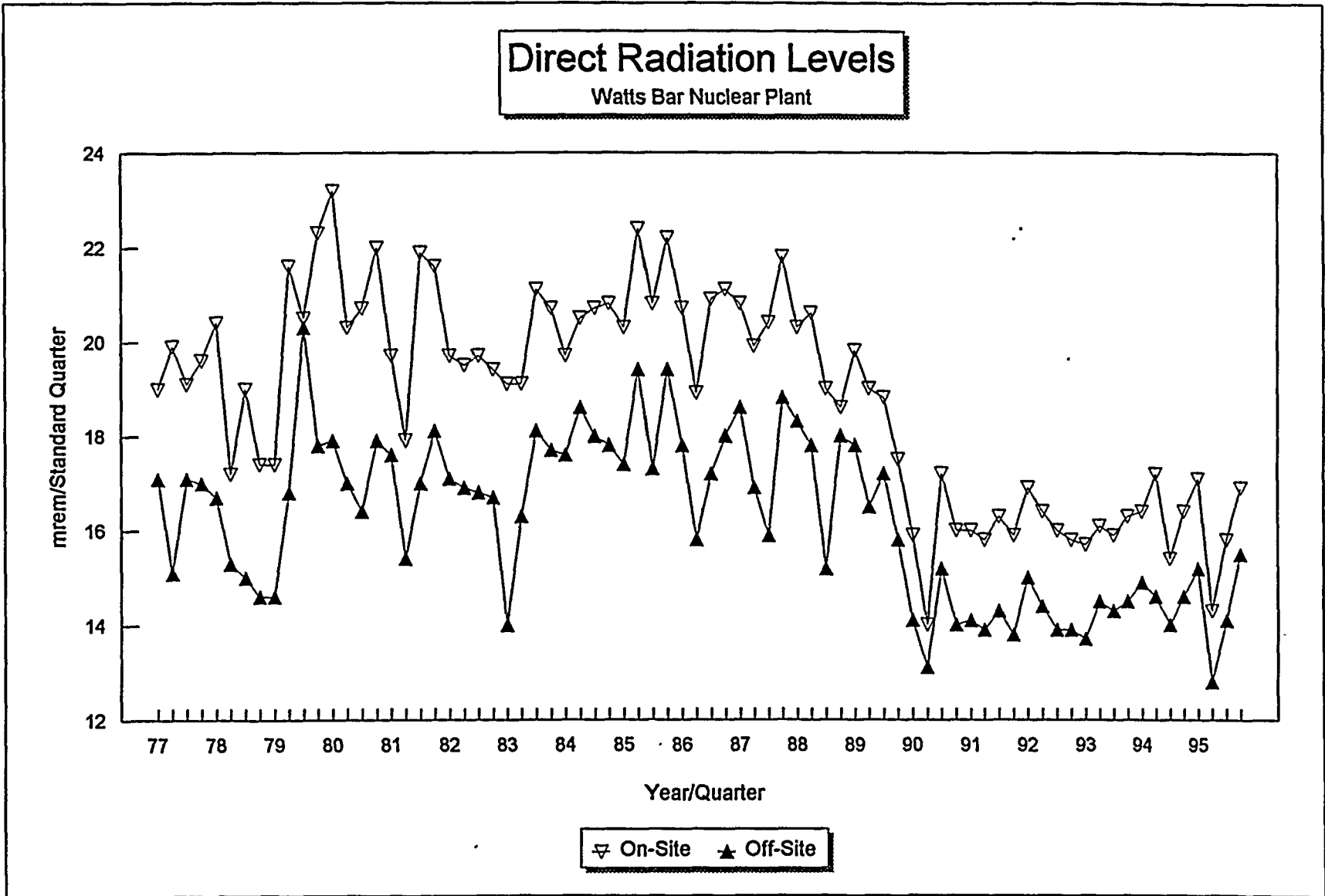


FIGURE H-3



