TENNESSEE VALLEY AUTHORITY

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT
BROWNS FERRY NUCLEAR PLANT
1988

RADIOLOGICAL CONTROL

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NUCLEAR ASSURANCE AND SERVICES

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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 in 1988. 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 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 a huge volume of data, the results of many thousands of measurements and laboratory analyses. The measurements are made to comply with regulations and to determine potential effects on public health and safety. This report is prepared annually in partial fulfillment of the requirements of the plant operating license. 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 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 uraninum-238, uranium-235, thorium-234, radium-226, radon-222, carbon-14, and hydrogen-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 below 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, milling, 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 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.

However, nuclear plants require 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 alarming mechanisms to allow for 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 ensure that the population is not being exposed to significant levels of radiation or radioactive materials.

Plant Technical Specifications limit the release of radioactive effluents, as well as doses to the general public from the release of these effluents. Additional limits are set by the Environmental Protection Agency (EPA) for doses to the public.

The offsite dose due to radioactive materials released to unrestricted areas, as given in the Technical Specifications for each unit, are limited to the following:

Liquid Effluents

Total body	<3 mrem/year per unit
Any organ	<10 mrem/year per unit

Gaseous Effluents

Noble gases:

Gamma radiation	≤10 mrad/year per unit
Beta radiation	≤20 mrad/year per unit

Particulates:

Any organ	≤15 mrem/year per unit

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

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

In addition, 10 CFR 20.106 provides maximum permissible concentrations (MPCs) for radioactive materials released to unrestricted areas. MPCs for the principal radionuclides associated with nuclear power plant effluents are presented in table 1.

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 the land 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 three dairy farms are located within a 10-mile radius of the plant.

Approximately 2000 people live within a 5-mile radius of the plant. The town of Athens has a population of about 15,000, while approximately 40,000 people live in the city of Decatur. The largest city in the area with approximately 150,000 people is Huntsville, Alabama, located about 24 miles east of the site.

Area recreation facilities are being developed along the Tennessee River. The nearest facility is a commercial boat dock across the river from the site and two county parks located about 8 miles west-northwest of 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.

The 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 January 1977. None of the units have operated since March 1985.

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

The unique environmental concern associated with a nuclear power plant is its production of radioactive materials and radiation. The vast majority of this radiation and radioactivity is contained within the reactor itself or one of the other plant systems designed to keep the material in the plant. The retention of the materials in each level of control is achieved by system engineering, design, construction, and operation. 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 conjuction 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 lists the sampling stations and the types of samples collected from each. Modifications made to the program in 1988 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. This is very important in that during the 1950s, 60s, and 70s, atmospheric nuclear weapons testing occurred which released radioactive material to the environment causing fluctuations in the natural background radiation levels. This radioactive material is the same type as that produced in the BFN reactors. Preoperational knowledge of natural 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 sophisticated radiation detection devices used to determine the radionuclide content of samples collected in the environment are generally quite sensitive to small amounts of radioactivity. In the field of radiation measurement, the sensitivity of the measurement process is discussed 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 complex radiation detection devices are

working properly and the analysis of special samples which are included alongside routine environmental samples. 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 any 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 1988 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, the electrons are released, along with a pulse of light. A measurement of the intensity of the light is directly proportional to the radiation to which the material was exposed. Materials which display these characteristics are used in the manufacture of TLDs.

TVA uses a manganese activated calcium fluoride (Ca_2F:Mn) TLD material encased in a glass bulb. The bulb is placed in an energy compensating shield

to correct for energy dependence of the material. 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 16 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 read with a Victoreen model 2810 TLD reader. The values are corrected for gamma response, self-irradiation, and fading, with individual gamma response calibrations and self-irradiation factors determined for each TLD. The system meets or exceeds the performance specifications outlined in Regulatory Guide 4.13 for environmental applications of TLDs.

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 greater 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 less sensitive dosimeters. 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. The WBN is a non-operating plant under construction near Spring City, Tennessee.

The quarterly gamma radiation levels determined from the TLDs deployed around BFN in 1988 are given in table H-1. The rounded average annual exposures are shown below.

	Annual Average Direct Radiation Levels mR/year	
	BFN	WBN
Onsite Stations	73	78
Offsite Stations	63	69

The data in table H-1 indicate that the average quarterly radiation levels at the BFN onsite stations are approximately 2-4 mR/quarter higher than levels at the offsite stations. This difference is also 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 1988. To reduce the 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 smoothed considerably. 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 1988 are consistent with direct radiation levels identified at locations which are not influenced by the operation of BFN. There is no indication that BFN operations 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 areas of greatest wind frequency. One additional station 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. Some changes were made in the monitor locations in 1988. These changes are described in appendix B.

Results from the analysis of samples in the atmospheric pathway are presented in tables H-2 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 anaylzed 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 a quarterly basis, all of the filters from a location are composited and analyzed 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. If activity above a specified limit is detected, a complete gamma spectroscopy analysis is performed.

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.

Results

The results from the analysis of air particulate samples are summarized in table H-2. Gross beta activity in 1988 was consistent with levels reported in previous years. The average level at both indicator and control stations was 0.021 pCi/m^3. The annual averages of the gross beta activity in air particulate filters at these stations for the years 1968-1988 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 were found at levels greater than the LLDs. As shown in table H-3, iodine-131 was detected in two charcoal canister samples at levels slightly higher than the nominal LLD. Since the half-life of I-131 is only about 8 days and the plant has not operated in over 3 years, this activity could not be from BFN.

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-4 through H-11.

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, two dairy farms have been identified within 7 miles of the plant. These three dairies are considered indicator stations and routinely provide milk samples. In addition, the land use survey identified one farm producing milk for private consumption. Since insufficient quantities of milk are available for sampling, samples of vegetation are taken at this farm. The results of the 1988 land use survey are presented in appendix G.

Sample Collection and Analysis

Milk samples are purchased weekly from three 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 is performed on each sample and a gamma spectroscopy analysis and Sr-89,90 analysis are performed every 4 weeks.

Samples of vegetation are collected every 4 weeks for I-131 analysis. The samples are collected from the same locations as milk samples and from selected air monitoring stations. The samples are collected by cutting or breaking enough vegetation to provide between 100 and 200 grams of sample. Care is taken not to include any soil with the vegetation. The sample is placed in a container with 1650 ml of 0.5 N NaOH for transport back to the radioanalytical laboratory. A second sample of between 750 and 1000 grams is also collected from each location. After drying and grinding, this sample is analyzed by gamma spectroscopy. Once each quarter, the sample is ashed after the gamma analysis is completed and analyzed for Sr-89,90.

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

Samples representative of food crops raised in the area near the plant are obtained from individual gardens, corner markets, or cooperatives. Types of foods may vary from year to year as a result of changes in the local vegetable gardens. In 1988 samples of cabbage, potatoes, and tomatoes were collected from local vegetable gardens. In addition, samples of apples and beef were also obtained from the area. The edible portion of each sample is prepared as

if it were to be eaten and is analyzed by gamma spectroscopy. After drying, grinding, and ashing, the sample is analyzed for gross beta activity.

Results

The results from the analysis of milk samples are presented in table H-4. 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 found in a little over half of the samples. 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). The average Sr-90 concentration reported from indicator stations was approximately 3.0 pCi/liter. An average of 2.7 pCi/liter was identified in samples from control stations. By far the predominent 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-5). All I-131 values were less than the nominal LLD. Average Cs-137 concentrations were 33.4 and 25.7 pCi/kg for indicator and control stations, respectively. Strontium-90 levels averaged 93.5 pCi/kg from indicator stations and 78.1 pCi/kg from control stations. 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 this isotope was approximately 0.6 pCi/g which is

consistent with levels previously reported from fallout. All Sr-89,90 values were less than the nominal LLDs. All other radionuclides reported were naturally occurring isotopes (table H-6).

Only the naturally occurring K-40 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. Gross beta concentrations for all indicator samples were consistent with the control values. Analysis of these samples indicated no contribution from plant activities. The results are reported in tables H-7 through H-11.

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 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-12 through H-19. Radioactivity levels in water, fish and clams were consistent with background and/or fallout levels previously reported. The presence of Co-60 and Cs-134 was identified in sediment samples; however, the projected exposure to the public from this medium is negligible.

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 at least once every 2 hours. The line is flushed and a sample collected into a composite jug. A 1-gallon sample is removed from the composite jug weekly and the remaining water in the jug is discarded. A 4-week composite sample is prepared from the weekly samples and 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 weekly 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.

Groundwater is sampled from an onsite well and from a private well in an area unaffected by BFN. The samples are collected every 4 weeks and analyzed by gamma spectroscopy. A quarterly composite sample is analyzed for tritium.

Samples of commercial and game fish species are collected semiannually from each of three reservoirs: the reservoir on which the plant is located (Wheeler Reservoir), the upstream reservoir (Guntersville Reservoir), and the downstream reservoir (Wilson 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. When the gamma

analysis is completed, the sample is ashed and analyzed for gross beta activity.

Bottom sediment is collected semiannually from selected Tennessee River Mile (TRM) locations using a dredging apparatus. 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.

A series of special sediment samples was taken from sampling locations downstream from the plant discharge in June 1988. The basis for the sampling and the results from the analysis of the special samples are presented in appendix I.

Samples of Asiatic clams are collected from the same locations as the bottom sediment. The clams are usually collected in the dredging process with the sediment. However, at times the clams are difficult to find and divers must be used. 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.

Results

All radioactivity in surface water samples was below the LLD except the gross beta activity and trace amounts of Sr-89 in one sample. With a half-life of approximately 60 days, this isotope cannot be present in the environment as a result of plant operations or previous nuclear weapons testing. The positive identification of Sr-89 is an artifact of the calculational process and the

low concentrations the laboratory is attempting to detect. These results are consistent with previously reported levels. A trend plot of the gross beta activity in surface water samples from 1968 through 1988 is presented in figure H-6. A summary table of the results for this reporting period is shown in table H-12.

For public water, average gross beta activity was 2.9 pCi/liter at the downstream stations and 2.7 pCi/liter at the control stations. The results are shown in table H-13 and a trend plot of the gross beta activity in drinking water from 1968 to the present is presented in figure H-7.

Concentrations of fission and activation products in groundwater were all below the LLDs. Only naturally occurring radionuclides and trace amounts of Sr-89 were identified in these samples. The results are presented in table H-14. As noted above, the identification of Sr-89 in environmental samples is an artifact of the calculational process.

Cesium-137 was identified in five fish samples. The downstream samples averaged 0.08 pCi/g while the upstream sample averaged 0.1 pCi/g. The only other radioisotope found in fish was the naturally occurring K-40. These values ranged from 5.6 pCi/g to 17.8 pCi/g. The maximum gross beta activity measured in downstream samples was 361 pCi/g, while the maximum value in upstream samples was 319 pCi/g. These results, which are summarized in tables H-15, H-16, and H-17, indicate that 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, Co-60, and Cs-134. The average levels of Cs-137 were 0.66 pCi/g in downstream samples and 0.33 pCi/g upstream. The Cs-137 concentration at downstream stations is approximately double the activity in upstream samples. This same relationship was reported from these stations during the preoperational phase of the monitoring at BFN, indicating that the levels reported herein are probably not the result of BFN operations.

Cobalt-60 concentrations in downstream samples averaged 0.19 pCi/g, while concentrations upstream averaged 0.03 pCi/g. The maximum concentrations were 0.43 and 0.04 pCi/g, respectively. Cesium-134 concentrations in upstream samples were all below the LLD. Levels in downstream samples averaged 0.07 pCi/g, with a maximum of 0.08 pCi/g. A realistic assessment of the impact to the general public from this activity produces a negligible dose equivalent. Results from the analysis of sediment samples are shown in table H-18.

Only naturally occurring radioisotopes were identified in clam flesh samples. The K-40 concentrations, presented in table H-19, ranged from 3.45 to 6.94 pCi/g.

ASSESSMENT AND EVALUATION

Potential doses to the public are estimated from measured effluents using computer models. These models were developed by TVA and are based on methodology provided by the NRC in Regulatory Guide 1.109 for determining the potential dose to individuals and populations living in the vicinity of a nuclear power plant. The doses calculated are a representation of the dose to a "maximum exposed individual." Some of the factors used in these calculations (such as ingestion rates) are maximum expected values which will tend to overestimate the dose to this "maximum" 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 maximum exposed individual due to radioactivity released from BFN in 1988 are presented in table 2. These estimates were made using the measured concentrations from the liquid and gaseous effluent monitors. Also shown are the technical specification limits for these doses and a comparison between the calculated dose and the corresponding 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 "Semiannual Radioactive Effluent Release Reports."

As indicated, the estimated increase in radiation dose equivalent to the general public resulting from the operation of BFN is trivial when compared to the dose from natural background radiation.

The results from each 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, Cs-134, 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 and Cs-134 were 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. Greater than 95 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.

The maximum calculated whole body dose equivalent from measured liquid effluents as presented in table 2 is 0.26 mrem/year, or 2.9 percent of the limit. The maximum organ dose equivalent from gaseous effluents is 0.010 mrem per year. This represents less than 0.1 percent of the technical specification limit.

REFERENCES

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

2. National Council on Radiation Protection and Measurements, Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," September 1987.

3. United States Nuclear Regulatory Commission, Regulatory Guide 8.29, "Instruction Concerning Risks From Occupational Radiation Exposure," July 1981.

Table 1

MAXIMUM PERMISSIBLE CONCENTRATIONS

FOR NONOCCUPATIONAL EXPOSURE

	MPC	
	In Water pCi/l*	In Air pCI/m^3*
Gross beta	3,000	100
H-3	3,000,000	200,000
Cs-137	20,000	500
Ru-103,106	10,000	200
Ce-144	10,000	100
Zr-95 - Nb-95	60,000	1,000
Ba-140 - La-140	20,000	1,000
I-131	300	100
Zn-65	100,000	2,000
Mn-54	100,000	1,000
Co-60	30,000	300
Sr-89	3,000	300
Sr-90	300	30
Cr-51	2,000,000	80,000
Cs-134	9,000	400
Co-58	90,000	2,000

*1 pCi = 3.7×10^{-2} Bq.

Source: 10 CFR, Part 20, Appendix B, Table II.

