VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 29, 1992

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No. 92-269
NAPS/JHL
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT NOS. 1 AND 2
ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Pursuant to Technical Specification 6.9.1.8, enclosed is the Annual Radiological Environmental Operating Report for North Anna Power Station Unit Nos. 1 and 2 for 1991.

If you have any questions or requi.e additional information, please contact us.

Very truly yours,

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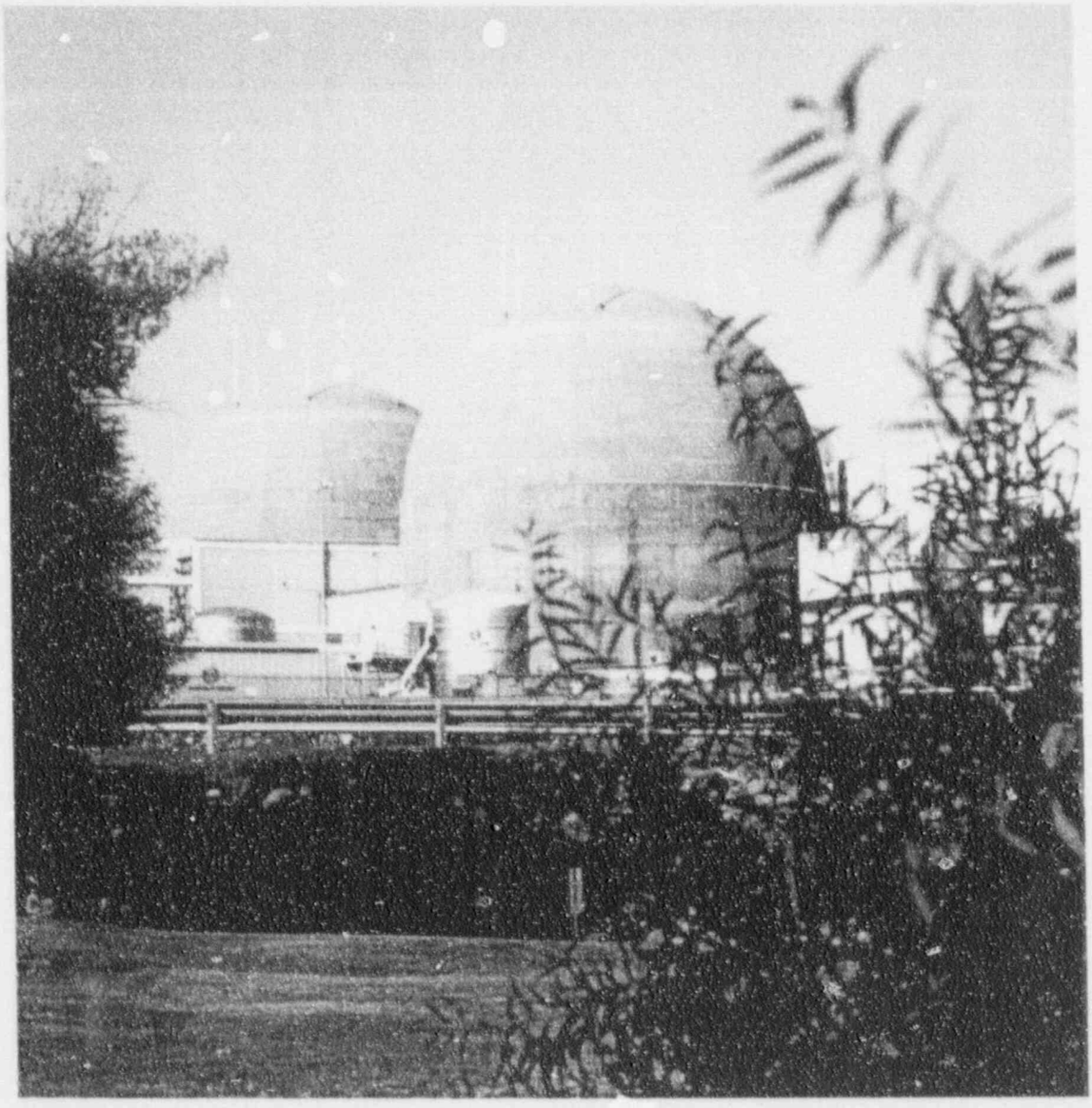
IE25

Virginia Electric and Power Company
North Anna Power Station
Radiological Environmental Monitoring Program