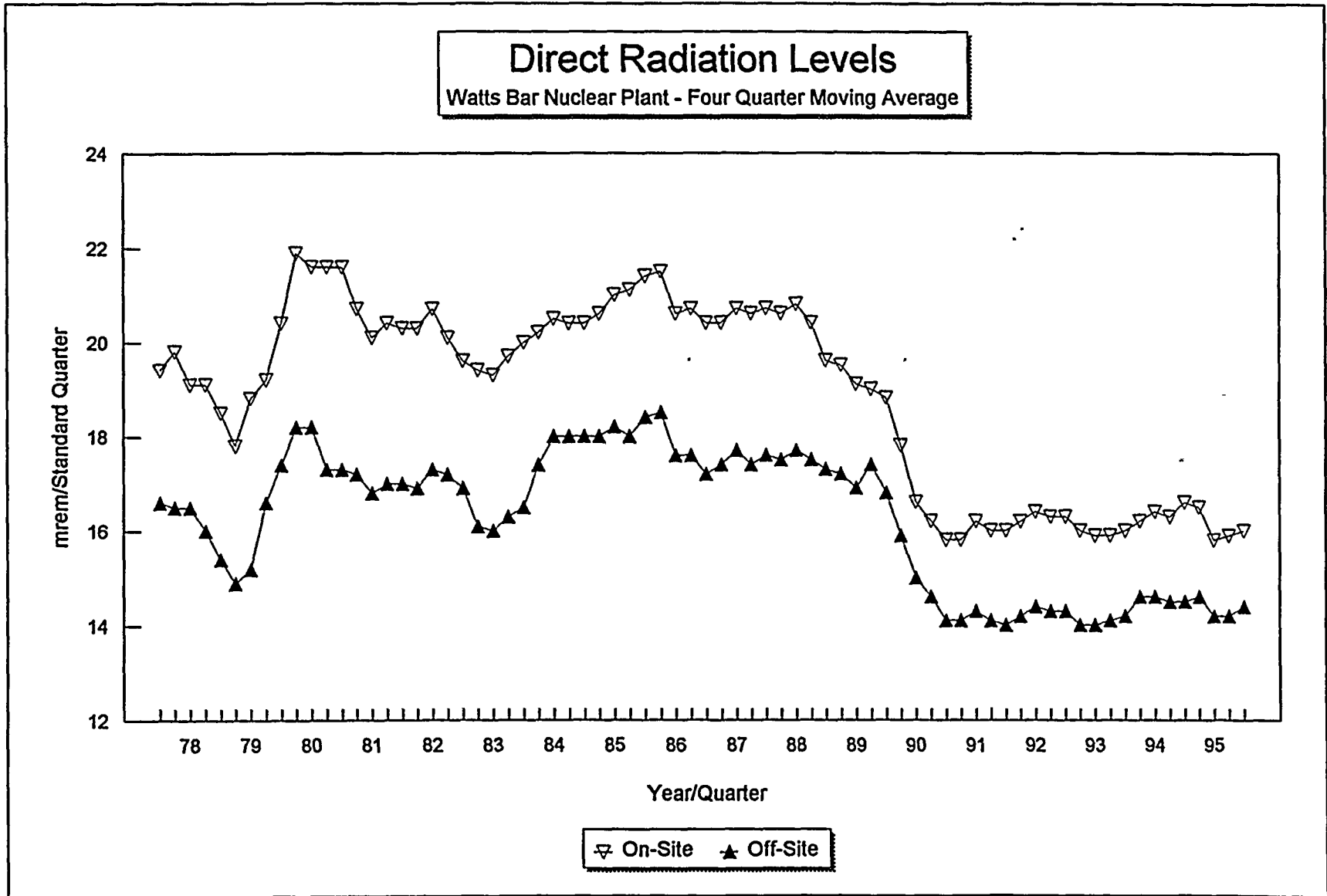
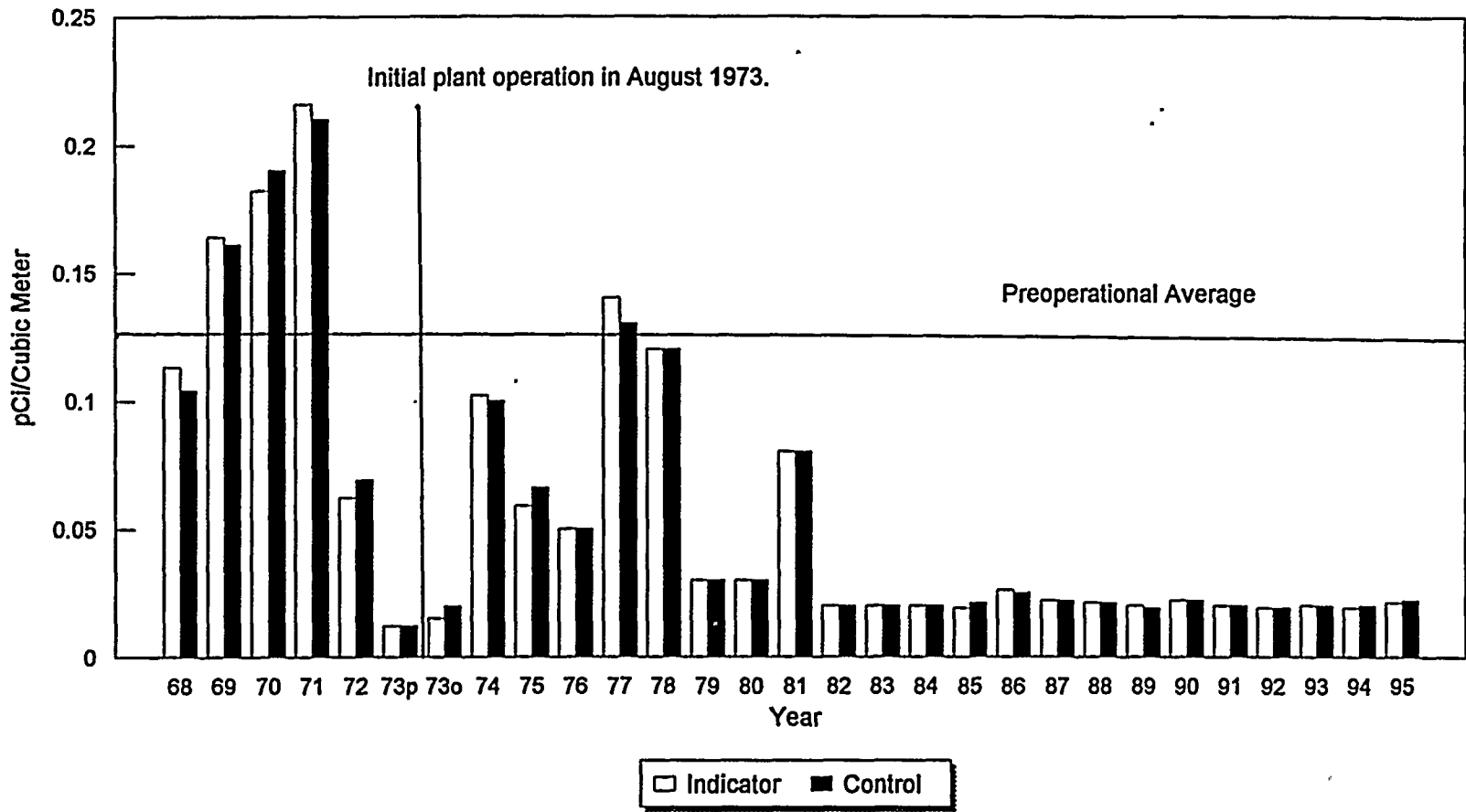