Table 2

Maximum Dose due to Radioactive Effluent Releases
Browns Ferry Nuclear Plant
1988
mrem/year

Liquid Effluents

Type	1988 Dose	NRC Limit	Percent of NRC Limit	EPA Limit	Percent of EPA Limit
Total Body	0.26	9	2.9	25	1.0
Any Organ	0.35	30	1.2	25	1.4

Gaseous Effluents

Type	1988 Dose	NRC Limit	Percent of NRC Limit	EPA Limit	Percent of EPA Limit
Noble Gas (Gamma)	0.0000006	45	<0.001	25	<0.001
Noble Gas (Beta)	0.000002	60	<0.001	25	<0.001
Any Organ	0.010	45	0.022	25	0.04

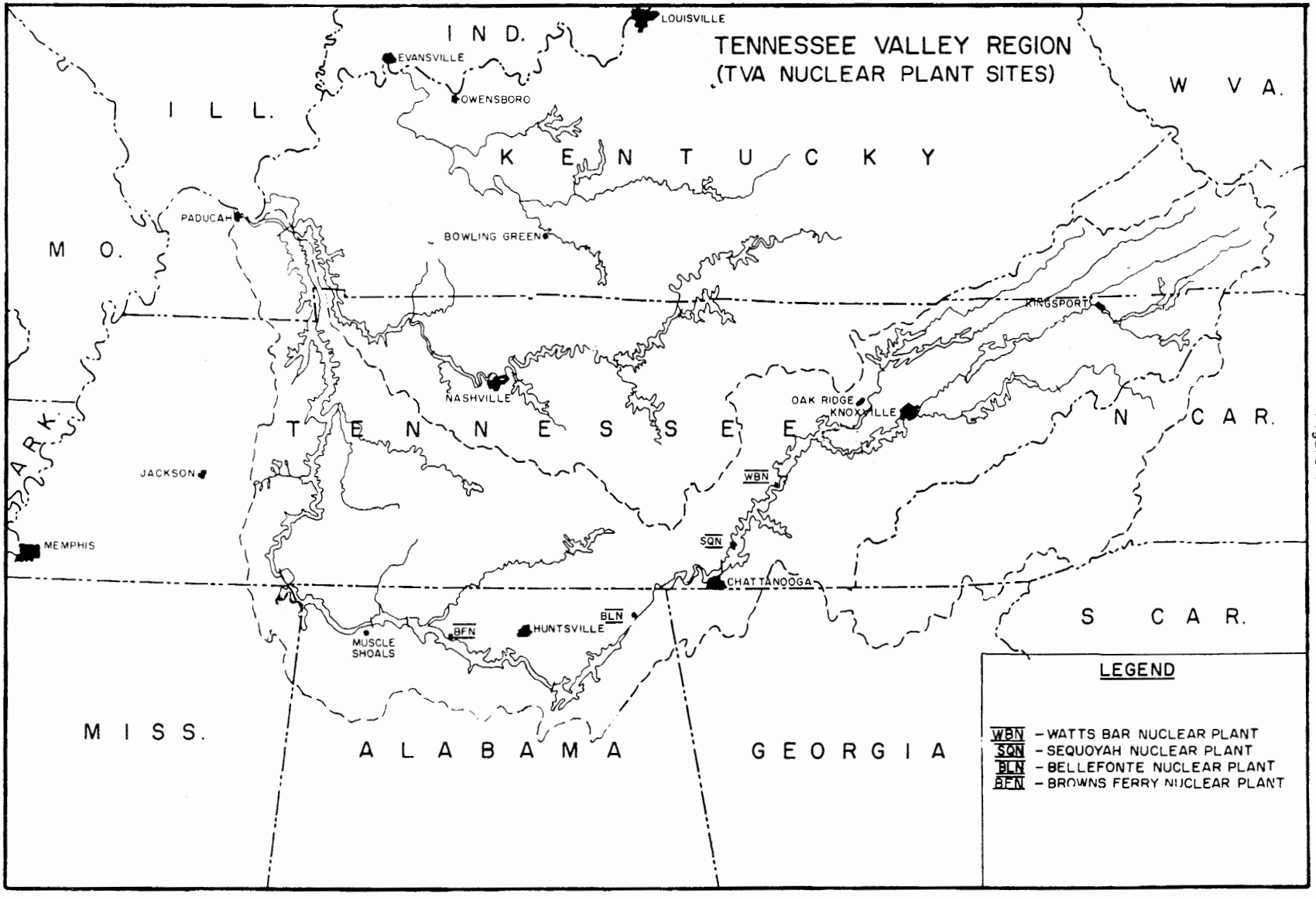
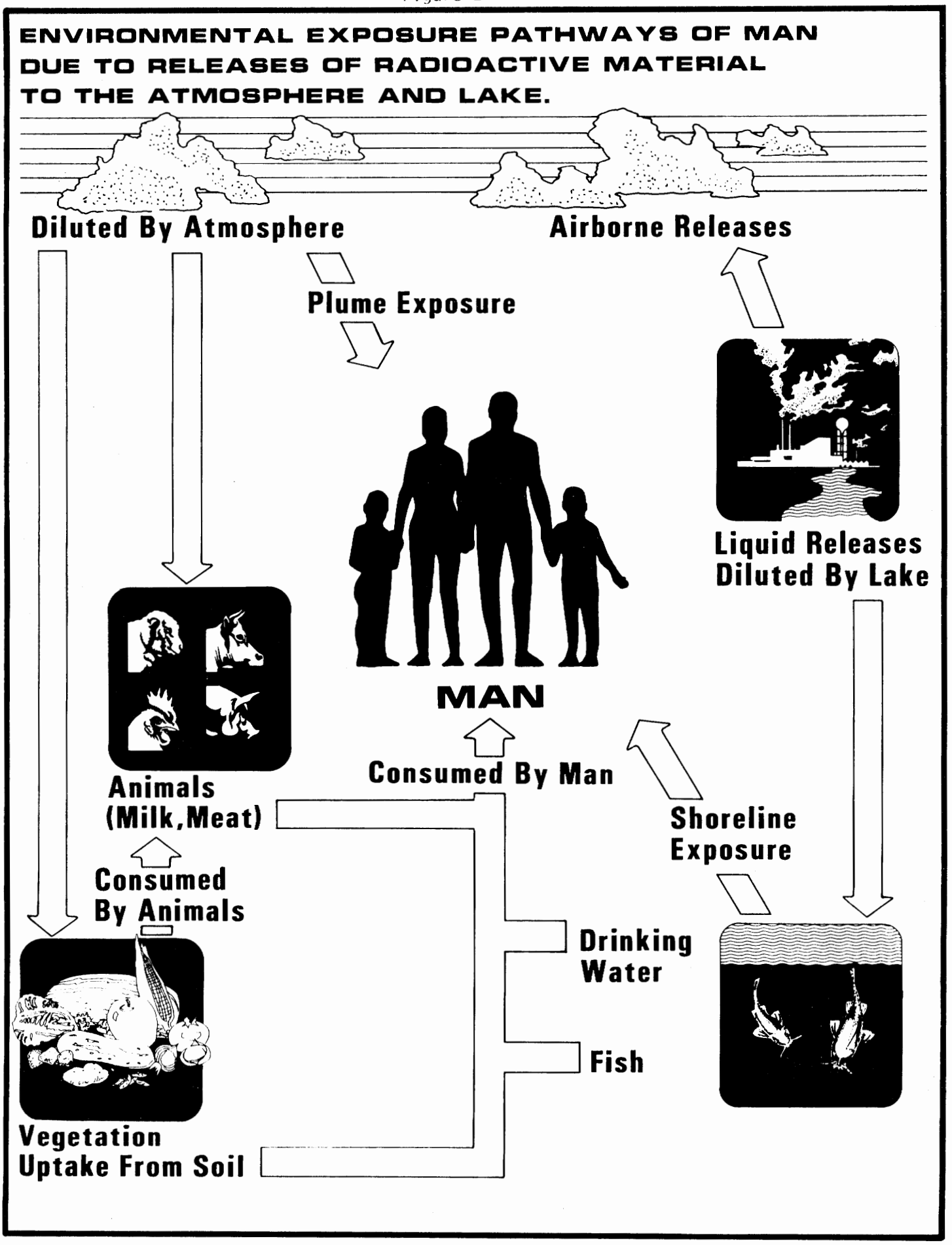

TENNESSEE VALLEY REGION
(TVA NUCLEAR PLANT SITES)
LOUISVILLE
IND.
EVANSVILLE
OWENSBORO
ILL.
W VA.
KENTUCKY
PADUCAH
BOWLING GREEN
MO.
KINGSPORT
NASHVILLE
OAK RIDGE
KNOXVILLE
ARK.
TENNESSEE
N CAR.
JACKSON
WBN
MEMPHIS
SQN
CHATTANOOGA
S CAR.
BLN
HUNTSVILLE
BFN
MUSCLE SHOALS
MISS.
ALABAMA
GEORGIA
LEGEND
WBN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

Figure I

Figure 2


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

APPENDIX A

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM AND SAMPLING LOCATIONS

Table A-1

BROWNS FERRY NUCLEAR PLANT

Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
AIRBORNE			
Particulates	Five samples from locations (in different sectors) at or near boundary site (LM-1, LM-2 LM-3, LM-4, LM-6, and LM-7) Two samples from control locations greater than 10 miles from the plant (RM-1 and RM-6) Three samples from locations in communities approximately 10 miles from the plant PM-1, PM-2, and PM-3)	Continuous sampler operation with sample collection as required by dust loading but at least once per 7 days	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. Analyze for Sr-89,90 content of quarterly composite (by location) at least once per 92 days.
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
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

Table A-1

BROWNS FERRY NUCLEAR PLANT

Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
	Two or more dosimeters placed at stations located greater than 5 miles from the plant in each of the 16 sectors	At least once per 92 days	Gamma dose once per 92 days
	Two or more dosimeters in at least 8 additional locations of special interest		
WATERBORNE			
Surface	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[c]	Gross beta and gamma scan on 4-week composite. Composite for Sr-89, Sr-90, and tritium at least once per 92 days
Drinking	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 7 days[c]	Gross beta and gamma scan on weekly 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 4-week composite. 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 [d] (TRM 305)	Collected by automatic sequential-type sampler with composite sample taken at least once per 7 days[c]	
Ground	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[c]	Gamma scan on each 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[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
	One sample at a control location upgradient from the plant (Farm L)	Grab 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
AQUATIC			
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)		
INGESTION			
Milk	At least 3 samples from dairy farms in the immediate vicinity of the plant (Farms B, Bn, and L)	At least once per 15 days when animals are on pasture; at least once per 31 days at other times	I-131 on each sample. Gamma scan, Sr-89 and Sr-90 at least once per 31 days
	At least one sample from control loction (Farm Be and/or O)		
Fish	Three samples representing commercial and game species in Guntersville Reservoir above the plant	At least once per 184 days	Gross beta and gamma scan at least once per 184 days on edible portions
	Three samples representing commercial and game species in Wheeler Reservoir near the plant and in Wilson Reservoir downstream from plant.		

Table A-1

BROWNS FERRY NUCLEAR PLANT

Environmental Radiological Monitoring Program[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
Clams	Samples from same locations as sediment (if available)	Same as sediment	Gamma scan on flesh only
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 One sample of each of the same foods grown at greater than 10 miles distance from the plant	At least once per year at time of harvest	Gamma scan on edible portion
Vegetation	Samples from the nearby farms (Farms B, Bn, L, W, and T) and from the air monitoring stations (LM-1, 2, 3, 4, 6, and 7) Control samples from one remote air monitor station (RM-1) and one control dairy (Farm 0)	Once per 31 days	I-131, gamma scan once per 31 days

a. The sampling program outlined in this table is that which was in effect at the end of 1988.
b. Sampling locations, sector and distance from plant, are described in Table A-2 and A-3 and shown in Figures A-1, A-2, and A-3.
c. Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
d. The surface water control sample shall be considered a control for the drinking water sample.

Table A-2

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program
Sampling Locations

Map Location Number[a]	Station	Sector	Approximate Distance (miles)	Indicator (I) or Control (C)	Samples Collected[b]
1	PM-1	NW	13.8	I	AP,CF,R,S
2	PM-2	NE	10.9	I	AP,CF,R,S
3	PM-3	SSE	8.2	I	AP,CF,R,S
4	LM-7[c]	W	2.1	I	AP,CF,R,S,V
5	RM-1	W	31.3	C	AP,CF,R,S,V
6	RM-6	E	24.2	C	AP,CF,R,S
7	LM-1	N	0.97	I	AP,CF,R,S,V
8	LM-2	NNE	0.88	I	AP,CF,R,S,V
9	LM-3	ENE	0.92	I	AP,CF,R,S,V
10	LM-4	NNW	1.7	I	AP,CF,R,S,V
11	LM-6	SSW	3.0	I	AP,CF,R,S,V
12	Farm B	NNW	6.8	I	M,V
13	Farm Bn	N	5.0	I	M,V
14	Farm L	ENE	5.9	I	M,V,W
17	Farm C[d]	N	32.0	C	M
20	Farm E[e]	NE	6.1	I	V
21	Farm W	NE	6.8	I	V
22	Well No. 6	NW	0.02	I	W
23	TRM[f] 282.6	-	11.4[g]	I	PW
24	TRM 306.0	-	12.0[g]	C	PW
25	Muscle Shoals, AL	W	31.3	I	PW
26	TRM 274.9	-	19.1[g]	I	PW
27	TRM 285.2	-	8.8[g]	I	SW
28	TRM 293.5	-	0.5[g]	I	SW
29	TRM 305.0	-	11.0[g]	C[h]	SW
30	TRM 307.52	-	13.52[g]	C	CL,SD
31	TRM 293.7	-	0.3[g]	I	CL,SD
32	TRM 288.78	-	5.22[g]	I	CL,SD
33	TRM 277.98	-	16.02[g]	I	CL,SD
34	Farm Be	NW	28.8	C	M
35	Farm O	E	26.2	C	M,V
36	Farm T[i]	WNW	3.3	I	V
37	TRM 297.0	-	3.0	C	CL,SD
	Wilson Reservoir[a] (TRM 259-275)	-	-	I	F

Table A-2

BROWNS FERRY NUCLEAR PLANT
Environmental Radiological Monitoring Program
Sampling Locations
(Continued)

Map Location Number[a]	Station	Sector	Approximate Distance (miles)	Indicator (I) or Control (C)	Samples Collected[a]
	Wheeler Reservoir[a] (TRM 275-349)	-	-	I	F
	Guntersville Reservoir[a] TRM (349-424)	-	-	C	F

a. See figures A-1, A-2, and A-3.
b. Sample Codes:

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

c. Station activated December 21, 1987 - first sample collected December 28, 1987.
d. Sampling discontinued August 29, 1988.
e. Sampling discontinued August 8, 1988.
f. TRM = Tennessee River Mile
g. Miles from plant discharge (TRM 294).
h. Also used as a control for public water.
i. Sampling began October 31, 1988.

Table A-3

BROWNS FERRY NUCLEAR PLANT
Thermoluminescent Dosimeter (TLD) Locations

Map Location Number[a]	Station	Sector	Approximate Distance (miles)	Onsite (On)[b] or Offsite (Off)
1	NW-3	NW	13.8	Off
2	NE-3	NE	10.9	Off
3	SSE-2	SSE	8.2	Off
5	W-3	W	31.3	Off
6	E-3	E	24.2	Off
7	N-1	N	0.97	On
8	NNE-1	NNE	0.88	On
9	ENE-1	ENE	0.92	On
10	NNW-2	NNW	1.7	On
38	N-2	N	5.0	Off
39	NNE-2	NNE	0.7	On
40	NNE-3	NNE	5.2	Off
41	NE-1	NE	0.8	On
42	NE-2	NE	5.0	Off
43	ENE-2	ENE	6.2	Off
44	E-1	E	0.8	On
45	E-2	E	5.2	Off
46	ESE-1	ESE	0.9	On
47	ESE-2	ESE	3.0	Off
48	SE-1	SE	0.5	On
49	SE-2	SE	5.4	Off
50	SSE-1	SSE	5.1	Off
51	S-1	S	3.1	Off
52	S-2	S	4.8	Off
53	SSW-1	SSW	3.0	Off
54	SSW-2	SSW	4.4	Off
55	SW-1	SW	1.9	On
56	SW-2	SW	4.7	Off
57	SW-3	SW	6.0	Off
58	WSW-1	WSW	2.7	Off
59	WSW-2	WSW	5.1	Off
60	WSW-3	WSW	10.5	Off
61	W-1	W	1.9	On
62	W-2	W	4.7	Off
63	W-4	W	32.1	Off
64	WNW-1	WNW	3.3	Off
65	WNW-2	WNW	4.4	Off
66	NW-1	NW	2.2	Off
67	NW-2	NW	5.3	Off

Table A-3

BROWNS FERRY NUCLEAR PLANT
Thermoluminescent Dosimeter (TLD) Locations
(Continued)

Map Location Number[a]	Station	Sector	Approximate Distance (miles)	Onsite (On)[b] or Offsite (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