January 1, 1991 to December 31, 1991



Prepared by

VIRGINIA ELECTRIC AND POWER COMPANY
and
TELEDYNE ISOTOPES

Annual Radiological Environmental Operating Report
North Anna Power Station

January 1, 1991 to December 31, 1991

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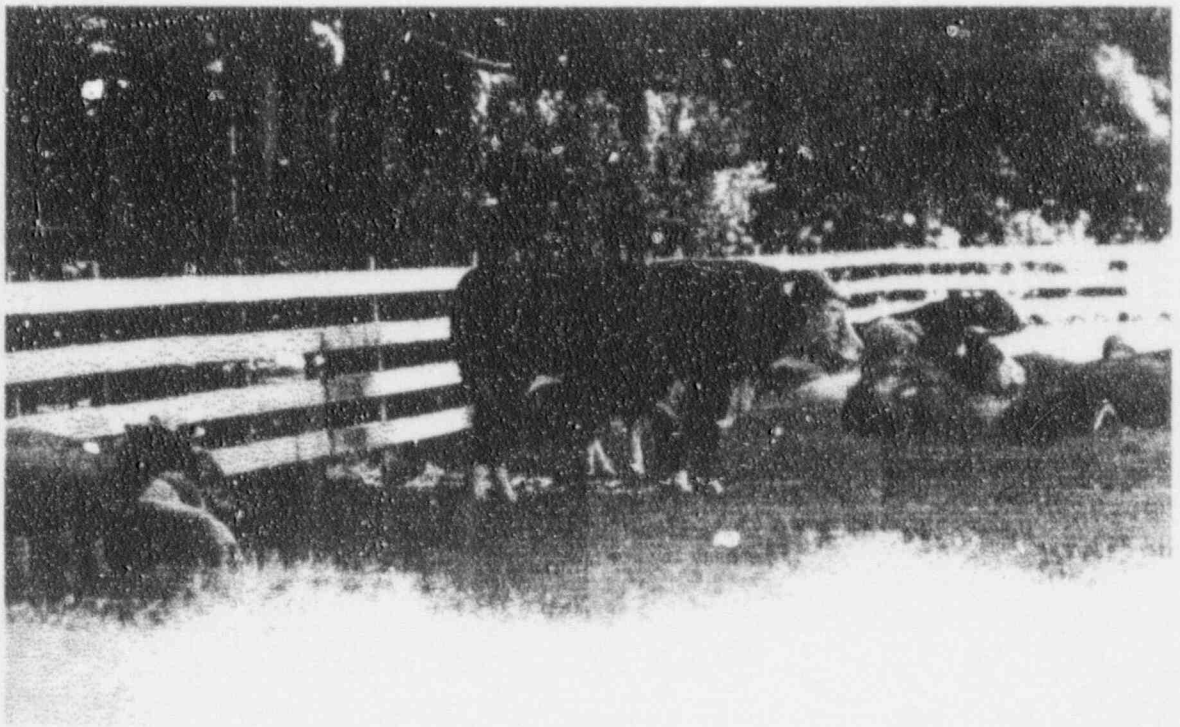

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Executive Summary

This document is a detailed report on the 1991 North Anna Nuclear Power Station Radiological Environmental Monitoring Program (REMP). Radioactivity levels from January 1 through December 31, 1991 in water, silt, shoreline sediment, milk, aquatic biota, food products, vegetation, and direct exposure pathways have been analyzed, evaluated, and summarized. The REMP is designed to ensure that radiological effluent releases are As Low As is Reasonably Achievable (ALARA), no undue environmental effects occur, and the health and safety of the public is protected. The program also detects any unexpected environmental processes which could allow radiation accumulations in the environment or food pathway chains.

Radiation and radioactivity in the environment is constantly monitored within a 25 mile radius of the station. Virginia Power also collects samples within this area. A number of sampling locations for each medium were selected using available meteorological, land use, and water use data. Two types of samples are obtained. The first type, control samples, are collected from areas that are beyond the measurable influence of North Anna Nuclear Power Station or any other nuclear facility. These samples are used as reference data. Normal background radiation levels, or radiation present due to causes other than North Anna Power Station, can thus be compared to the environment surrounding the nuclear power station. Indicator samples are the second sample type obtained. These samples show how much radiation is contributed to the environment by the plant. Indicator samples are taken from areas close to the station where any plant contribution will be at the highest concentration.

Prior to station operation, samples were collected and analyzed to determine the amount of radioactivity present in the area. The resulting values are used as a "pre-operational baseline." Analysis results from the indicator samples are compared to both current control sample values and the pre-operational baseline to determine if changes in radioactivity levels are attributable to station operations, other causes such as the Chernobyl accident, or natural variation.