FIGURE H-4





### Annual Average Gross Beta Activity Air Filters (pCi/Cubic Meter)



Browns Ferry Nuclear Plant

FIGURE H-5



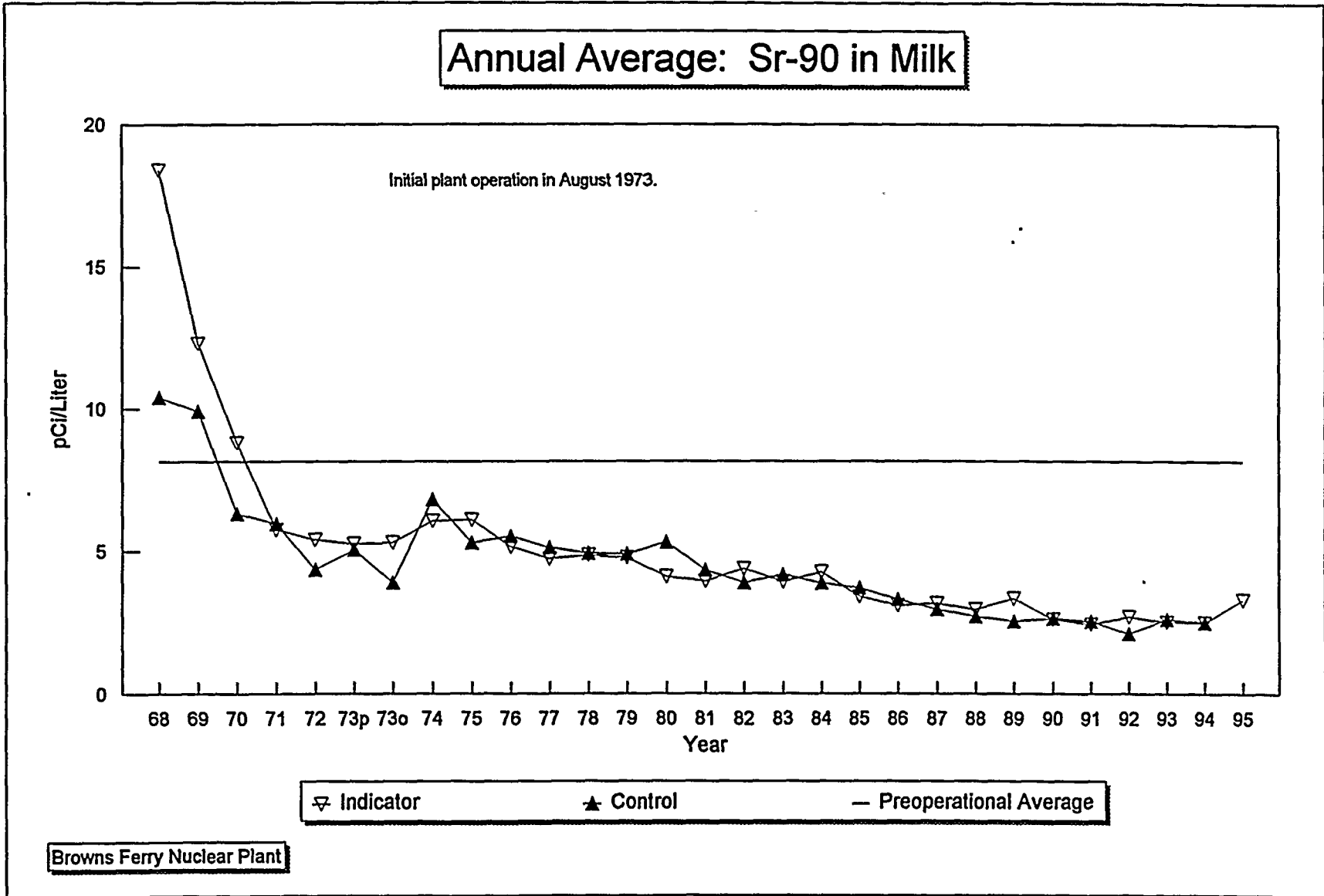
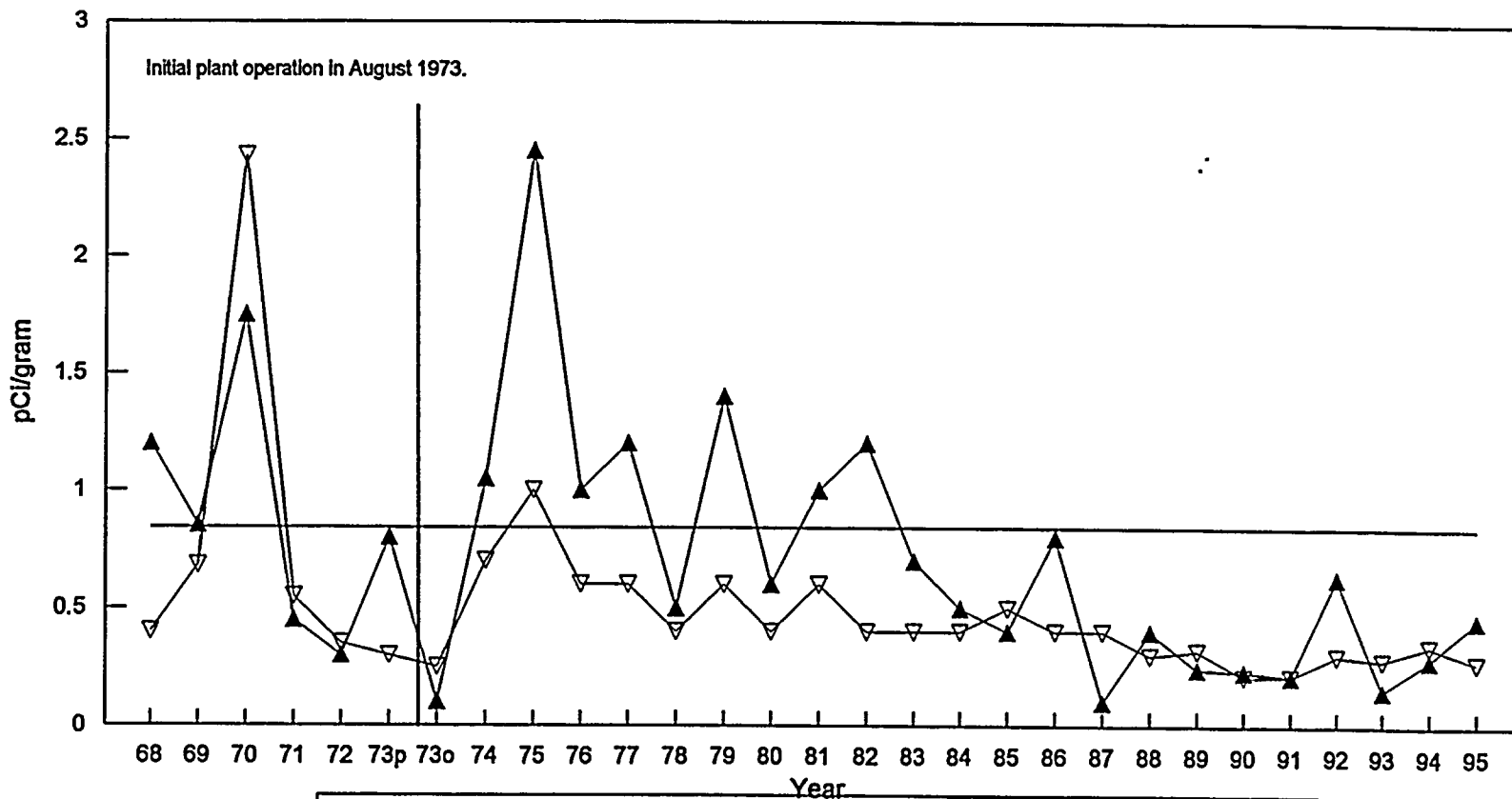