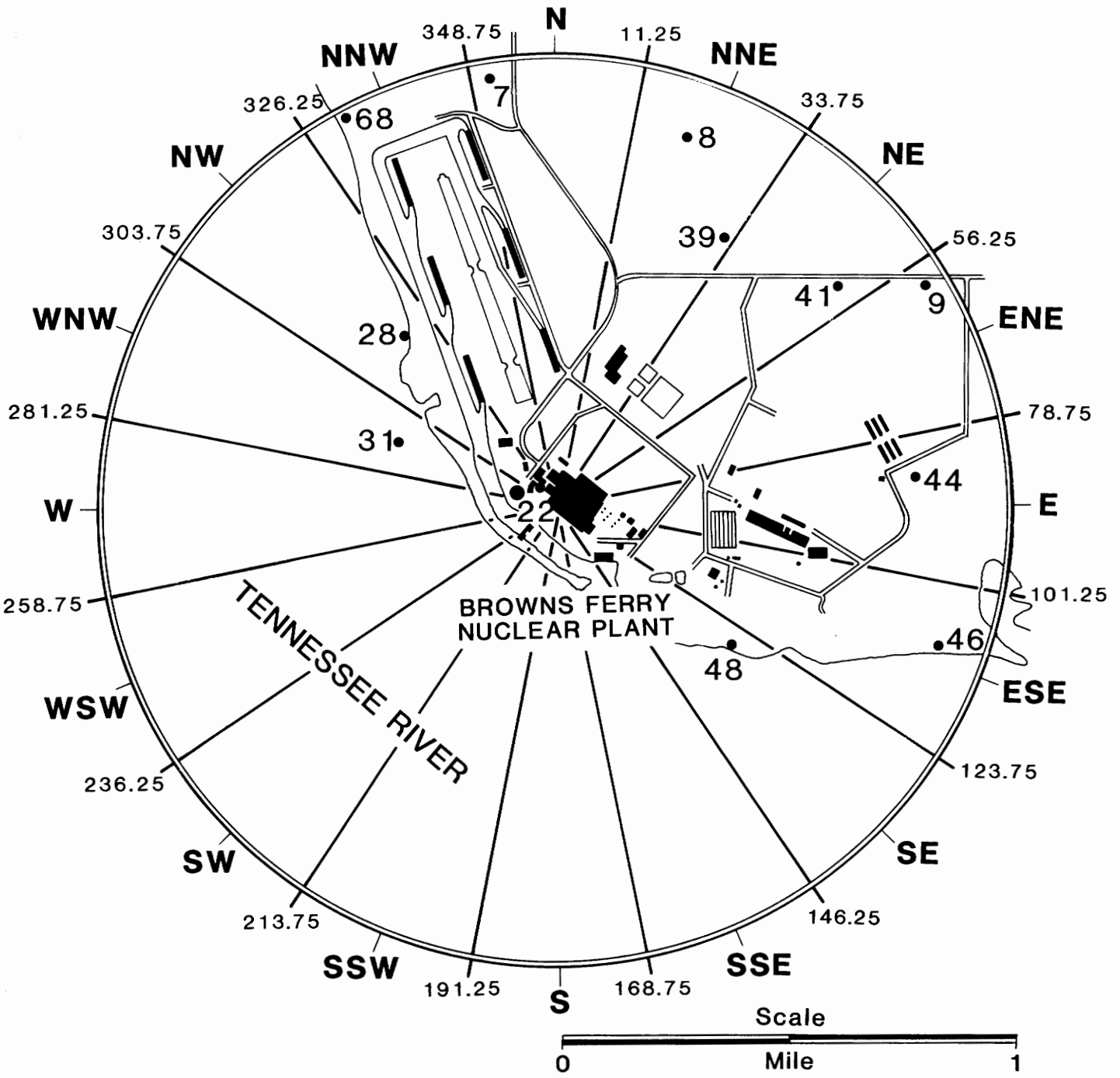


Figure A-2

Environmental Radiological Sampling Locations

From 1 to 5 Miles From The Plant

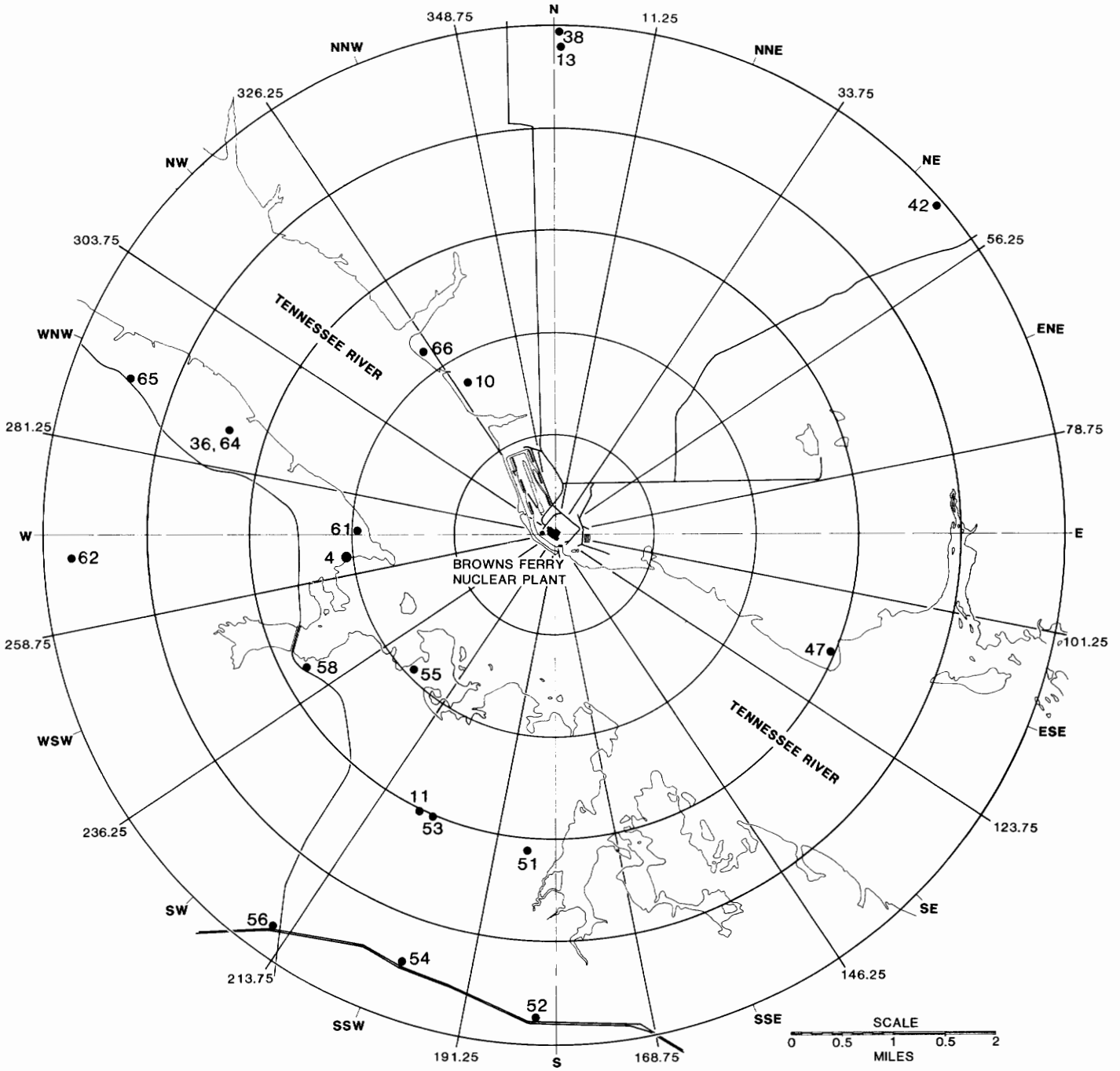
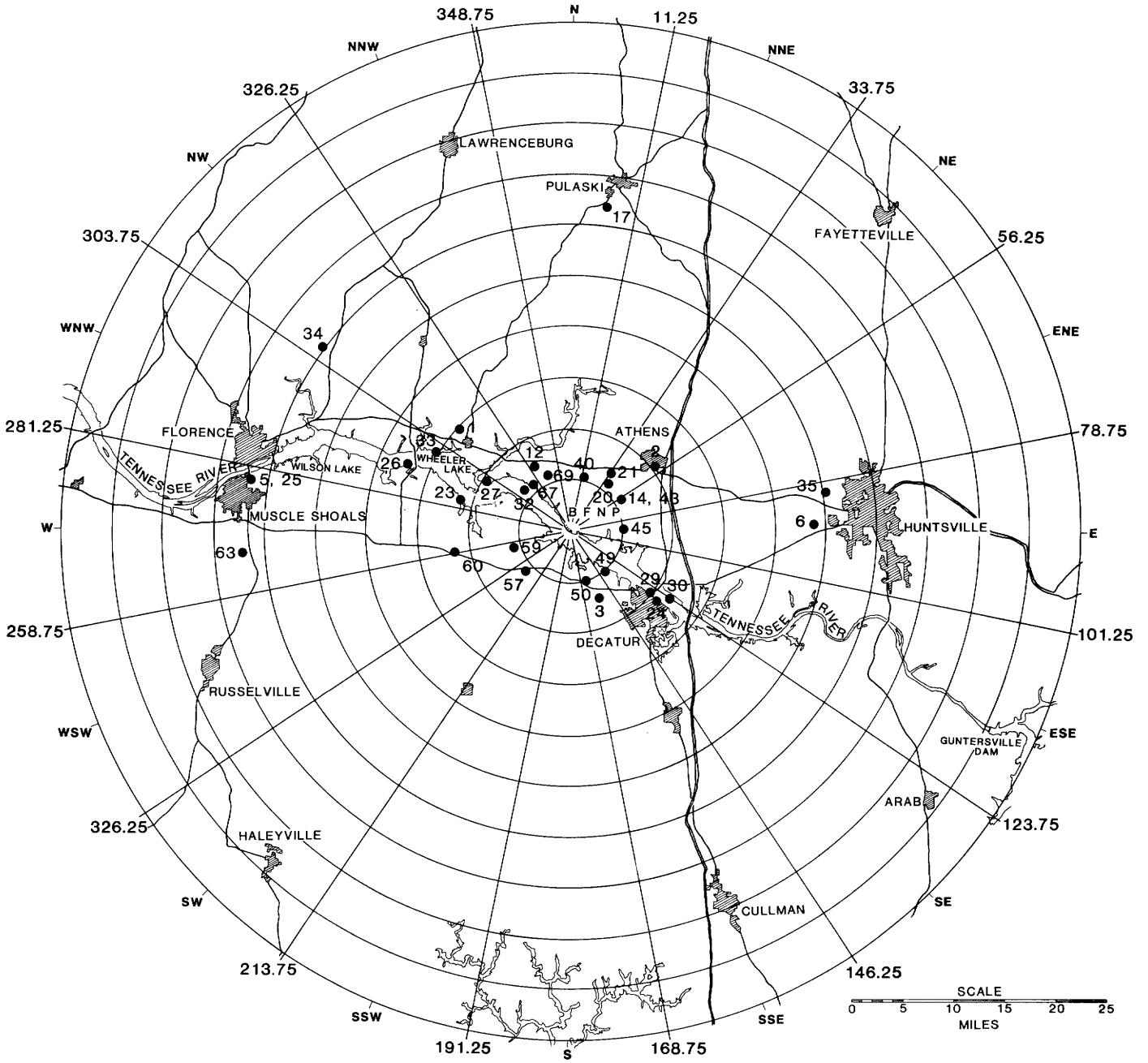


Figure A-3

Environmental Radiological Sampling Locations

Greater Than 5 Miles From The Plant



APPENDIX B

1988 PROGRAM MODIFICATIONS

APPENDIX B

Environmental Radiological Monitoring Program Modifications

During 1988, a small number of modifications were made in the environmental monitoring program.

An air sampling station was added to obtain data at a subdivision near the plant. One farm was deleted and one farm added to the program as a result of the land use survey. One control dairy was deleted after another had been added in 1987.

The following table lists the changes in the monitoring program in 1988.

Table B-1

Environmental Radiological Monitoring Program Modifications

Date	Station	Location	Remarks
12/21/87	LM-7	2.1 miles west	Added to the sampling program to obtain data at a residential subdivision near the plant (see table A-2 for samples collected).
8/8/88	Farm E	6.1 miles NE	The milk-producing animal disposed of. Sampling discontinued.
8/29/88	Farm C	32 miles N	Sampling discontinued after a replacement dairy nearer the analytical laboratory was added to the program in late 1987.
10/31/88	Farm T	3.3 miles NWN	Added to the sampling program after the 1988 land use survey identified a milk-producing animal at this location (see appendix G for details and table A-2 for samles collected).

APPENDIX C

MISSED SAMPLES AND ANALYSES

Appendix C

Missed Samples and Analyses

During 1988, a small number of samples were not collected and several analyses were not completed on some collected samples. Those occurrences resulted in deviations from the scheduled program but not from the program required by the Technical Specifications. Table C-1 lists these occurrences. A general description follows.

Two milk samples were missed because the milk collection truck ran earlier than scheduled, three samples (air, public water, and well water) were not collected because of equipment malfunction, one clam sample was not collected because of scarcity of clams, one food crop (green beans) could not be found because of severe drought conditions in the area, and four samples (two milk and two air filters) were destroyed during processing preventing complete analysis. Missed milk samples were from extra sampling locations, equipment malfunctions were corrected, and the analyst responsible for the destroyed samples received additional training to prevent recurrence.

Table C-1

Environmental Radiological Monitoring Program Deviations

Date	Station	Location	Remarks
1/19/88	Farm O	26.2 miles E	Milk sample not available for collection.
2/8/88	Farm O	26.2 miles E	Milk sample lost or destroyed in analysis - strontium analysis not done.
3/7/88	RM-1	31.3 miles W	Air particulate and charcoal (iodine) sample not collected - sampler malfunction.
3/28/88	TRM 282.6	11.4 miles downstream	Public water sample not available for collection.
5/9/88	Farm Bn	5 miles N	Milk sample lost or destroyed before analysis for I-131 done.
5/11/88	TRM 277.98	16.02 miles downstream	Clam sample not available for collection
8/29/88	LM-2	.88 miles NNE	Air particulate filter (quarterly composite) lost or destroyed during analysis for strontium.
8/29/88	LM-7	2.1 miles W	Air particulate filter (quarterly composite) lost or destroyed during analysis for strontium.
9/19/88	Farm O	26.2 miles E	Milk sample not available for collection.
12/19/88	Well 6	Onsite	Well water not available because of sampling pump malfunction.

APPENDIX D

ANALYTICAL PROCEDURES

APPENDIX D

Analytical Procedures

All analyses 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, transfering 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 commerically 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 mutlichannel analyzer system. Spectral data reduction is performed by the computer program HYPERMET.

The gaseous radioiodine analyses are performed with well-type NaI detectors interfaced with a single channel analyzer. The system is calibrated to measure I-131. If activity above a specified limit is detected, the sample is analyzed by gamma spectroscopy.

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

APPENDIX E

NOMINAL LOWER LIMITS OF DETECTION (LLD)

Appendix E

Nominal Lower Limits of Detection

Sensitive radiation detection devices can give a signal or reading 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 machine noise. Thus, there is always some sort of signal on these sensitive devices. 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 some 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 machine 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 measureable 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 Technical Specifications, are presented in the following table.

Table E-1

Nominal LLD Values
A. Radiochemical Procedures

	Air Filters (pCi/m^3)	Charcoal Filters (pCi/m^3)	Water (pCi/L)	Milk (pCi/L)	Fish Flesh (pCi/g dry)	Whole Fish (pCi/g dry)	Food Crops (pCi/kg wet)	Sediment and Soil (pCi/g dry)
Gross Beta	0.002		1.7				9	
Tritium			250					
Iodine-131		.020	1.0	0.2				
Strontium-89	0.0006		3.0	2.5	0.3	0.7		1.0
Strontium-90	0.00025		1.4	2.0	0.04	0.09		0.3

	Wet Vegetation (pCi/kg Wet)	Clam Flesh (pCi/g Dry)	Meat (pCi/kg Wet)
Gross Beta		0.2	15
Iodine-131	4		
Strontium-89	140		
Strontium-90	60		

Table E-1

Nominal LLD Values
B. Gamma Analyses (GeLi)

	Air Particulates pCi/m3	Water and Milk pCi/L	Vegetation and Grain pCi/g, dry	Wet Vegetation pCi/kg, wet	Soil and Sediment pCi/g, dry	Fish pCi/g, dry	Clam Flesh pCi/g, dry	Foods, Tomatoes Potatoes, etc. pCi/kg, wet	Meat and Poultry pCi/kg, wet
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

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 are complex and 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 reproduciblity 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 answer questions about the performance of the 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 measureable 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.

There is another kind of replicate sample. From time to time, 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 measureable 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 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.

TVA splits certain environmental samples with laboratories operated by the States of Alabama and Tennessee and the EPA Eastern Environmental Radiation Facility in Montgomery, Alabama. When radioactivity has been present in the environment in measureable 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 help or improvement. The end result is a measurement process that provides accurate 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)

	Gross Alpha		Gross Beta		Strontium-90		Cesium-137	
Date	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.
3/88	20±9	24	50±9	52	17±2.6	16	16±9	14
8/88	8±9	<1[a]	29±9	16[a]	8±2.6	6	12±9	11

B. Radiochemical Analysis of Water (pCi/L)

	Gross Beta		Strontium-89		Strontium-90		Tritium		Iodine-131	
Date	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.
1/88	8±9	11	30±9	21[b]	15±2.6	13				
2/88							3327±627	3221		
3/88	13±9	14								
4/88[c]			5±9	<7	5±2.6	4				
4/88									7.5±1.3	6.3
5/88	11±9	11	20±9	15	20±2.6	18			76 ±14	76
6/88							5565±965	4408[e]		
7/88	4±9[d]	7								
8/88										
9/88	10±9	11								
10/88							2316±606	2293		
10/88[c]			11±9	11	10±2.6	8.3				
11/88	9±9	11								
12/88									115±21	13[f]

Table F-1

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM (Continued)

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

	Chromium-51		Cobalt-60		Zinc-65		Ruthenium-106		Cesium-134		Cesium-137	
Date	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.
2/88			69±9	70	94±16	93	105±18	94	64±9	59	94±9	93
4/88[c]			50±9	52					7±9	7	7±9	7
6/88	302±52	306	15±9	15	101±17	100	195±35	186	20±9	20	25±9	25
10/88	251±43	252	25±9	27	151±26	154	152±26	141	25±9	24	15±9	16
10/88[c]									15±9	14	15±9	15

D. Food (pCi/Kg, Wet Weight)

	Iodine-131		Cesium-137		Potassium-40[g]	
Date	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.
1/88	102±18	100	91±9	89	1230±107	1720[h]
7/88	107±19	104	49±9	47	1240±107	1170

E. Milk (pCi/L)

	Strontium-89		Strontium-90		Iodine-131		Cesium-137		Potassium-40[g]	
Date	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.	EPA Value (±3σ)	TVA Avg.
2/88					4±0.7	4				
6/88	40±9	25[b]	60±5	61	94±16	97	51±9	51	1600±139	1633
10/88	40±9	45	60±5	45[b]	91±16	91	50±9	50	1600±139	1700[h]

Footnotes for Table F-1

Results Obtained in Interlaboratory Comparison Program

a. Apparently, self-absorption caused by sample mounting or preparation caused all gross alpha and gross beta values to be consistently low.

b. The low strontium result was investigated. A definitive cause for the low result could not be identified. Further evaluation of the strontium radioanalytical procedure continues.

c. Performance Evaluation Intercomparison Study.

d. Results not reported properly to EPA.

e. Reanalysis of sample gave 4666 pCi/l. No errors could be found in our analysis. Subsequent analyses were good.

f. Transcription error - 113 should have been the reported average.

g. Units are milligram of total potassium per kilogram or liter rather than picrocuries of K-40 per kilogram or liter.

h. Errors in K-40 measurement may be due to changes in temperature. These samples are initially refrigerated and then warm gradually while they are counted, possibly causing a gain shift in the detector.