Teledyne Isotopes provides sample analyses for various radioisotopes as appropriate for each sample media. Participation in the Environmental Protection Agency's (EPA) Interlaboratory Comparison Program provides an independent check of sample measurement precision and accuracy. Typically, radioactivity levels in the environment are so low that analysis values frequently fall below the minimum detection limits of state-of-the-art measurement methods. Because of this, the Nuclear Regulatory Commission (NRC) requires that equipment used for radiological environmental monitoring must be able to detect specified minimum Lower Limits of Detection (LLD). This ensures that analyses are as accurate as possible. Samples with extremely low levels of radiation which cannot be detected are therefore reported as being below the LLD. The NRC also mandates a "reporting level." Licensed nuclear facilities must report any releases

equal to or greater than this reporting level. Environmental radiation levels are sometimes referred to as a percent of the reporting level.

Analytical results are divided into five categories based on exposure pathways: Airborne, waterborne, aquatic, ingestion, and direct radiation. Each of these pathways is described below:

- The airborne exposure pathway includes airborne iodine, airborne particulate, precipitation, and soil samples. The overall 1991 airborne results were very similar to previous years and to preoperational levels. No increase was noted and there were no detections of fission products or other man-made isotopes in the airborne particulate media during 1991.

- The waterborne exposure pathway includes ground/well water, river water, and surface water samples. No man-made or natural isotopes were detected in Lake Anna surface water except for tritium. The average tritium activity in 1991 was 11.6% of the NRC reporting level. This has increased from preoperational levels but has not increased from 1989 and 1990 levels.

- The aquatic exposure pathway includes sediment/silt and shoreline samples. North Anna sediment contained some cobalt-60, cesium-134 and cesium-137. During the preoperational period, cesium-137 was detected. Additional man-made isotopes appear to have accumulated since that time. Sediment contamination, however, does not provide a direct dose pathway to man. Shoreline soil, which may provide a direct dose pathway, contained no cesium-134. Cesium-137 levels increased from 378 pCi/kg in 1989 to 502 pCi/kg in 1991.

- The ingestion exposure pathway includes milk, fish, and food/vegetation samples. Iodine-131 was not detected in any 1991 milk samples. Although cesium-137 has been detected in the past, it was not detected in 1991 milk samples. Strontium-90 was detected at levels comparable to 1989, and lower than preoperational years. Both strontium-90 and cesium-137 are attributable to atmospheric nuclear weapons testing in the past. Naturally occurring potassium-40 was detected at normal environmental levels.

  Fish samples during 1991 contained cesium-137 at a slightly higher activity than preoperational levels. Steam generator repairs and better liquid waste processing, however, have reduced these activity levels from previous years. Vegetation samples were statistically similar to both control and preoperational levels.

- The direct radiation exposure pathway measures environmental radiation doses by use of thermoluminescent dosimeters (TLDs). TLD results have remained essentially the same since the preoperational period in 1977.

During 1991, as in previous years, operation of the North Anna Nuclear Power Station created no adverse environmental affects or health hazards. The maximum radiation dose calculated for a hypothetical individual at the North Anna Power Station boundary due to liquid and gaseous effluents released from the site during 1991 was 1.016 millirem. For reference this dose may be compared to the 360 millirem average annual exposure to every person in the United States from natural and man-made sources. Natural sources in the environment provide approximately 82% of radiation exposure to man while Nuclear Power contributes less than 0.1%. These results demonstrate not only compliance with federal and state regulations, but also demonstrate the adequacy of radioactive effluent control at the North Anna Nuclear Power Station.

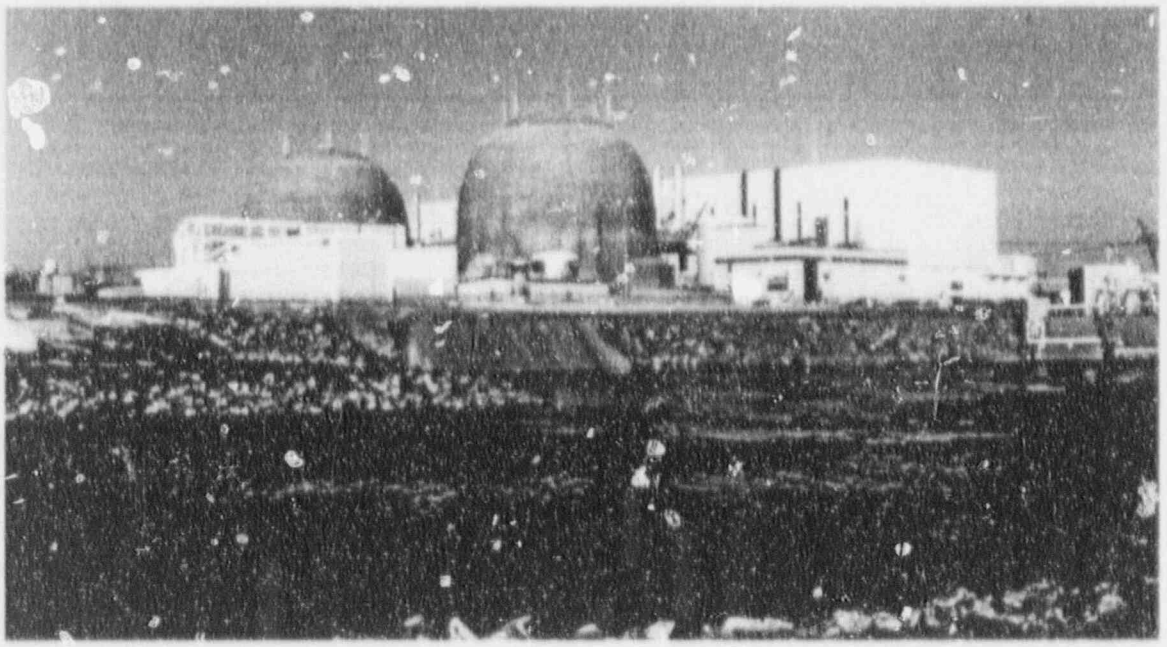
Virginia Electric And Power Company
North Anna Power Station
Radiological Environmental Operating Program