FIGURE H-6



### Annual Average: Cs-137 in Soil



▽ Indicator      ▲ Control      — Preoperational Average

Browns Ferry Nuclear Plant

Note: Detector system changed from NaI to GeLI in 1977.

FIGURE H-7



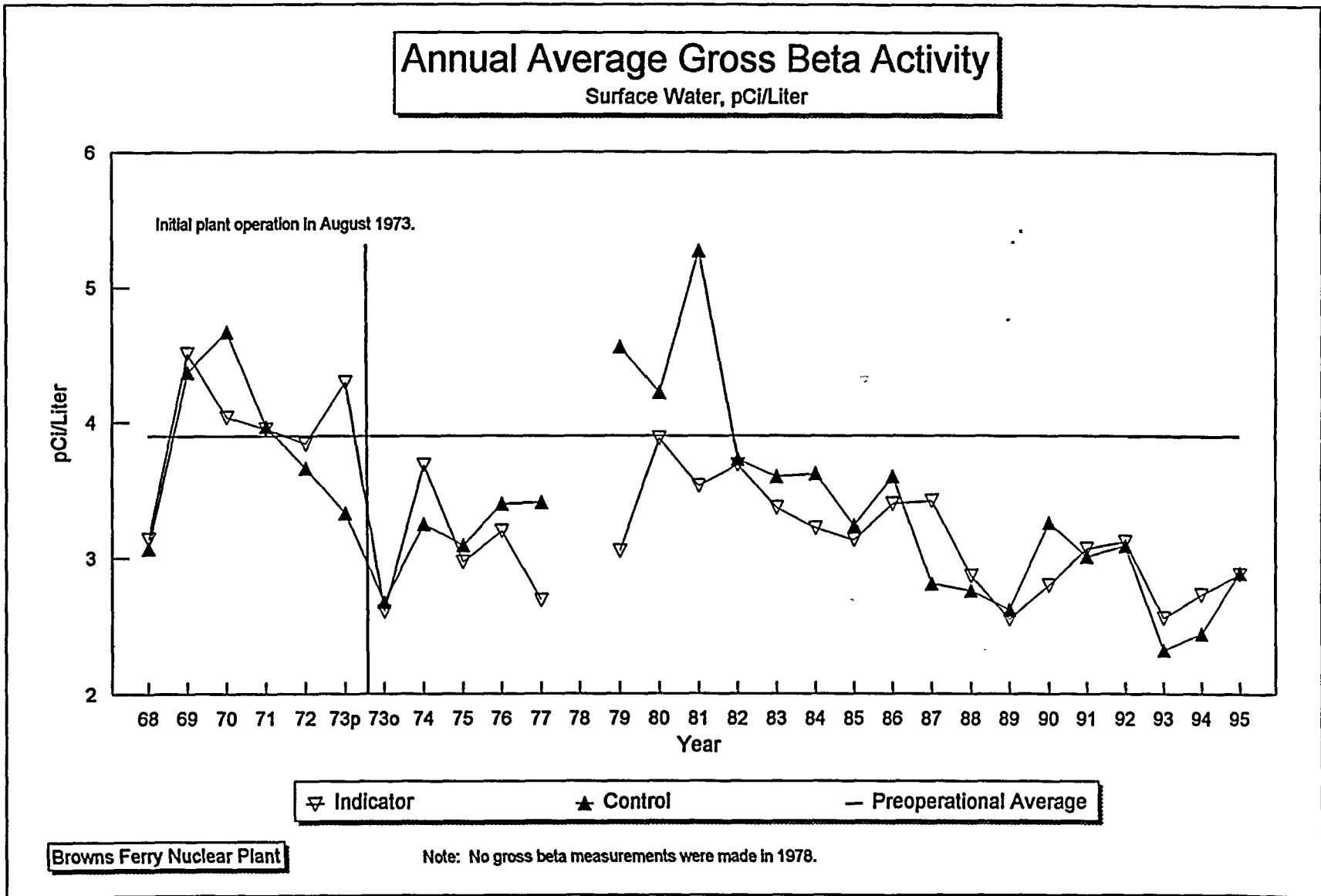
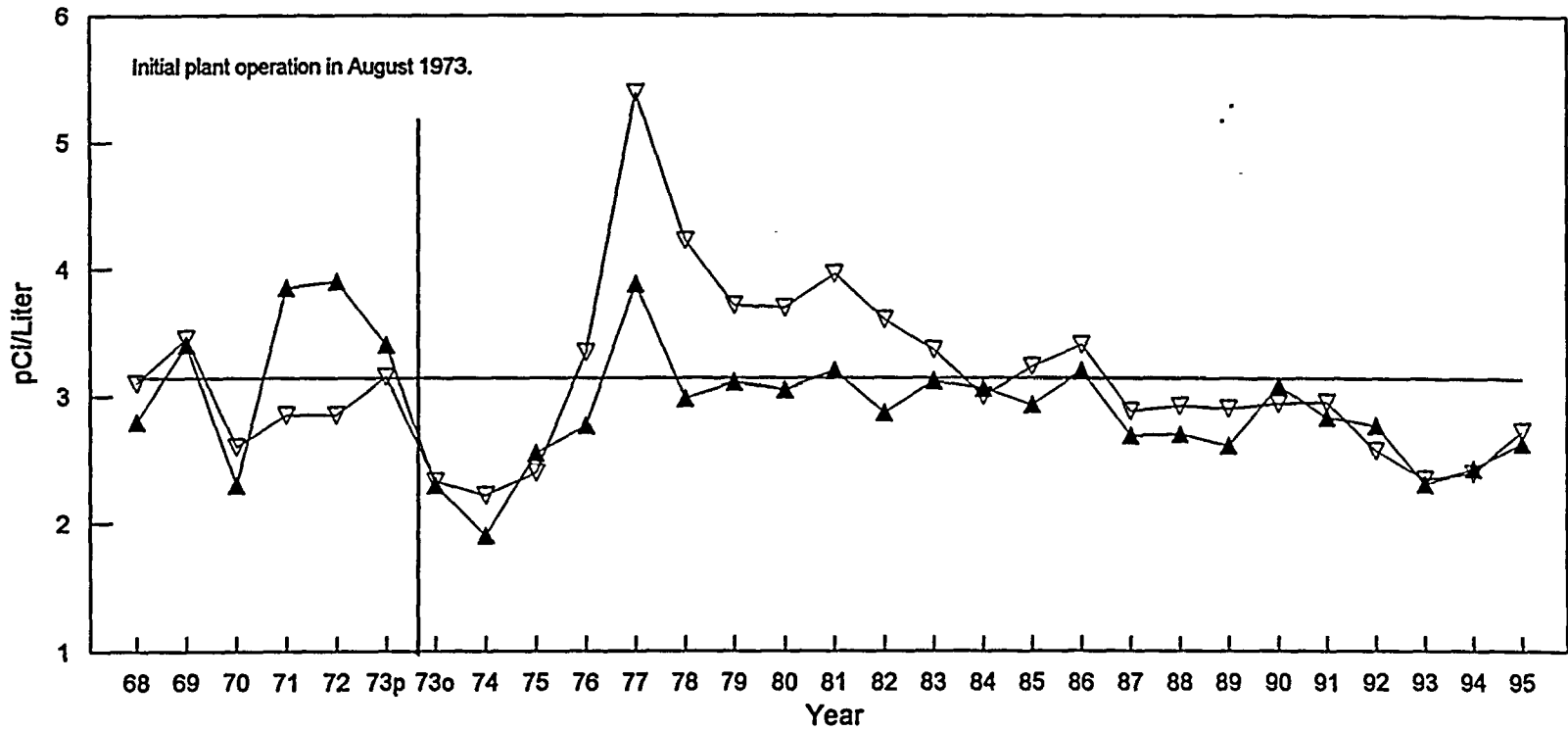