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.

From these data, radiation doses are projected for individuals living near the plant. Doses from breathing air (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. These doses are calculated using design basis source terms and historical meteorological data.

Several changes were made in the methodology used to calculate these doses. In the past, receptor information reported in the land use survey and located

on an aerial photo map were transferred to a topographic map. The distances measured on this map were usually different from those reported in the land use survey. Now, the distances reported in the land use survey are used for dose calculations. Elevations for receptors had been read from the topographic map. Now, the highest elevation in a sector within 5 miles of the plant will be used for any receptor identified in that sector.

Doses calculated for air submersion were slightly higher, reflecting changes in methodology as noted above.

Doses calculated for ingestion of home-grown foods changed in some sectors, reflecting shifts in the location of the nearest garden. The most notable increase occurred in the north sector where a garden was identified approximately 1 mile nearer the plant than in 1987.

For milk ingestion, projected annual doses changed at two locations. At one location, 6.8 miles northeast of the plant, doses were not calculated because the milk-producing animal was disposed of. This location will be removed from the sampling schedule. At another location, 3.3 miles west-northwest of the plant, a milk-producing animal was identified at a farm that previously had no milk-producing animals. Dose calculations indicate that this location should be part of the monitoring program. Contact with the owner revealed that sufficient quantities of milk for analysis would not be available. Therefore, in lieu of milk samples, the owner agreed to allow monthly collection of vegetation samples. The first sample was collected October 31, 1988.

Tables G-1, G-2, and G-3 show the comparative calculated doses for 1987 and 1988.

Table G-1

BROWNS FERRY NUCLEAR PLANT

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

	1987 Survey		1988 Survey	
Sector	Approximate Distance (Miles)	Annual Dose	Approximate Distance (Miles)	Annual Dose
N	1.01	0.46	1.04	0.45
NNE	1.77	0.08	1.68	0.11
NE	2.53	0.08	2.34	0.14
ENE	1.22	0.14	1.07	0.19
E	2.76	0.10	2.37	0.11
ESE	2.89	0.06	2.70	0.09
SE	5.03	0.07	5.03	0.08
SSE	4.45	0.07	4.40	0.08
S	2.77	0.12	2.82	0.13
SSW	2.58	0.14	2.60	0.17
SW	3.04	0.10	3.15	0.13
WSW	3.57	0.07	2.70	0.08
W	1.58	0.14	1.63	0.15
WNW	2.75	0.10	2.82	0.13
NW	2.18	0.21	1.89	0.31
NNW	1.03	0.53	0.95	0.68

Table G-2

BROWNS FERRY NUCLEAR PLANT

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

Sector	1987 Survey		1988 Survey		Number of Gardens Within 3 Miles (1988)
	Approximate Distance (Miles)	Annual Dose	Approximate Distance (Miles)	Annual Dose	
N	2.04	4.30	1.04	9.75	4
NNE	1.85	2.10	1.80	2.16	3
NE	2.47	1.41	2.75	1.25	3
ENE	1.22	3.60	1.68	2.52	4
E	2.47	2.28	2.37	2.43	5
ESE	2.85	2.02	a	----	0
SE	a	----	a	----	0
SSE	4.47	1.08	4.40	1.10	0
S	2.77	2.24	2.82	2.19	1
SSW	2.58	2.82	2.60	2.79	4
SW	3.37	1.03	3.15	1.15	0
WSW	2.57	0.69	2.70	0.65	4
W	2.19	0.89	1.89	1.08	2
WNW	2.75	1.54	3.36	1.16	0
NW	2.18	5.21	2.20	5.13	2
NNW	1.14	10.10	1.14	10.10	7

a. Garden not identified in this sector.

Table G-3

BROWNS FERRY NUCLEAR PLANT

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

Location	Sector	Approximate Distance (Miles)	Annual Dose 1987	1988
Farm Bn[a,b]	N	5.0	0.04	0.04
Farm L[a,b]	ENE	5.9	0.01	0.01
Farm B[a,b]	NNW	6.8	0.02	0.02
Farm W[c]	NE	6.8	0.08	----
Farm T[b,d]	WNW	3.3	----	0.09

a. Milk being sampled at these locations.
b. Vegetation being sampled at these locations.
c. Milk producing animal no longer at this location in 1988.
d. This location was identified as having a milk-producing animal in 1988.

Table H-1

DIRECT RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from Browns Ferry Nuclear Plant for Each Quarter - 1988
mR/Quarter[a]

Distance Miles	Average External Gamma Radiation Levels[b] 1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
0-1	20.3 ± 2.5	19.7 ± 3.5	17.9 ± 2.7	17.9 ± 1.1
1-2	16.7 ± 3.3	17.5 ± 3.3	15.2 ± 2.4	16.5 ± 2.1
2-4	18.0 ± 3.7	16.1 ± 2.5	14.1 ± 2.2	16.2 ± 2.8
4-6	17.1 ± 1.5	17.2 ± 2.9	14.0 ± 1.3	16.1 ± 1.5
> 6	16.0 ± 1.9	14.7 ± 2.6	13.0 ± 1.4	15.2 ± 1.4
Average, 0-2 miles (onsite)	19.4 ± 3.0	19.1 ± 3.4	17.2 ± 2.8	17.6 ± 1.4
Average, greater than 2 miles (offsite)	16.9 ± 2.2	16.2 ± 2.9	13.7 ± 1.6	15.8 ± 1.8

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

RADIOACTIVITY IN AIR FILTER

PCI/M(3) - 0.037 BQ/M(3)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA 582	2.00E-03	2.14E-02(477/ 477) 1.25E-02 - 3.53E-02	LM3 BF NORTHEAST 1.0 MILE ENE	2.24E-02(53/ 53) 1.42E-02 - 3.53E-02	2.08E-02(105/ 105) 1.31E-02 - 3.43E-02	
GAMMA (GELI) 154						
BI-214	5.00E-03	9.67E-03(10/ 126) 5.10E-03 - 2.24E-02	LM-6BF BAKER BOT 3.0 MILES SSW	1.66E-02(2/ 14) 1.07E-02 - 2.24E-02	7.90E-03(1/ 28) 7.90E-03 - 7.90E-03	
PB-214	5.00E-03	6.92E-03(4/ 126) 5.50E-03 - 8.90E-03	ROGERSVILLE, AL 13.8 MILES NW	8.90E-03(1/ 14) 8.90E-03 - 8.90E-03	8.70E-03(1/ 28) 8.70E-03 - 8.70E-03	
BE-7	2.00E-02	1.08E-01(126/ 126) 7.45E-02 - 1.53E-01	LM3 BF NORTHEAST 1.0 MILE ENE	1.14E-01(14/ 14) 8.05E-02 - 1.53E-01	1.06E-01(28/ 28) 6.89E-02 - 1.40E-01	
TL-208	NOT ESTAB	2.75E-04(4/ 126) 2.00E-04 - 4.00E-04	ATHENS, AL 10.9 MILES NE	4.00E-04(1/ 14) 4.00E-04 - 4.00E-04	9.00E-04(1/ 28) 9.00E-04 - 9.00E-04	
AC-228	NOT ESTAB	3.11E-03(9/ 126) 1.20E-03 - 3.20E-03	ROGERSVILLE, AL 13.8 MILES NW	6.40E-03(1/ 14) 6.40E-03 - 6.40E-03	1.48E-03(5/ 28) 7.00E-04 - 2.30E-03	
SR 89 42	6.00E-04	34 VALUES <LLD ANALYSIS PERFORMED			8 VALUES <LLD	
SR 90 42	3.00E-04	34 VALUES <LLD ANALYSIS PERFORMED			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).

TABLE H-3

RADIOACTIVITY IN CHARCOAL FILTERS

PCI/M(3) - 0.037 BQ/M(3)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	2.00E-02	2.77E-02(2/ 477)	ATHENS, AL	3.44E-02(1/ 53)	105 VALUES <LLD	
582		2.09E-02 - 3.44E-02	10.9 MILES NE	3.44E-02 - 3.44E-02		

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

TABLE H-4

RADIOACTIVITY IN MILK

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	2.00E-01	158 VALUES <LLD			140 VALUES <LLD	
296		ANALYSIS PERFORMED				
GAMMA (GELI)						
73						
K-40	1.50E+02	1.24E+03(39/ 39)	LOONEY FARM 5.9	1.27E+03(13/ 13)	1.35E+03(34/ 34)	
		9.18E+02 - 1.55E+03	S ENE	1.14E+03 - 1.47E+03	1.23E+03 - 1.55E+03	
BI-214	2.00E+01	4.55E+01(2/ 39)	LOONEY FARM 5.9	6.39E+01(1/ 13)	2.04E+01(1/ 34)	
		2.72E+01 - 6.39E+01	S ENE	6.39E+01 - 6.39E+01	2.04E+01 - 2.04E+01	
PB-214	2.00E+01	4.61E+01(2/ 39)	LOONEY FARM 5.9	6.97E+01(1/ 13)	34 VALUES <LLD	
		2.25E+01 - 6.97E+01	S ENE	6.97E+01 - 6.97E+01		
TL-208	NOT ESTAB	1.51E+00(3/ 39)	SMITH/BENNETT FA	2.76E+00(1/ 13)	1.25E+00(2/ 34)	
		3.36E-01 - 2.76E+00	5.0 MILES N	2.76E+00 - 2.76E+00	7.35E-01 - 1.77E+00	
AC-228	NOT ESTAB	39 VALUES <LLD			1.21E+01(5/ 34)	
					6.14E+00 - 1.93E+01	
SR 89	2.50E+00	2.56E+00(1/ 39)	LOONEY FARM 5.9	2.56E+00(1/ 13)	3.03E+00(1/ 33)	
72		2.56E+00 - 2.56E+00	S ENE	2.56E+00 - 2.56E+00	3.03E+00 - 3.03E+00	
SR 90	2.00E+00	2.95E+00(29/ 39)	SMITH/BENNETT FA	3.13E+00(11/ 13)	2.71E+00(16/ 33)	
72		2.05E+00 - 5.03E+00	5.0 MILES N	2.21E+00 - 5.03E+00	2.10E+00 - 3.97E+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).

TABLE H-5

RADIOACTIVITY IN VEGETATION

PCI/KG - C.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	4.00E+00	141 VALUES <LLD			26 VALUES <LLD	
167		ANALYSIS PERFORMED				
GAMMA (GELI)						
167						
CS-137	2.40E+01	3.34E+01(3/ 141)	WISER FARM 6.8	3.98E+01(1/ 13)	2.57E+01(1/ 26)	
		2.85E+01 - 3.98E+01	S NE	3.98E+01 - 3.98E+01	2.57E+01 - 2.57E+01	
K-40	4.00E+02	5.13E+03(141/ 141)	LOONEY FARM 5.9	5.86E+03(13/ 13)	5.68E+03(26/ 26)	
		6.06E+02 - 1.51E+04	S ENE	6.06E+02 - 1.51E+04	1.91E+03 - 1.01E+04	
BI-214	4.80E+01	8.69E+01(36/ 141)	BROOKS FARM 6.8	1.25E+02(5/ 13)	7.69E+01(7/ 26)	
		4.97E+01 - 2.39E+02	S NNW	5.91E+01 - 2.39E+02	4.83E+01 - 1.19E+02	
BI-212	NOT ESTAB	1.53E+02(5/ 141)	LM3 BF NORTHEAST	1.92E+02(1/ 13)	26 VALUES <LLD	
		1.00E+02 - 1.92E+02	1.0 MILE ENE	1.92E+02 - 1.92E+02		
PB-214	8.00E+01	1.27E+02(14/ 141)	BROOKS FARM 6.8	1.86E+02(2/ 13)	1.06E+02(2/ 26)	
		8.01E+01 - 2.25E+02	S NNW	1.48E+02 - 2.25E+02	8.81E+01 - 1.24E+02	
PB-212	4.00E+01	8.52E+01(14/ 141)	LM3 BF NORTHEAST	1.44E+02(2/ 13)	7.05E+01(4/ 26)	
		4.19E+01 - 1.75E+02	1.0 MILE ENE	1.12E+02 - 1.75E+02	4.95E+01 - 8.64E+01	
BE-7	2.00E+02	2.36E+03(131/ 141)	EVANS FARM	4.77E+03(8/ 9)	1.98E+03(21/ 26)	
		2.01E+02 - 1.32E+04	6.1 MILES NE	3.37E+02 - 1.32E+04	3.81E+02 - 6.57E+03	
TL-208	NOT ESTAB	1.64E+01(47/ 141)	LM3 BF NORTHEAST	3.74E+01(4/ 13)	2.21E+01(8/ 26)	
		3.44E-01 - 6.75E+01	1.0 MILE ENE	1.50E+01 - 6.75E+01	1.53E+00 - 5.41E+01	
AC-228	NOT ESTAB	6.55E+01(30/ 141)	LM1 BF NORTHWEST	1.12E+02(1/ 13)	5.03E+01(8/ 26)	
		1.65E+01 - 1.37E+02	1.0 MILE N	1.12E+02 - 1.12E+02	1.80E+01 - 1.06E+02	
SR 89	1.40E+02	44 VALUES <LLD			8 VALUES <LLD	
52		ANALYSIS PERFORMED				
SR 90	6.00E+01	9.35E+01(21/ 44)	WISER FARM 6.8	1.68E+02(2/ 4)	7.81E+01(3/ 8)	
52		6.23E+01 - 2.72E+02	S NE	6.51E+01 - 2.72E+02	6.35E+01 - 8.89E+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).