FIGURE H-8





### Annual Average Gross Beta Activity Drinking Water, pCi/Liter



▽ Indicator      ▲ Control      — Preoperational Average

Browns Ferry Nuclear Plant

FIGURE H-9



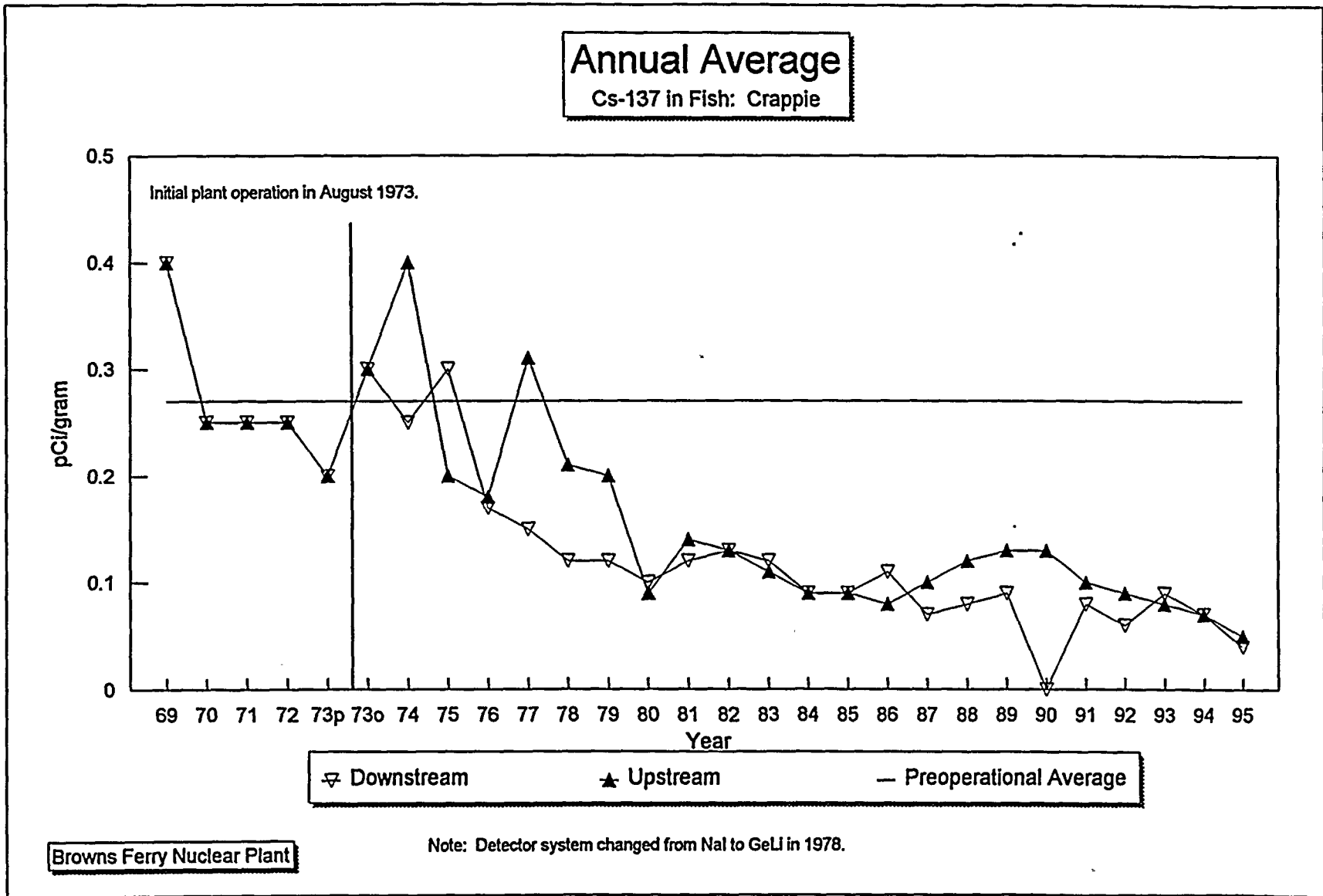
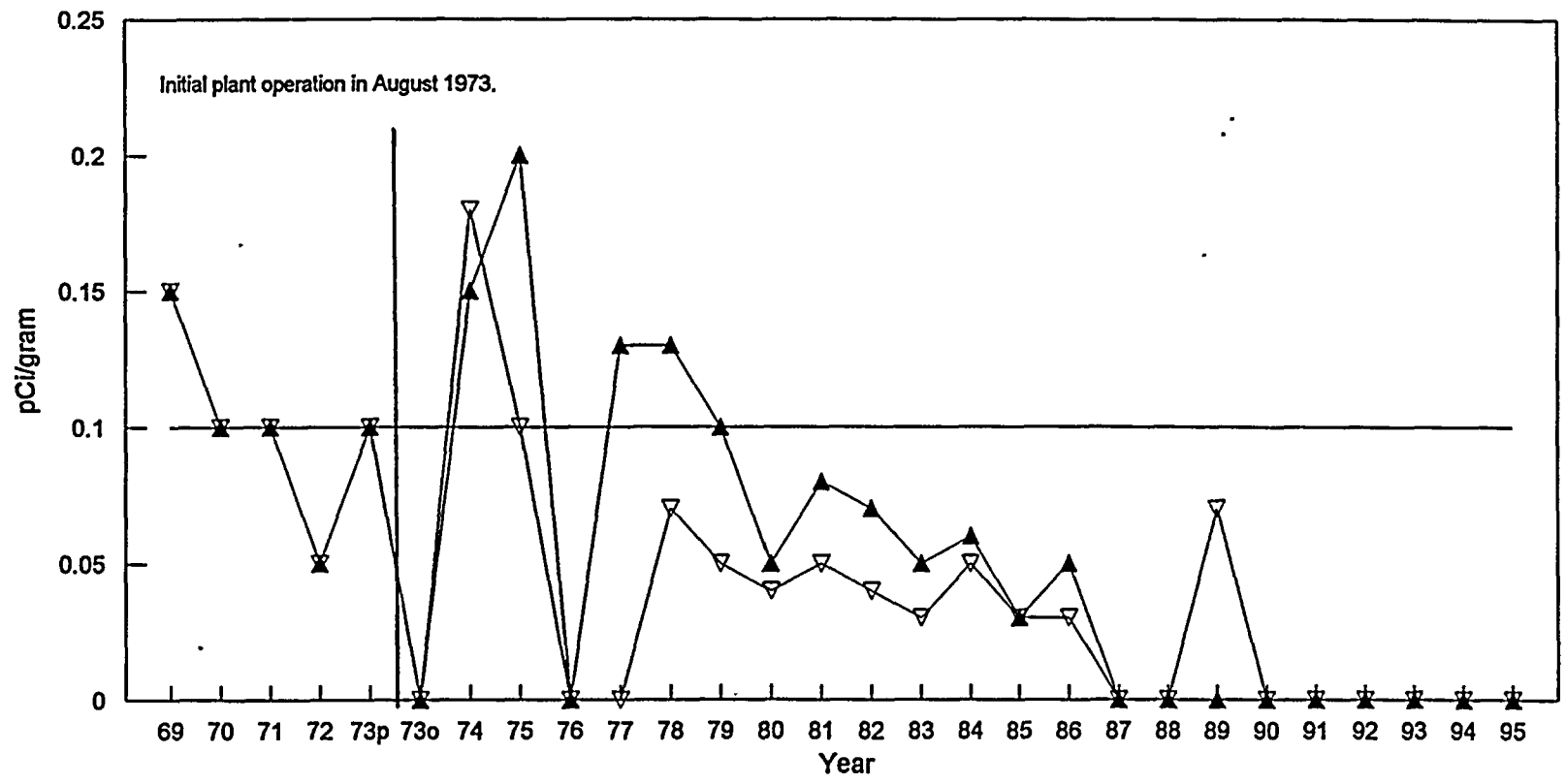


FIGURE H-10



### Annual Average Cs-137 in Fish: Smallmouth Buffalo, Flesh



▽ Downstream      ▲ Upstream      — Preoperational Average

Browns Ferry Nuclear Plant

Note: Detector system changed from NaI to GeLi in 1978.