TABLE H-6

RADIOACTIVITY IN SOIL

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI)						
11						
CS-137	1.00E-02	3.32E-01(9/ 9)	ATHENS, AL	5.56E-01(1/ 1)	4.24E-01(2/ 2)	
		5.85E-02 - 5.56E-01	10.9 MILES NE	5.56E-01 - 5.56E-01	3.53E-01 - 4.94E-01	
K-40	2.00E-01	5.56E+00(9/ 9)	LM4 BF TRAILER P	8.58E+00(1/ 1)	4.12E+00(2/ 2)	
		2.71E+00 - 8.58E+00	1.7 MILES NNW	8.58E+00 - 8.58E+00	3.43E+00 - 4.81E+00	
BI-214	4.00E-02	1.12E+00(9/ 9)	LM4 BF TRAILER P	1.53E+00(1/ 1)	8.61E-01(2/ 2)	
		6.26E-01 - 1.53E+00	1.7 MILES NNW	1.53E+00 - 1.53E+00	7.53E-01 - 9.71E-01	
BI-212	1.00E-01	1.23E+00(9/ 9)	LM4 BF TRAILER P	1.69E+00(1/ 1)	8.78E-01(2/ 2)	
		5.76E-01 - 1.69E+00	1.7 MILES NNW	1.69E+00 - 1.69E+00	7.95E-01 - 9.62E-01	
PB-214	2.00E-02	1.20E+00(9/ 9)	LM4 BF TRAILER P	1.61E+00(1/ 1)	9.31E-01(2/ 2)	
		6.76E-01 - 1.61E+00	1.7 MILES NNW	1.61E+00 - 1.61E+00	7.90E-01 - 1.07E+00	
PB-212	2.00E-02	1.14E+00(9/ 9)	LM4 BF TRAILER P	1.46E+00(1/ 1)	7.73E-01(2/ 2)	
		5.99E-01 - 1.46E+00	1.7 MILES NNW	1.46E+00 - 1.46E+00	6.32E-01 - 9.14E-01	
RA-226	5.00E-02	1.12E+00(9/ 9)	LM4 BF TRAILER P	1.53E+00(1/ 1)	8.61E-01(2/ 2)	
		6.26E-01 - 1.53E+00	1.7 MILES NNW	1.53E+00 - 1.53E+00	7.53E-01 - 9.71E-01	
RA-224	NOT ESTAB	1.28E+00(6/ 9)	DECATUR, AL	1.69E+00(1/ 1)	8.07E-01(2/ 2)	
		6.55E-01 - 1.69E+00	8.2 MILES SSE	1.69E+00 - 1.69E+00	6.62E-01 - 9.52E-01	
TL-208	2.00E-02	4.02E-01(9/ 9)	LM4 BF TRAILER P	5.32E-01(1/ 1)	2.65E-01(2/ 2)	
		2.00E-01 - 5.32E-01	1.7 MILES NNW	5.32E-01 - 5.32E-01	2.24E-01 - 3.06E-01	
AC-228	6.00E-02	1.18E+00(9/ 9)	LM4 BF TRAILER P	1.56E+00(1/ 1)	8.23E-01(2/ 2)	
		5.93E-01 - 1.56E+00	1.7 MILES NNW	1.56E+00 - 1.56E+00	6.96E-01 - 9.50E-01	
PA-234M	NOT ESTAB	3.30E+00(4/ 9)	LM2 BF NORTH	3.46E+00(1/ 1)	2.34E+00(1/ 2)	
		3.05E+00 - 3.46E+00	0.9 MILE NNE	3.46E+00 - 3.46E+00	2.34E+00 - 2.34E+00	
SR 89	1.00E+00	9 VALUES <LLD			2 VALUES <LLD	
11		ANALYSIS PERFORMED				
SR 90	3.00E-01	9 VALUES <LLD			2 VALUES <LLD	
11		ANALYSIS PERFORMED				

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

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

TABLE H-7

RADIOACTIVITY IN CABBAGE

PCI/KG - C.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA 2	9.00E+00	3.95E+03(1/ 1) 3.95E+03 - 3.95E+03	LM-6BF BAKER EOT 3.0 MILES SSW	3.95E+03(1/ 1) 3.95E+03 - 3.95E+03	3.62E+03(1/ 1) 3.62E+03 - 3.62E+03	
GAMMA (GELI) 2						
K-40	1.50E+02	1.08E+03(1/ 1) 1.08E+03 - 1.08E+03	LM-6BF BAKER EOT 3.0 MILES SSW	1.08E+03(1/ 1) 1.08E+03 - 1.08E+03	1.64E+03(1/ 1) 1.64E+03 - 1.64E+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).

TABLE H-8

RADIOACTIVITY IN POTATOES

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	9.00E+00	6.47E+03(1/ 1)	BROOKS FARM 6.8	6.47E+03(1/ 1)	7.02E+03(1/ 1)	
2		6.47E+03 - 6.47E+03	S NNW	6.47E+03 - 6.47E+03	7.02E+03 - 7.02E+03	
GAMMA (GELI)						
2						
K-40	1.50E+02	3.24E+03(1/ 1)	BROOKS FARM 6.8	3.24E+03(1/ 1)	3.42E+03(1/ 1)	
		3.24E+03 - 3.24E+03	S NNW	3.24E+03 - 3.24E+03	3.42E+03 - 3.42E+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).

TABLE H-9

RADIOACTIVITY IN TOMATOES

PCI/KG - C.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA 2	9.00E+00	3.31E+03(1/ 1) 3.81E+03 - 3.81E+03	7 MILES NNW	3.81E+03(1/ 1) 3.81E+03 - 3.81E+03	4.59E+03(1/ 1) 4.59E+03 - 4.59E+03	
GAMMA (GELI) 2						
K-40	1.50E+02	2.10E+03(1/ 1) 2.10E+03 - 2.10E+03	7 MILES NNW	2.10E+03(1/ 1) 2.10E+03 - 2.10E+03	2.41E+03(1/ 1) 2.41E+03 - 2.41E+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).

TABLE H-10

RADIOACTIVITY IN APPLES

PCI/KG - 0.037 BQ/KG (WET WT)

NAME OF FACILITY BROWNS FERRY DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	9.00E+00	1.12E+03(1/ 1)	7 MILES NNW	1.12E+03(1/ 1)	1.66E+03(1/ 1)	
2		1.12E+03 - 1.12E+03		1.12E+03 - 1.12E+03	1.66E+03 - 1.66E+03	
GAMMA (GELI)						
2						
K-40	1.50E+02	8.47E+02(1/ 1)	7 MILES NNW	8.47E+02(1/ 1)	8.40E+02(1/ 1)	
		8.47E+02 - 8.47E+02		8.47E+02 - 8.47E+02	8.40E+02 - 8.40E+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).

TABLE H-11

RADIOACTIVITY IN BEEF

PCI/KG - 0.037 BQ/KG (WET WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA 2	1.50E+01	6.18E+03(1/ 1) 6.18E+03 - 6.18E+03	SMITH/BENNETT FA 5.0 MILES N	6.18E+03(1/ 1) 6.18E+03 - 6.18E+03	4.38E+03(1/ 1) 4.38E+03 - 4.38E+03	
GAMMA (GELI) 2						
K-40	3.00E+02	2.21E+03(1/ 1) 2.21E+03 - 2.21E+03	SMITH/BENNETT FA 5.0 MILES N	2.21E+03(1/ 1) 2.21E+03 - 2.21E+03	2.19E+03(1/ 1) 2.19E+03 - 2.19E+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).

TABLE H-12

RADIOACTIVITY IN SURFACE WATER TOTAL

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	1.70E+00	2.87E+00(28/ 28)	TRM 293.5	2.94E+00(14/ 14)	2.76E+00(14/ 14)	
42		2.09E+00 - 4.67E+00		2.09E+00 - 4.67E+00	2.11E+00 - 3.86E+00	
GAMMA (GELI)						
42		28 VALUES <LLD			14 VALUES <LLD	
		ANALYSIS PERFORMED				
SR 89	3.00E+00	3.05E+00(1/ 10)	TRM 285.2	3.05E+00(1/ 5)	5 VALUES <LLD	
15		3.05E+00 - 3.05E+00		3.05E+00 - 3.05E+00		
SR 90	1.40E+00	10 VALUES <LLD			5 VALUES <LLD	
15		ANALYSIS PERFORMED				
TRITIUM	2.50E+02	10 VALUES <LLD			5 VALUES <LLD	
15		ANALYSIS PERFORMED				

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-13

RADIOACTIVITY IN PUBLIC WATER SUPPLY

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	1.70E+00	2.92E+00 (67/ 78)	CHAMPION PAPER	3.08E+00 (50/ 52)	2.70E+00 (27/ 27)	
105		1.74E+00 - 5.61E+00	TRM 282.6	1.84E+00 - 5.61E+00	1.93E+00 - 3.98E+00	
GAMMA (GELI)						
105						
BI-214	2.00E+01	3.15E+01 (2/ 78)	WHEELER DAM, AL	3.93E+01 (1/ 13)	27 VALUES <LLD	
		2.37E+01 - 3.93E+01	TRM 274.9	3.93E+01 - 3.93E+01		
PB-214	2.00E+01	4.51E+01 (1/ 78)	WHEELER DAM, AL	4.51E+01 (1/ 13)	27 VALUES <LLD	
		4.51E+01 - 4.51E+01	TRM 274.9	4.51E+01 - 4.51E+01		
TL-208	NOT ESTAB	9.73E-01 (6/ 78)	CHAMPION PAPER	9.98E-01 (5/ 52)	6.48E-01 (2/ 27)	
		6.14E-02 - 2.81E+00	TRM 282.6	6.14E-02 - 2.81E+00	1.35E-01 - 1.16E+00	
AC-228	NOT ESTAB	1.09E+01 (6/ 78)	CHAMPION PAPER	1.09E+01 (6/ 52)	3.98E+00 (3/ 27)	
		2.74E+00 - 1.95E+01	TRM 282.6	2.74E+00 - 1.95E+01	1.51E+00 - 6.07E+00	
SR 89	3.00E+00	13 VALUES <LLD			3.34E+00 (1/ 9)	
22					3.34E+00 - 3.34E+00	
SR 90	1.40E+00	13 VALUES <LLD			9 VALUES <LLD	
22		ANALYSIS PERFORMED				
TRITIUM	2.50E+02	13 VALUES <LLD			9 VALUES <LLD	
22		ANALYSIS PERFORMED				

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-14

RADIOACTIVITY IN WELL WATER

PCI/L - 0.037 BQ/L

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI)						
26						
BI-214	2.00E+01	1.04E+02(12/ 13)	BFN WELL #6	1.04E+02(12/ 13)	6.38E+02(13/ 13)	
		3.09E+01 - 3.47E+02	0.02 MILES W	3.09E+01 - 3.47E+02	3.15E+02 - 1.15E+03	
PB-214	2.00E+01	9.36E+01(13/ 13)	BFN WELL #6	9.36E+01(13/ 13)	6.46E+02(13/ 13)	
		2.13E+01 - 3.42E+02	0.02 MILES W	2.13E+01 - 3.42E+02	3.43E+02 - 1.07E+03	
TL-208	NOT ESTAB	4.42E+00(1/ 13)	BFN WELL #6	4.42E+00(1/ 13)	13 VALUES <LLD	
		4.42E+00 - 4.42E+00	0.02 MILES W	4.42E+00 - 4.42E+00		
SR 89	3.00E+00	3.92E+00(2/ 4)	BFN WELL #6	3.92E+00(2/ 4)	4 VALUES <LLD	
8		3.06E+00 - 4.77E+00	0.02 MILES W	3.06E+00 - 4.77E+00		
SR 90	1.40E+00	4 VALUES <LLD			4 VALUES <LLD	
8		ANALYSIS PERFORMED				
TRITIUM	2.50E+02	4 VALUES <LLD			4 VALUES <LLD	
8		ANALYSIS PERFORMED				

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-15

RADIOACTIVITY IN CRAPPIE (FLESH)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296
LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	1.00E-01	1.84E+02(4/ 4)	WILSON RESERVOIR	1.96E+02(2/ 2)	1.77E+02(2/ 2)	
6		3.22E+01 - 3.61E+02	TRM 259-275	3.22E+01 - 3.61E+02	3.55E+01 - 3.19E+02	
GAMMA (GELI)						
6						
CS-137	6.00E-02	7.81E-02(4/ 4)	WHEELER RES	9.09E-02(2/ 2)	1.25E-01(1/ 2)	
		6.35E-02 - 9.68E-02	TRM 275-349	8.50E-02 - 9.68E-02	1.25E-01 - 1.25E-01	
K-40	1.00E+00	1.56E+01(4/ 4)	WILSON RESERVOIR	1.58E+01(2/ 2)	1.55E+01(2/ 2)	
		1.38E+01 - 1.78E+01	TRM 259-275	1.38E+01 - 1.78E+01	1.47E+01 - 1.63E+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).

TABLE H-16

RADIOACTIVITY IN SMALLMOUTH BUFFALO (FLESH)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA	1.00E-01	9.58E+01(4/ 4)	WHEELER RES	1.03E+02(2/ 2)	1.13E+02(2/ 2)	
6		2.16E+01 - 1.94E+02	TRM 275-349	2.16E+01 - 1.94E+02	2.02E+01 - 2.06E+02	
GAMMA (GELI)						
6						
K-40	1.00E+00	9.00E+00(4/ 4)	WHEELER RES	9.93E+00(2/ 2)	9.20E+00(2/ 2)	
		6.97E+00 - 1.08E+01	TRM 275-349	9.12E+00 - 1.08E+01	8.44E+00 - 9.95E+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).

TABLE H-17

RADIOACTIVITY IN SMALLMOUTH BUFFALO (WHOLE)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS BETA 6	1.00E-01	1.16E+02(4/ 4) 1.63E+01 - 2.56E+02	WHEELER RES TRM 275-349	1.36E+02(2/ 2) 1.67E+01 - 2.56E+02	8.88E+01(2/ 2) 1.63E+01 - 1.61E+02	
GAMMA (GELI) 6						
K-40	1.00E+00	8.46E+00(4/ 4) 6.39E+00 - 1.28E+01	WHEELER RES TRM 275-349	9.72E+00(2/ 2) 6.62E+00 - 1.28E+01	6.18E+00(2/ 2) 5.57E+00 - 6.79E+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).

TABLE H-18

RADIOACTIVITY IN SEDIMENT

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1988

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI)						
10						
CO-60	1.00E-02	1.89E-01(4/ 6)	TRM 293.7	2.91E-01(2/ 2)	3.28E-02(2/ 4)	
		3.82E-02 - 4.34E-01	BFN DISCHARGE	1.48E-01 - 4.34E-01	2.41E-02 - 4.15E-02	
CS-134	1.00E-02	7.44E-02(3/ 6)	TRM 293.7	7.73E-02(2/ 2)	4 VALUES <LLD	
		6.86E-02 - 8.49E-02	BFN DISCHARGE	6.97E-02 - 8.49E-02		
CS-137	1.00E-02	6.65E-01(6/ 6)	TRM 293.7	8.00E-01(2/ 2)	3.33E-01(4/ 4)	
		5.41E-01 - 8.09E-01	BFN DISCHARGE	7.90E-01 - 8.09E-01	1.34E-01 - 7.03E-01	
K-40	2.00E-01	1.08E+01(6/ 6)	TRM 293.7	1.30E+01(2/ 2)	1.39E+01(4/ 4)	
		5.86E+00 - 1.30E+01	BFN DISCHARGE	1.30E+01 - 1.30E+01	1.22E+01 - 1.57E+01	
BI-214	4.00E-02	9.45E-01(6/ 6)	TRM 293.7	1.11E+00(2/ 2)	9.76E-01(4/ 4)	
		6.12E-01 - 1.23E+00	BFN DISCHARGE	1.02E+00 - 1.19E+00	7.92E-01 - 1.27E+00	
BI-212	1.00E-01	1.31E+00(6/ 6)	TRM 293.7	1.49E+00(2/ 2)	1.31E+00(4/ 4)	
		9.68E-01 - 1.79E+00	BFN DISCHARGE	1.42E+00 - 1.56E+00	1.02E+00 - 1.63E+00	
PB-214	2.00E-02	1.04E+00(6/ 6)	TRM 293.7	1.20E+00(2/ 2)	1.07E+00(4/ 4)	
		6.41E-01 - 1.36E+00	BFN DISCHARGE	1.12E+00 - 1.28E+00	8.62E-01 - 1.39E+00	
PB-212	2.00E-02	1.13E+00(6/ 6)	TRM 293.7	1.45E+00(2/ 2)	1.25E+00(4/ 4)	
		7.15E-01 - 1.53E+00	BFN DISCHARGE	1.36E+00 - 1.53E+00	1.07E+00 - 1.52E+00	
RA-226	NOT ESTAB	9.45E-01(6/ 6)	TRM 293.7	1.11E+00(2/ 2)	9.76E-01(4/ 4)	
		6.12E-01 - 1.23E+00	BFN DISCHARGE	1.02E+00 - 1.19E+00	7.92E-01 - 1.27E+00	
RA-224	NOT ESTAB	1.26E+00(5/ 6)	TRM 293.7	1.52E+00(1/ 2)	1.30E+00(2/ 4)	
		8.78E-01 - 1.52E+00	BFN DISCHARGE	1.52E+00 - 1.52E+00	1.23E+00 - 1.37E+00	
TL-208	2.00E-02	4.09E-01(6/ 6)	TRM 293.7	4.95E-01(2/ 2)	4.26E-01(4/ 4)	
		2.74E-01 - 5.40E-01	BFN DISCHARGE	4.50E-01 - 5.40E-01	3.52E-01 - 5.55E-01	
AC-228	6.00E-02	1.27E+00(6/ 6)	TRM 293.7	1.51E+00(2/ 2)	1.31E+00(4/ 4)	
		8.19E-01 - 1.55E+00	BFN DISCHARGE	1.47E+00 - 1.55E+00	1.14E+00 - 1.51E+00	
PA-234M	NOT ESTAB	6 VALUES <LLD			2.98E+00(1/ 4)	
					2.98E+00 - 2.98E+00	
SR 89	1.00E+00	6 VALUES <LLD			4 VALUES <LLD	
10		ANALYSIS PERFORMED				
SR 90	3.00E-01	6 VALUES <LLD			4 VALUES <LLD	
10		ANALYSIS PERFORMED				