FIGURE H-11



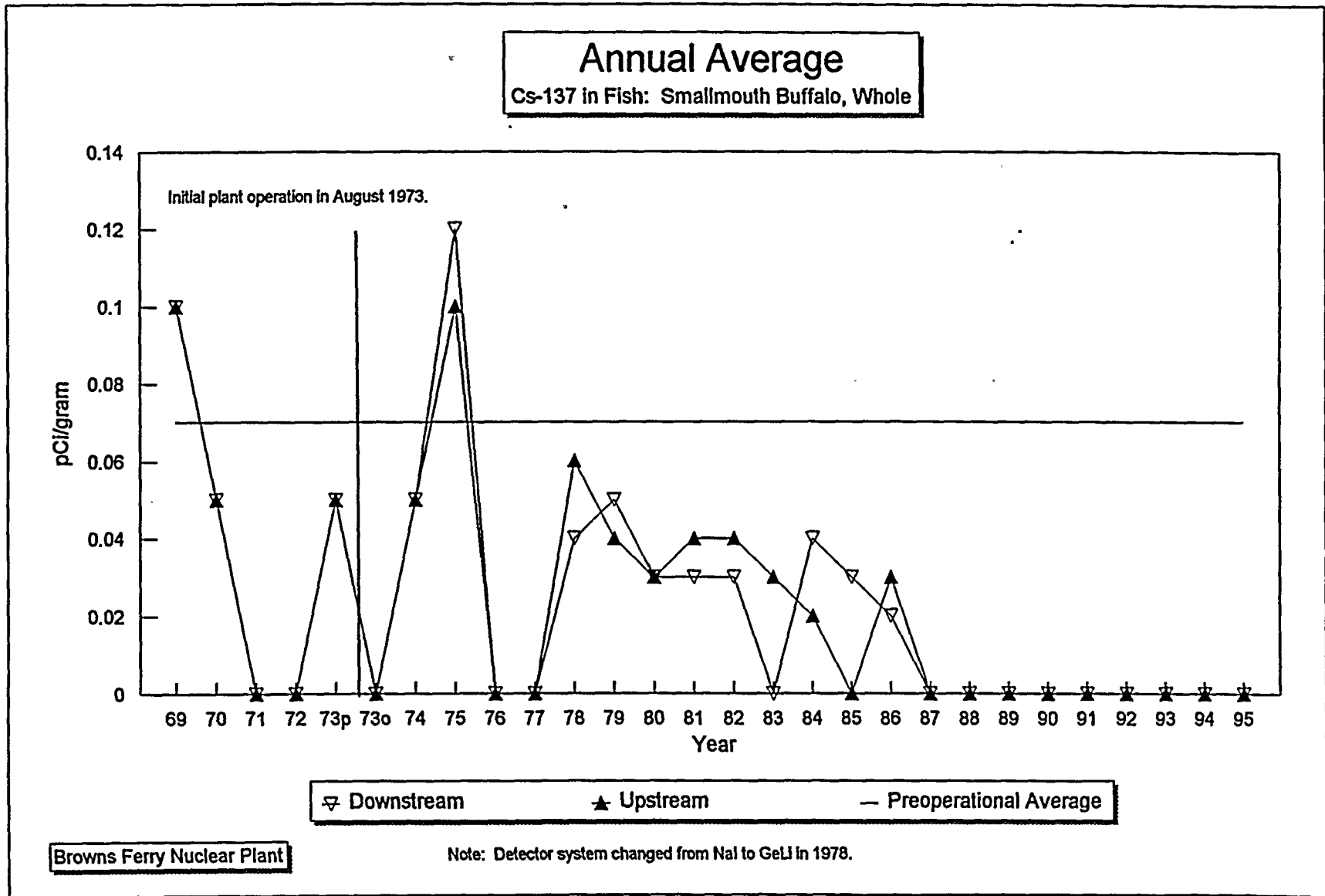
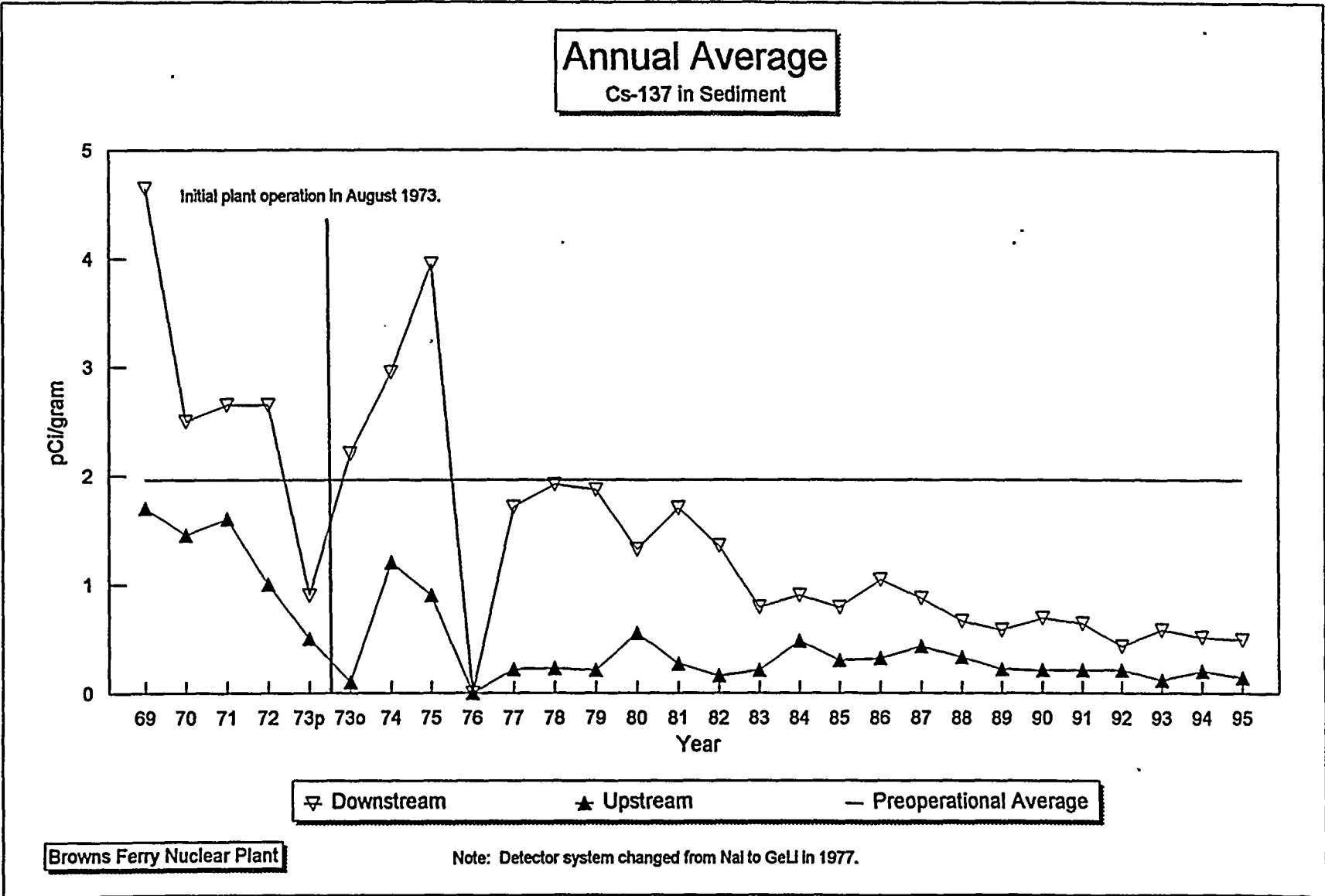