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-19

RADIOACTIVITY IN CLAM FLESH

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BROWNS FERRY — DOCKET NO. 50-259,260,296

LOCATION OF FACILITY LIMESTONE ALABAMA — REPORTING PERIOD 1983

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION (LLD) SEE NOTE 1	ALL INDICATOR LOCATIONS MEAN (F) RANGE SEE NOTE 2	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F) RANGE SEE NOTE 2	CONTROL LOCATIONS MEAN (F) RANGE SEE NOTE 2	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI) 9						
K-40	2.00E+00	5.19E+00(1/ 5) 5.19E+00 - 5.19E+00	TRM 277.98	5.19E+00(1/ 1) 5.19E+00 - 5.19E+00	4.63E+00(4/ 4) 3.45E+00 - 6.94E+00	
BI-214	2.50E-01	1.63E+00(1/ 5) 1.63E+00 - 1.63E+00	TRM 277.98	1.63E+00(1/ 1) 1.63E+00 - 1.63E+00	5.31E-01(2/ 4) 5.02E-01 - 5.61E-01	
PB-214	2.50E-01	1.20E+00(2/ 5) 5.27E-01 - 1.87E+00	TRM 277.98	1.87E+00(1/ 1) 1.87E+00 - 1.87E+00	7.58E-01(2/ 4) 7.39E-01 - 7.78E-01	
TL-208	NOT ESTAB	5 VALUES <LLD			3.01E-02(1/ 4) 3.01E-02 - 3.01E-02	
AC-228	NOT ESTAB	2.61E-01(1/ 5) 2.61E-01 - 2.61E-01	TRM 288.78	2.61E-01(1/ 2) 2.61E-01 - 2.61E-01	1.08E+00(2/ 4) 9.42E-01 - 1.21E+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
Browns Ferry Nuclear Plant

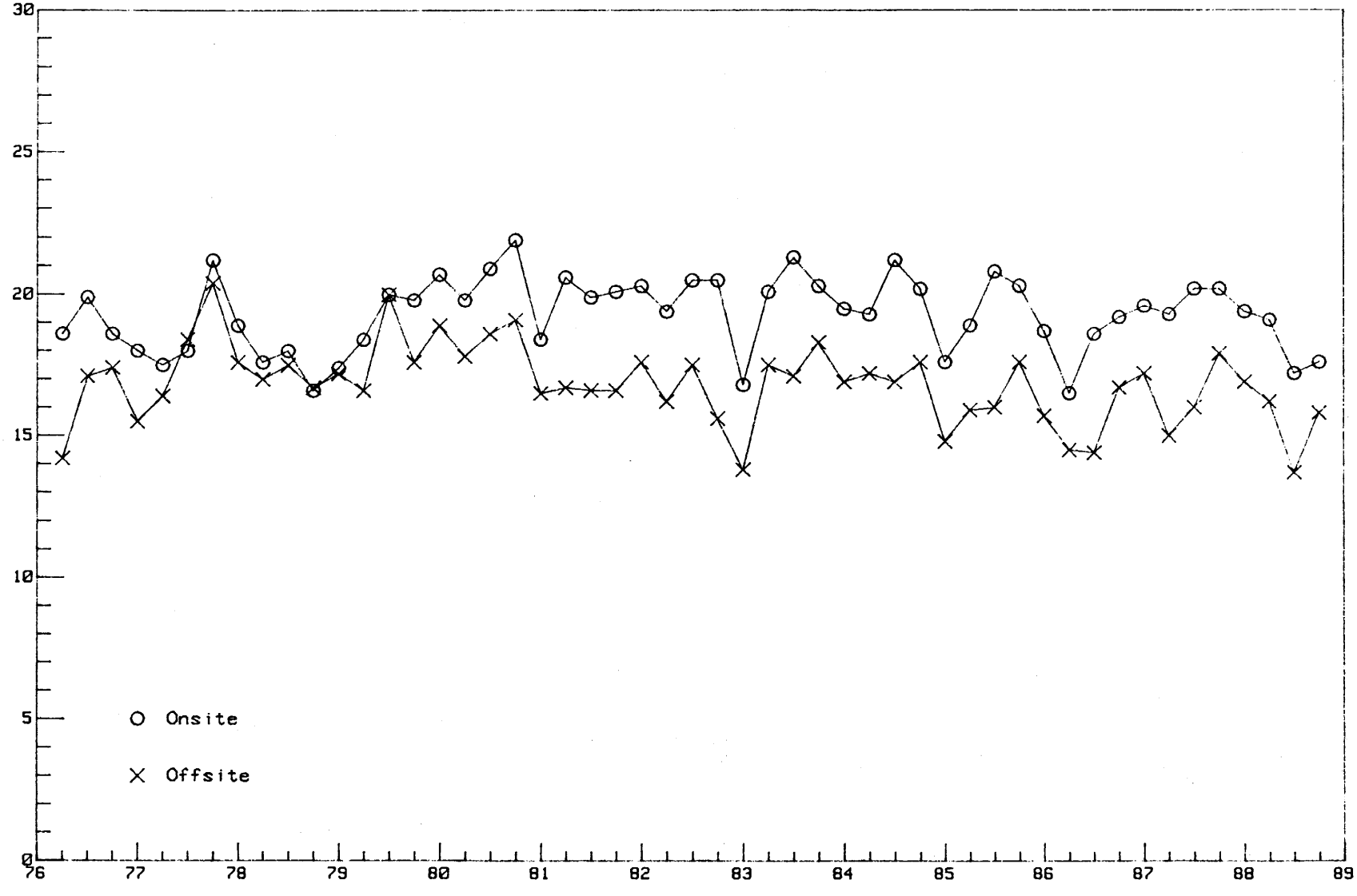


Figure H-2

Direct Radiation Levels
Browns Ferry Nuclear Plant
4-Quarter Moving Average

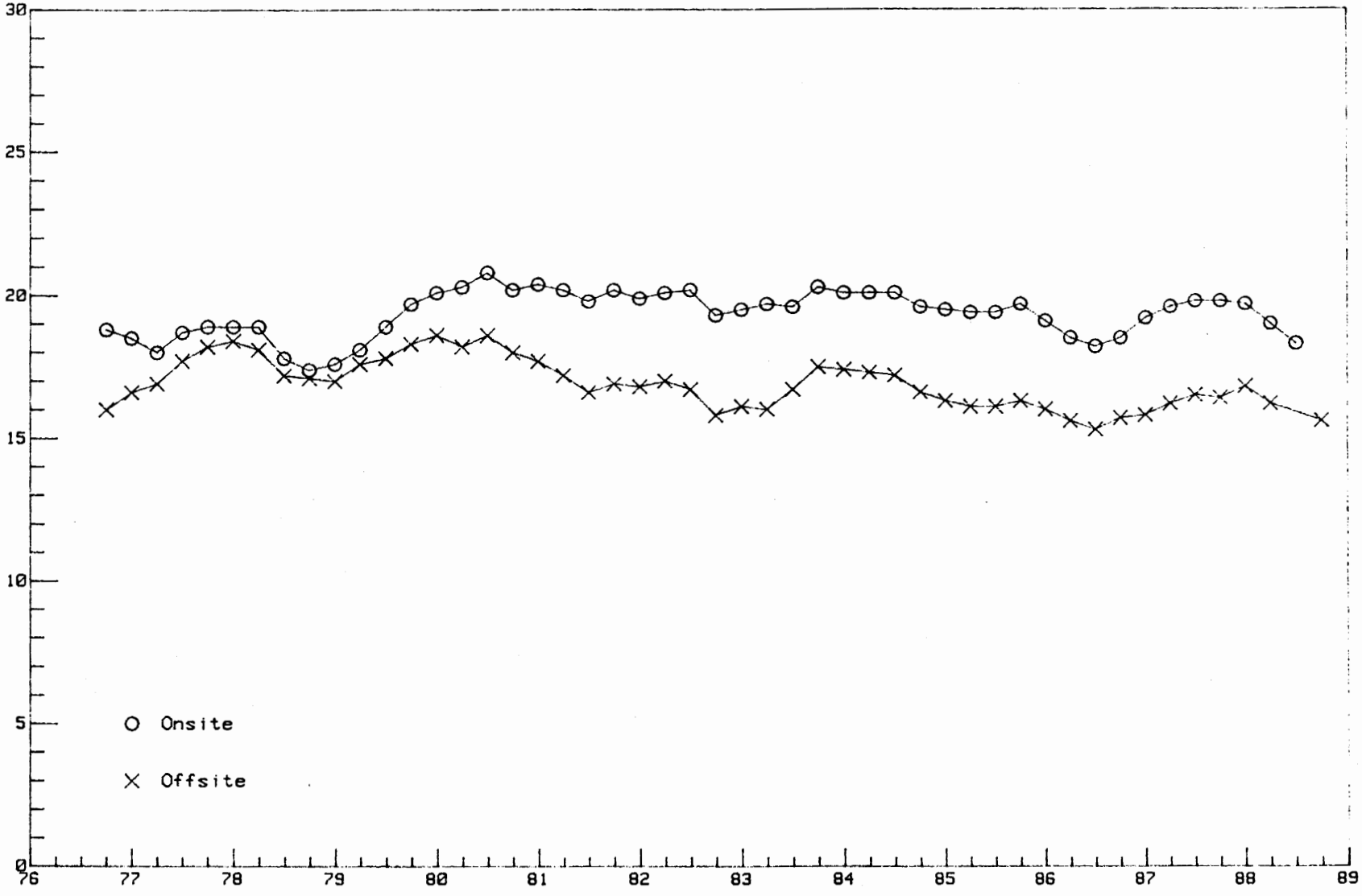


Figure H-3

Direct Radiation Levels
Watts Bar Nuclear Plant

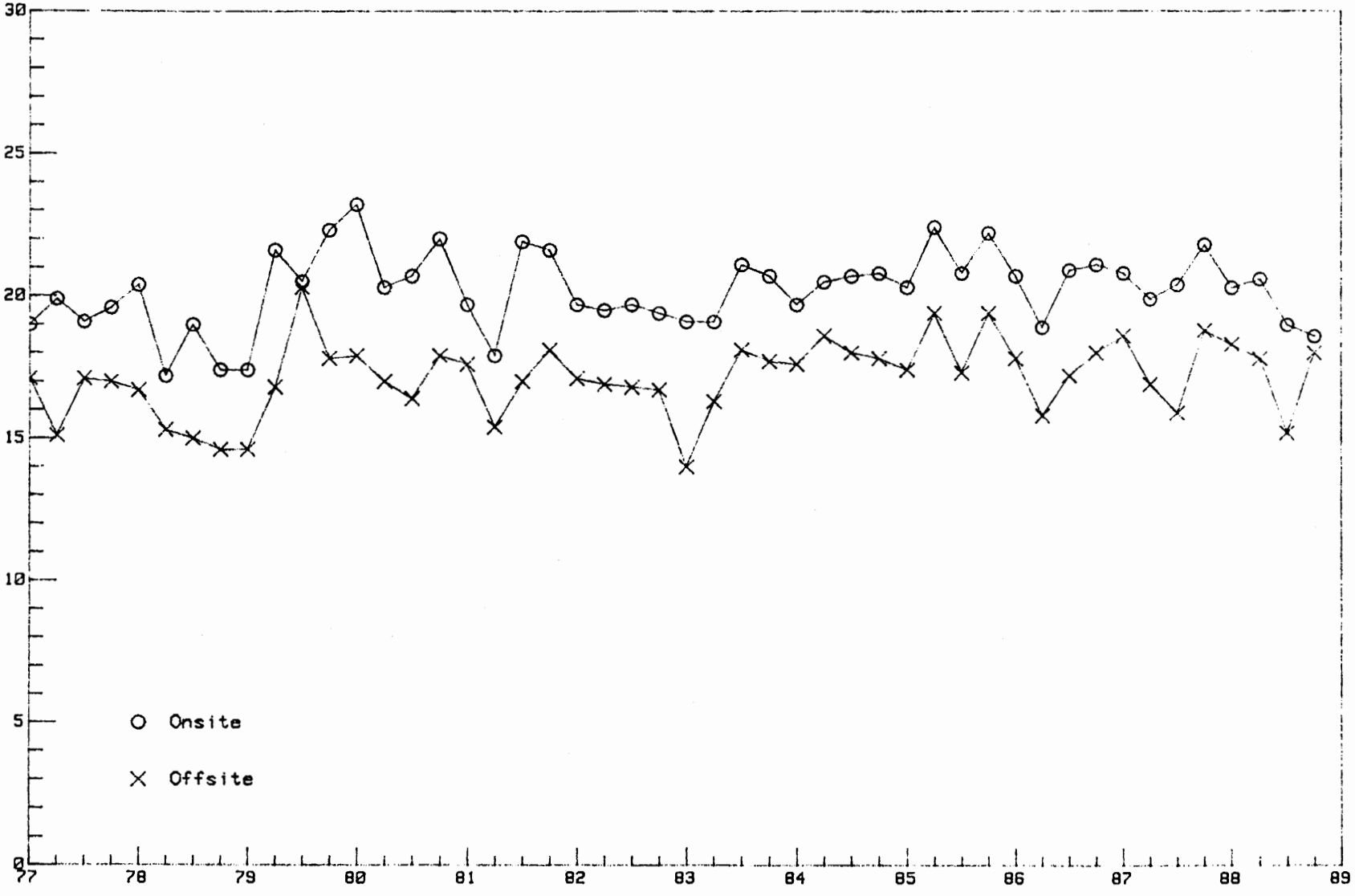


Figure H-4

Direct Radiation Levels
Watts Bar Nuclear Plant
4-Quarter Moving Average

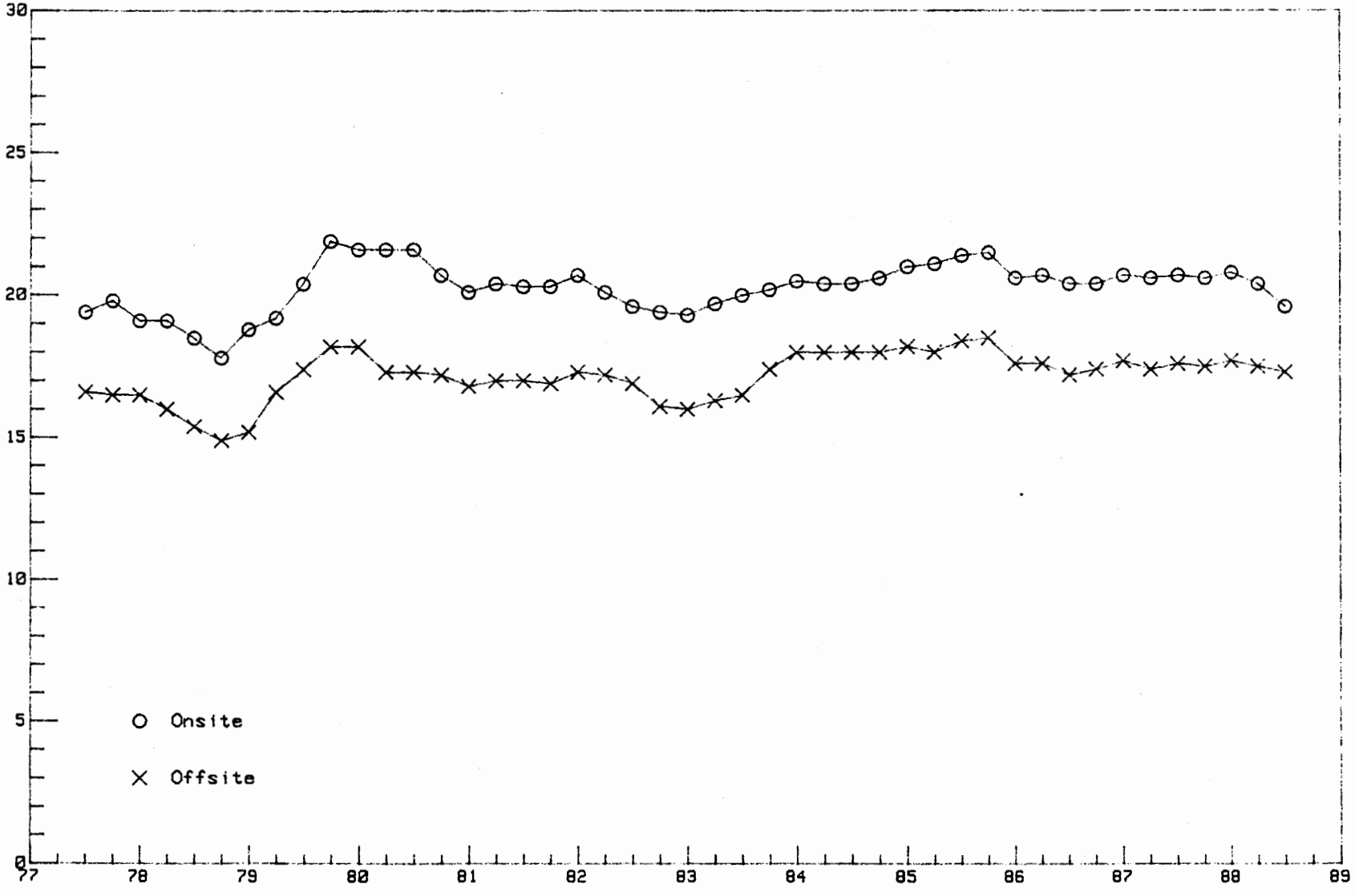


Figure H-5

Annual Average Gross Beta Activity
Air Filters (pCi/Cubic Meter)
Browns Ferry Nuclear Plant

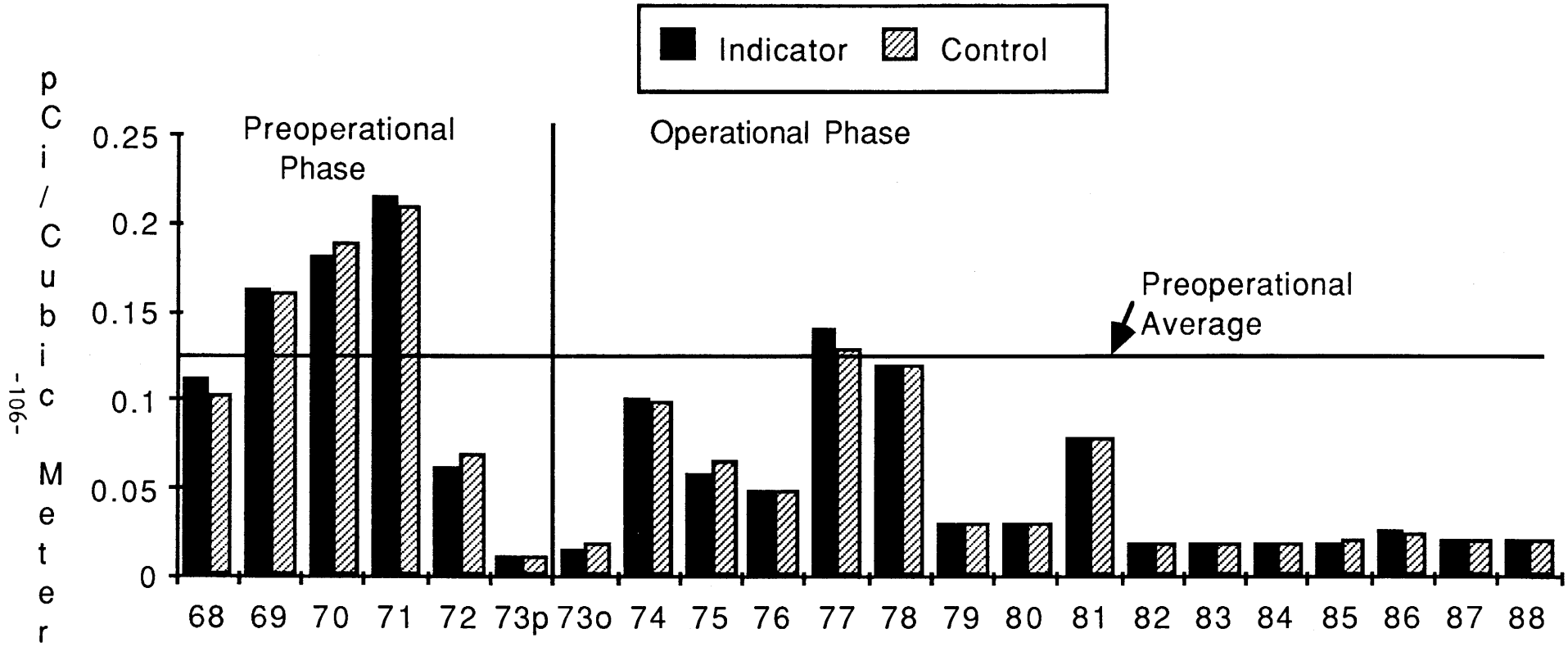
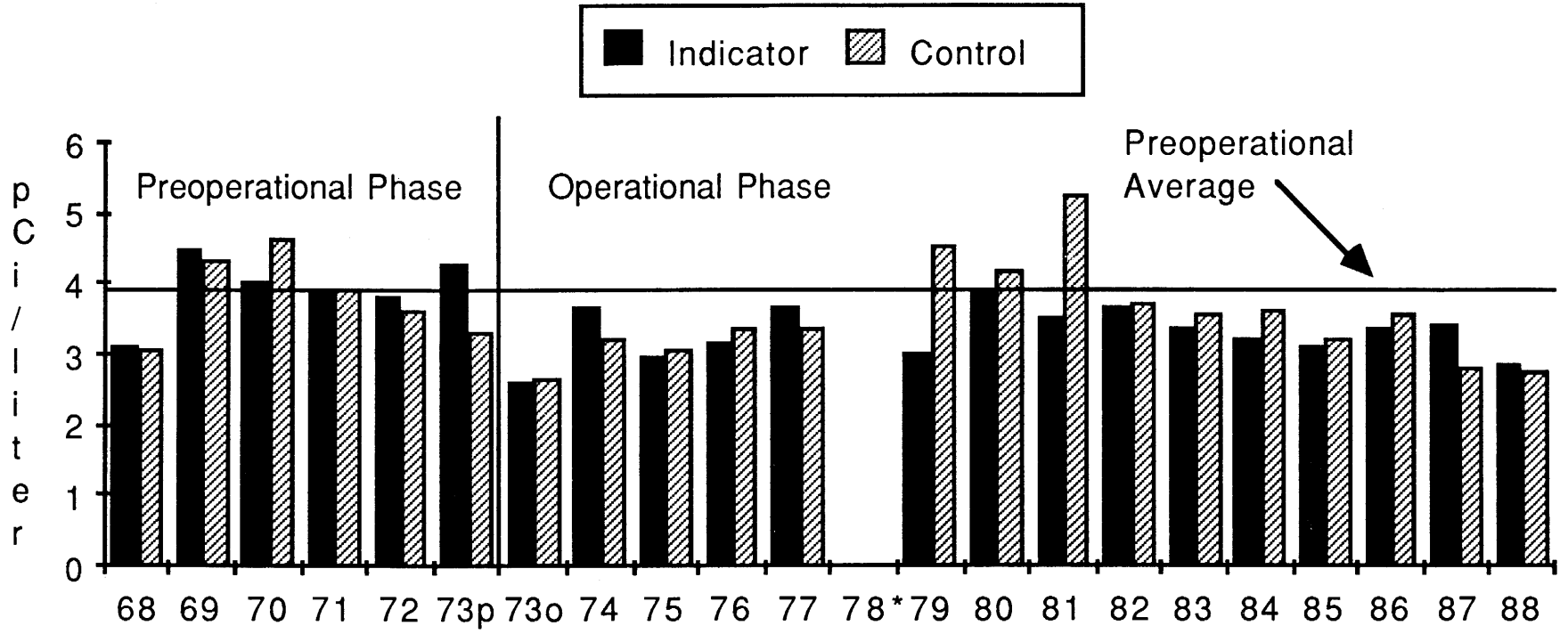


Figure H-6

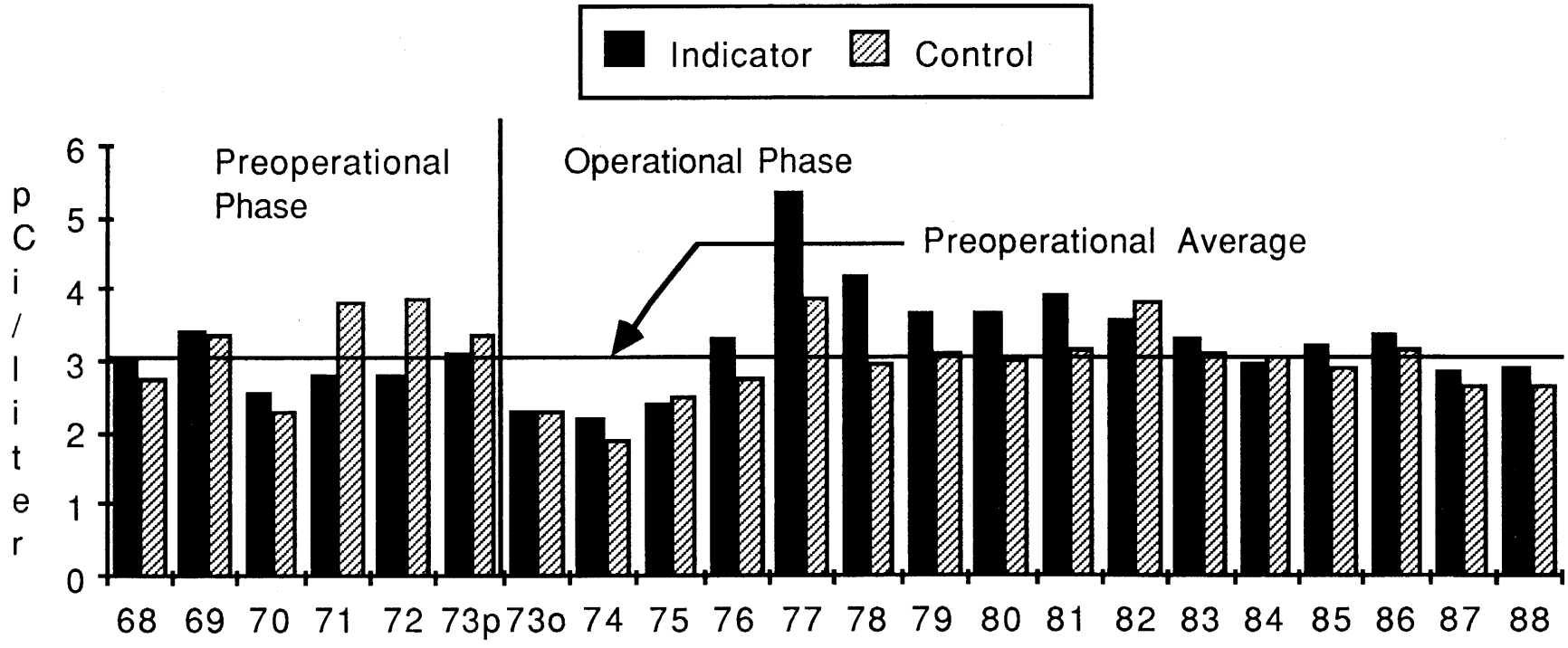
Annual Average Gross Beta Activity
Surface Water (pCi/liter)
Browns Ferry Nuclear Plant



*No gross beta measurements made in 1978

Figure H-7

Annual Average Gross Beta Activity
Drinking Water (pCi/liter)
Browns Ferry Nuclear Plant



APPENDIX I

SPECIAL SAMPLING

APPENDIX I

Special Sampling

Sediment samples collected over the past 2 to 3 years from the routine BFN environmental radiological monitoring stations near the plant discharge have contained higher levels of Co-60 than the upstream stations. Analysis of these samples has indicated that the activity was not homogeneous and could be attributed to particles of stainless steel or oxides of stainless steel. In an effort to better identify the distribution of these particles in the sediment, a sampling scheme was developed to investigate the areal extent of possible sediment contamination. Based on the assumption that the principal source of the cobalt discharge is from the BFN diffuser system or from the residual heat removal service water system (RHRSW), the sampling grid was designed to cover principally the main river channel. Additional sampling locations were identified on the right side of the channel immediately downstream of the RHRSW discharge pipes. The sampling system was divided into two parts: the near-field region and the far-field region; each consisting of about 150 sampling points.

The grid system for the near-field region was designed to determine if effluent plume deposition exists. The region encompasses an area of about 0.5 miles in length and 0.4 miles in width. The grid density is the highest on the right-hand side of the river with a grid dimension of 100 feet by 100 feet. The size of the grid increases toward the left-hand side of the

channel, with the largest grid having a dimension of 400 feet by 400 feet. The entire sampling grid is shown in figure I-1 and a detailed grid of the near-field stations is presented in figure I-2.

The far-field sampling was designed to measure the extent of potential deposition area. With a median grain size of 200 microns and a specific gravity of 1.2, an average river flow of 35,000 cubic feet per second and a 40-foot vertical drop (the distance from pipe outlet to channel bottom), the distance that a discrete particle travels before it reaches river bottom is estimated to be about 0.3 miles in this section of the river. Particles with irregular shapes settle somewhat more slowly than spheres of equivalent volume. Factors such as scouring (resuspension) due to higher flow and mixing due to flow turbulence also tend to delay the settling of the particles. In this study, a far-field region of 1.5 miles (TRM 293.5 to 292) was used. The location of the far-field grid stations is shown in figure I-1.

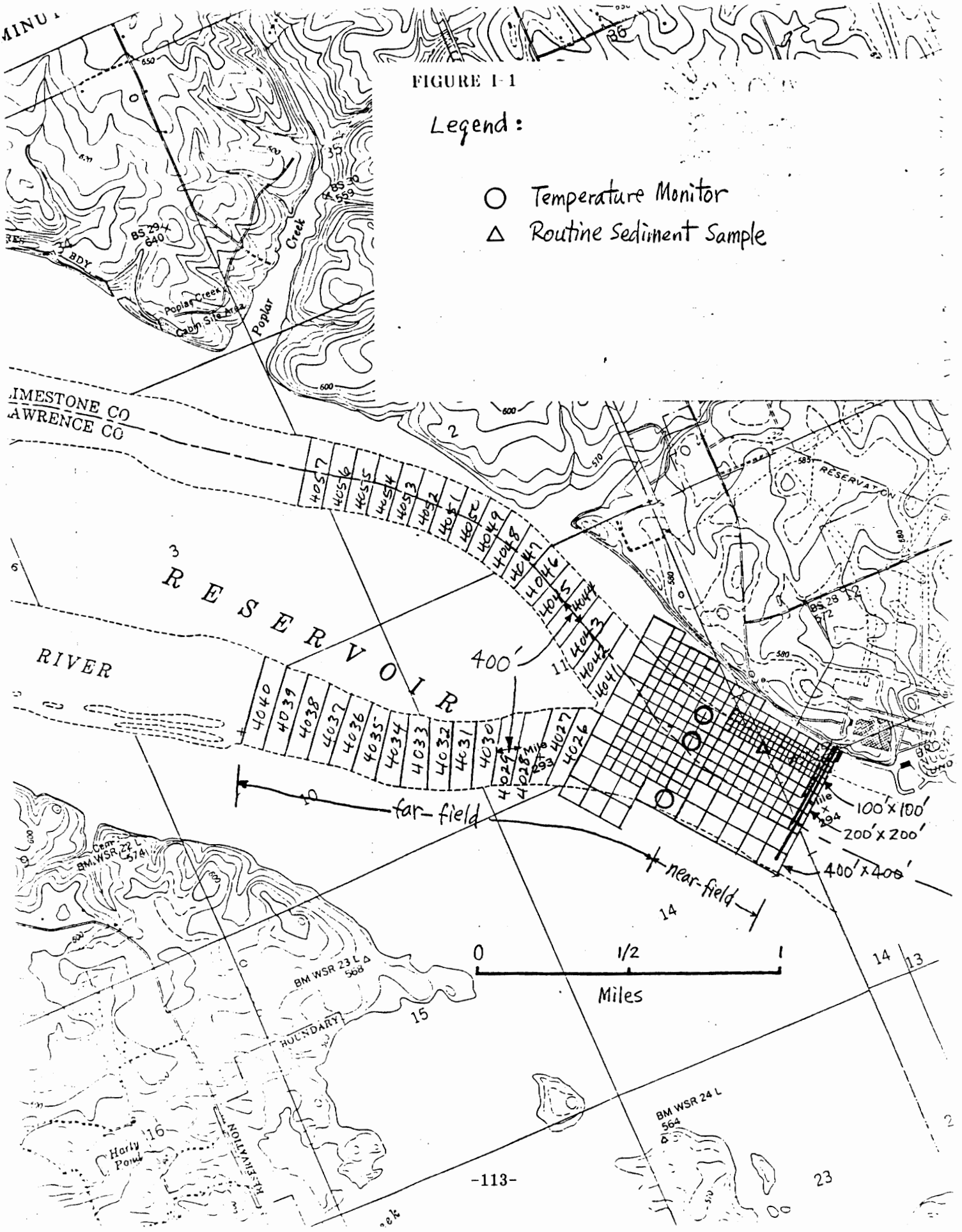
Of the approximately 300 sampling stations identified, sediment was found at about 222 stations. All samples were dried, ground, and analyzed by gamma spectroscopy. The results are presented in table I-1. The location identification was lost on 23 of the samples. In table I-1, these sampling locations are identified as "unknown".