FIGURE H-12









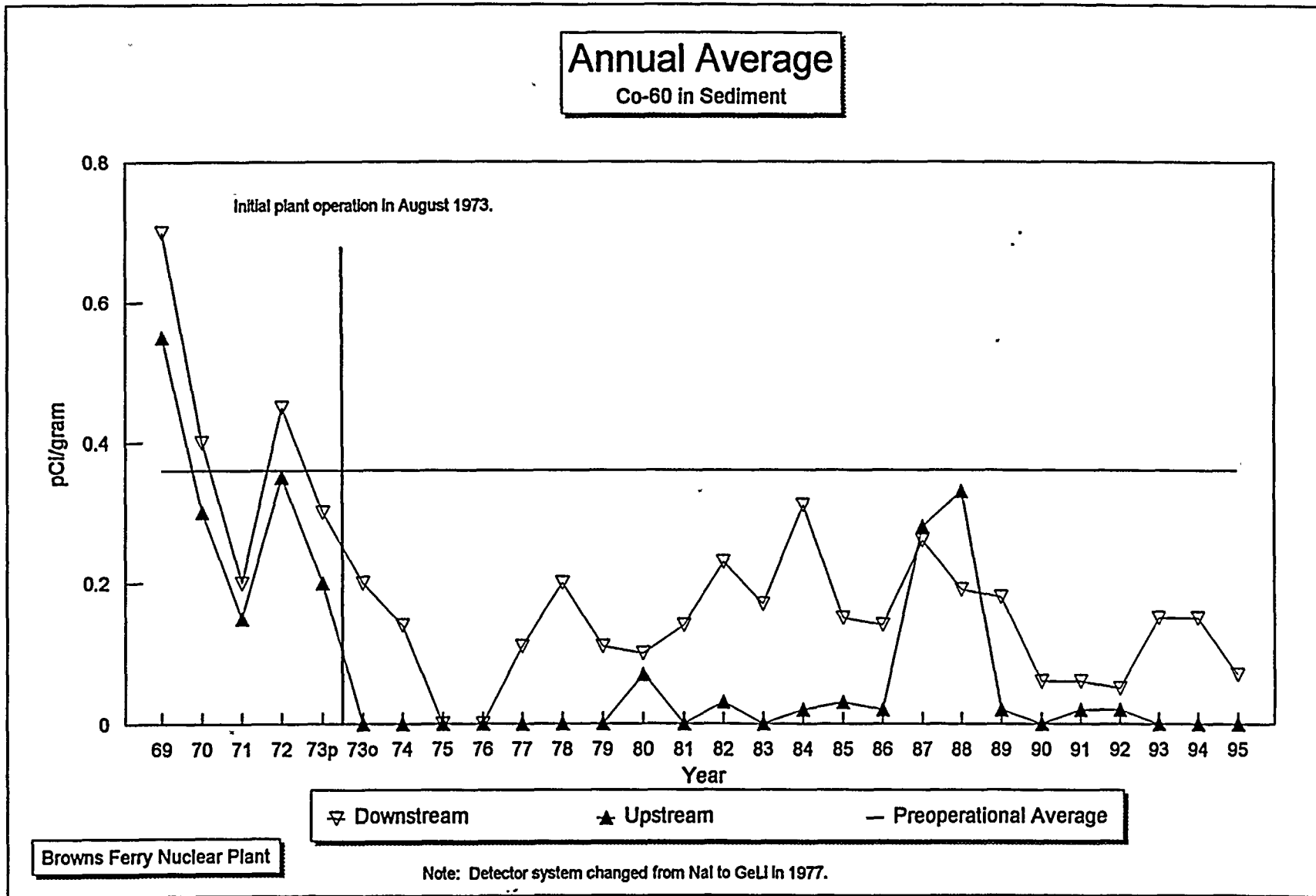


FIGURE H-14