The majority of all concentrations measured are in the general range of the levels reported at the routine sampling stations in the past 2 years. Co-60 concentrations at eight of the stations exceeded the highest concentration

reported at the routine stations in 1988. Of the six identified stations, five were along the right-hand side of the river. The higher Cs-134 and Cs-137 tended to fall in this region also; however, no pattern or pocket of contamination was identified. All higher values tended to be randomly distributed on the right-hand side of the river.

The results of this study indicate no widespread contamination in the sediment and no areas of general contamination. Particles containing Co-60 appear to be distributed randomly in the area below the discharge on the right-hand side of the river. Samples from the routine sampling stations should adequately monitor radioactivity concentrations in the sediment.

FIGURE I-1


Legend:
Temperature Monitor
Routine Sediment Sample
RESERVOIR
RIVER
400'
far-field
near-field
100'x100'
200'x200'
400'x400'
0
1/2
1
Miles
LIMESTONE CO
LAWRENCE CO
Poplar Creek
Cabin Site Area
BDY
BM WSR 22 L 574
BM WSR 23 L 568
BM WSR 24 L 564
BOUNDARY
RESERVATION
Harly Pond
4057
4056
4055
4054
4053
4052
4051
4050
4049
4048
4047
4046
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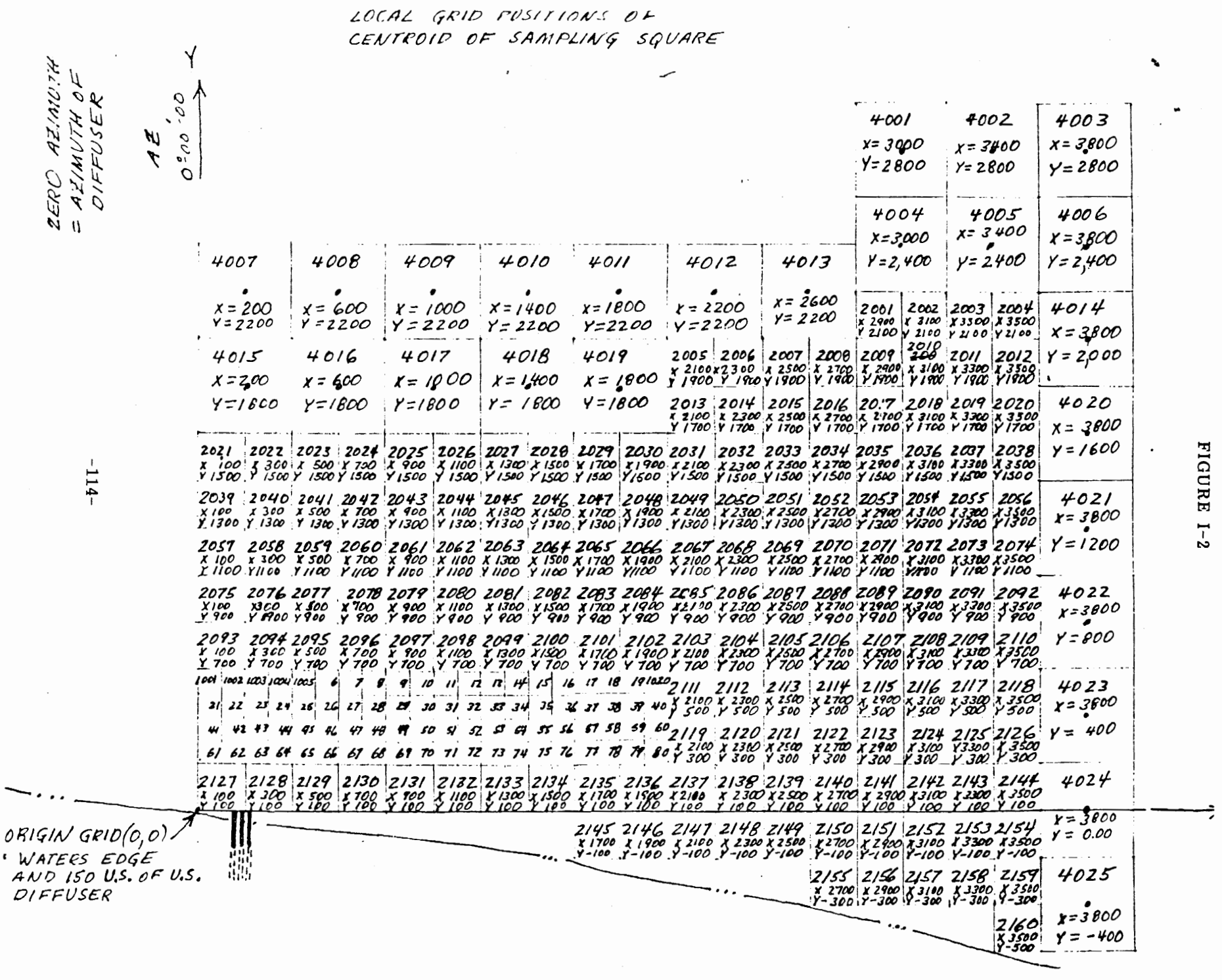
LOCAL GRID POSITIONS OF CENTROID OF SAMPLING SQUARE
ZERO AZIMUTH = AZIMUTH OF DIFFUSER
AZ 0°00'00"
Y
4001 X=3000 Y=2800
4002 X=3400 Y=2800
4003 X=3800 Y=2800
4004 X=3000 Y=2,400
4005 X=3400 Y=2400
4006 X=3800 Y=2,400
4007 X=200 Y=2200
4008 X=600 Y=2200
4009 X=1000 Y=2200
4010 X=1400 Y=2200
4011 X=1800 Y=2200
4012 X=2200 Y=2200
4013 X=2600 Y=2200
4014 X=3800 Y=2,000
4015 X=200 Y=1800
4016 X=600 Y=1800
4017 X=1000 Y=1800
4018 X=1400 Y=1800
4019 X=1800 Y=1800
4020 X=3800 Y=1600
4021 X=3800 Y=1200
4022 X=3800 Y=800
4023 X=3800 Y=400
4024 X=3800 Y=0.00
4025 X=3800 Y=-400
ORIGIN GRID(0,0)
WATERS EDGE AND 150 U.S. OF U.S. DIFFUSER

FIGURE I-2

Table I-1

Gamma Analysis Results
Special Sediment Samples
Browns Ferry Nuclear Plant
March, 1987

Sample Point	Activity, pCi/gram	
	Co-60	Cs-137
1[1]	0.08 ± 0.01	0.36 ± 0.01
2	0.08 ± 0.01	0.37 ± 0.01
3	0.14 ± 0.01	0.59 ± 0.01
4	0.15 ± 0.02	0.56 ± 0.01
5	0.25 ± 0.01	0.65 ± 0.01
6[2]	2.36 ± 0.03	0.76 ± 0.02

1. Location nearest the discharge.

2. Location nearest the routine sampling station.

Table I-1

Radioactivity in Sediment Downstream From
Browns Ferry Nuclear Plant
Special Study
June 9-17, 1988

Location Code	Activity, pCi/gm, Dry Weight		
	Co-60	Cs-137	Cs-134
1001	0.08	0.57	--
1012	--	0.49	--
1014	--	0.46	--
1015	--	0.47	--
1016	0.12	0.62	0.06
1017	0.08	0.57	--
1018	0.11	1.08	0.06
1019	0.25	0.88	0.07
1020	0.12	0.88	0.08
1021	--	0.71	--
1027	--	0.23	--
1031	0.10	0.56	--
1032	0.26	1.13	0.04
1033	0.10	0.68	0.05
1034	0.26	1.22	0.13
1035	0.13	0.60	--
1036	0.16	0.81	0.08
1037	0.15	0.85	0.07
1038	0.13	0.85	0.06
1039	0.11	0.87	0.05
1040	0.14	0.93	0.06
1044	0.26	0.65	--
1049	0.04	1.10	--
1050	0.08	0.92	--
1051	0.06	0.86	0.03
1052	0.09	0.74	0.03
1053	0.08	0.89	--
1054	0.24	0.88	0.08
1055	0.12	0.84	0.06
1056	0.14	0.86	0.07
1057	0.12	0.76	0.05
1058	0.24	0.93	0.08
1059	4.95	0.81	0.06
1060	0.17	0.91	0.08
1066	0.08	0.31	0.04
1067	0.38	0.44	--
1068	0.18	0.57	0.06
1069	0.10	0.71	0.05
1070	0.10	0.73	0.05

Table I-1

Radioactivity in Sediment Downstream From
Browns Ferry Nuclear Plant
Special Study
June 9-17, 1988
(Continued)

Location Code	Activity, pCi/gm, Dry Weight		
	Co-60	Cs-137	Cs-134
1071	0.09	0.66	0.04
1072	0.10	0.67	--
1073	0.22	0.84	0.08
1074	0.51	0.70	0.06
1075	0.16	0.83	0.11
1076	0.15	0.75	0.06
1077	0.14	0.79	0.08
1078	0.22	0.82	0.08
1079	0.13	0.88	0.07
1080	0.25	0.92	0.09
2003	0.06	0.44	0.04
2004	0.08	0.56	0.04
2005	0.11	0.54	0.05
2007	0.17	0.44	--
2008	0.10	0.54	0.05
2010	0.08	0.50	--
2011	0.12	0.61	0.05
2012	0.12	0.50	0.05
2014	--	0.47	--
2015	0.54	0.67	0.07
2016	0.09	0.49	--
2017	0.12	0.55	--
2019	0.10	0.60	--
2021	--	0.16	--
2022	0.16	0.66	--
2026	0.25	0.89	--
2027	0.08	0.38	--
2028	0.12	0.51	--
2029	0.14	0.61	0.07
2030	0.14	0.60	0.08
2037	0.12	0.59	--
2038	0.15	0.91	--
2039	0.05	0.39	0.01
2040	0.15	0.48	--
2041	0.22	0.69	0.08
2042	0.15	0.53	--
2043	--	0.33	--
2044	--	0.42	--
2045	0.11	0.43	--

Table I-1

Radioactivity in Sediment Downstream From
Browns Ferry Nuclear Plant
Special Study
June 9-17, 1988
(Continued)

Location Code	Activity, pCi/gm, Dry Weight		
	Co-60	Cs-137	Cs-134
2046	--	0.32	--
2049	0.08	0.46	--
2050	0.11	0.49	0.05
2051	0.14	0.62	--
2053	0.09	0.50	0.06
2054	0.16	0.79	0.08
2056	0.13	0.52	0.06
2057	0.03	0.47	--
2061	0.20	0.75	--
2065	--	0.76	--
2066	0.18	1.09	--
2068	0.09	0.56	0.06
2069	0.12	0.56	--
2070	0.14	0.70	0.08
2071	0.13	0.70	0.06
2073	0.14	0.81	0.06
2074	0.14	0.92	0.20
2075	0.05	0.54	--
2079	0.18	0.56	0.08
2081	--	0.50	--
2083	--	0.40	--
2084	0.12	0.74	0.07
2085	0.20	0.70	--
2086	0.17	0.78	0.08
2088	0.17	0.74	0.11
2089	0.17	0.95	0.12
2090	0.16	0.85	0.10
2091	0.14	0.83	0.09
2092	0.29	0.78	0.08
2093	0.07	0.56	0.02
2099	--	0.60	--
2100	--	0.44	--
2101	--	0.59	--
2102	0.16	0.71	0.07
2103	0.17	1.09	0.16
2104	0.14	0.94	0.12
2105	0.19	0.68	0.08
2107	0.17	0.82	0.09

Table I-1

Radioactivity in Sediment Downstream From
Browns Ferry Nuclear Plant
Special Study
June 9-17, 1988
(Continued)

Location Code	Activity, pCi/gm, Dry Weight		
	Co-60	Cs-137	Cs-134
2108	0.20	0.84	0.08
2109	0.14	0.87	0.09
2110	0.30	0.95	0.09
2111	0.17	0.87	0.08
2114	0.42	0.58	0.05
2116	0.16	0.86	0.07
2117	0.17	0.93	0.20
2118	0.19	0.95	0.09
2119	0.13	0.84	0.05
2120	0.16	0.87	0.08
2122	0.67	0.92	0.09
2123	0.17	0.90	0.10
2124	0.16	0.91	0.08
2125	0.16	0.90	0.07
2126	0.15	0.91	0.09
2130	0.25	0.74	0.08
2131	0.15	0.75	0.09
2132	0.14	0.60	0.05
2133	0.14	0.82	0.18
2134	0.19	0.75	0.07
2135	0.15	0.91	0.10
2136	0.15	0.85	0.08
2137	0.45	0.92	0.08
2139	0.18	0.96	0.09
2141	0.15	0.85	0.09
2142	0.16	0.88	0.08
2144	0.16	0.96	0.09
2146	0.07	0.24	0.03
2150	0.18	0.92	0.11
2151	0.15	0.78	0.09
2152	0.17	0.89	0.10
2153	0.18	0.88	0.11
2154	0.20	0.87	0.07
2156	--	0.38	--
2159	0.10	0.49	0.05
2160	0.10	0.68	--
4001	--	0.36	--
4002	--	0.39	--

Table I-1

Radioactivity in Sediment Downstream From
Browns Ferry Nuclear Plant
Special Study
June 9-17, 1988
(Continued)

Location Code	Activity, pCi/gm, Dry Weight		
	Co-60	Cs-137	Cs-134
4003	0.07	0.43	--
4006	0.12	0.50	--
4007	--	0.15	--
4014	0.14	0.89	0.09
4015	0.09	0.26	--
4017	0.12	0.78	--
4019	0.14	0.60	--
4020	0.10	0.54	0.04
4021	0.13	0.85	0.09
4022	0.14	0.82	0.08
4023	0.15	0.87	0.10
4024	0.24	0.93	0.09
4025	--	0.47	--
4026	0.10	0.70	0.07
4027	0.10	0.65	0.05
4028	0.13	0.60	0.04
4029	0.11	0.58	0.05
4030	0.09	0.60	0.05
4031	0.12	0.78	0.08
4032	0.16	0.76	0.06
4033	0.32	0.73	0.04
4034	0.12	0.72	--
4035	0.17	0.71	0.07
4036	0.14	0.76	0.07
4037	0.19	0.71	0.06
4038	0.16	0.86	0.06
4039	0.14	0.79	0.07
4040	0.16	0.81	0.05
4041	0.13	0.67	0.06
4042	0.18	0.92	0.09
4043	0.09	0.46	0.04
4044	0.16	0.92	0.09
4045	0.21	0.87	0.07
4046	0.15	0.90	0.10
4047	0.14	0.76	0.07
4048	0.12	0.74	0.07
4049	0.20	0.94	0.08
4050	0.26	0.97	0.09

Table I-1

Radioactivity in Sediment Downstream From
Browns Ferry Nuclear Plant
Special Study
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(Continued)

4051	0.20	0.96	0.08
4052	0.20	1.15	0.11
4053	0.12	0.83	0.05
4054	0.20	1.00	0.09
4055	0.16	0.97	0.10
4056	0.16	0.89	0.08
4057	0.16	0.88	0.07
Unknown	0.13	0.55	0.06
Unknown	0.16	0.89	0.08
Unknown	0.19	0.87	0.09
Unknown	0.27	0.67	--
Unknown	0.09	0.45	0.04
Unknown	0.05	0.31	0.03
Unknown	0.17	0.93	0.10
Unknown	0.46	0.82	0.06
Unknown	0.14	0.78	0.08
Unknown	0.09	0.45	0.05
Unknown	--	0.56	--
Unknown	0.07	0.33	--
Unknown	0.16	0.98	0.09
Unknown	0.30	0.38	0.04
Unknown	0.15	0.80	0.09
Unknown	0.10	0.44	0.05
Unknown	0.18	0.65	0.06
Unknown	0.14	0.95	0.10
Unknown	0.07	0.40	--
Unknown	0.84	0.95	0.11
Unknown	0.14	0.77	0.07
Unknown	0.08	0.39	0.03
Unknown	--	0.46	--