I. Introduction

The operational Radiological Environmental Monitoring Program (REMP) conducted for the year 1991 for North Anna Power Station is provided in this report. The results of measurements and analyses of data obtained from samples collected from January 1, 1991 through December 31, 1991 are summarized.

A. The North Anna Power Station of Virginia Electric and Power Company is located on Lake Anna in Mineral, Virginia, approximately 35 miles southwest of Fredericksburg, Virginia. The site consists of two units, each with pressurized water reactor (PWR) nuclear steam supply systems and turbine generators furnished by Westinghouse Electric Corporation. Each unit is designed with a gross electrical output of 970 megawatts electric (MWe). Unit 1 achieved commercial operation on June 6, 1978, and Unit 2 on December 14, 1980.

B. The United States Nuclear Regulatory Commission (USNRC) regulations (10 CFR 50.34a) require that nuclear power plants be designed, constructed, and operated to keep levels of radioactive material in effluents to unrestricted areas As Low As is Reasonably Achievable (ALARA). To ensure these criteria are met, the operating license for North Anna Power Station includes Technical Specifications which address the release of radioactive effluents. Inplant monitoring is used to ensure release limits are not exceeded. As a precaution against unexpected or undefined environmental processes which might allow undue accumulation of radioactivity in the environment, a program for monitoring the plant environs is also included in Virginia Power's Station Administrative Procedure VPAP-2103, Offsite Dose Calculation Manual (ODCM).



C. Virginia Electric and Power Company is responsible for collecting the various indicator and control environmental samples. Teledyne Isotopes is responsible for sample analysis and submitting reports of radioanalyses. The results are used to determine if changes in radioactivity levels could be attributable to station operations. Measured values are compared to control levels, which vary with time due to such external events as cosmic ray bombardment, weapons test fallout, and seasonal variations of naturally occurring isotopes. Data collected prior to the plant operation is used to indicate the degree of natural variation to be expected. This preoperational data is compared to data collected during the operational phase to assist in evaluating any radiological impact of plant operations.

D. Occasionally samples of environmental media show the presence of man-made isotopes. As a method of referencing the measured radionuclide concentrations in the sample media to a dose consequence to man, the data is compared to the reporting level concentrations listed in the USNRC Regulatory Guide 4.8 and North Anna Power Station's ODCM. These concentrations are based upon the annual dose commitment recommended by 10 CFR 50, Appendix I, to meet the criterion of "As Low As Is Reasonably Achievable."

E. This report documents the results of the Radiological Environmental Monitoring Program for 1991 and satisfies the following objectives of the program:

1. Provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides that lead to the highest potential radiation exposure of the maximum exposed members of the public resulting from the station operation.

2. Supplements the radiological effluent monitoring program by verifying that radioactive effluents are within allowable limits.

3. Identifies radioactivity changes in the environment.

4. Verifies that the plant operations have no detrimental effect on the health and safety of the public.

II. Nuclear Power And The Environment: In Perspective

Coal, oil, natural gas, nuclear power, and hydropower have all been used to run the nation's electric generating stations. Each method, however, has its drawbacks. Coal-fired power can damage the environment during the mining process, or by airborne discharges such as fly ash and chemicals which contribute to acid rain. Oil and natural gas are costly because of their limited supply. Few suitable sites for hydropower exist, and building the large dams necessary to produce Hydropower has a significant impact on the environment.

Nuclear energy provides an alternate source of energy which is readily available. The operation of nuclear power stations has a very small impact on the environment. In fact, hundreds of acres adjoining Surry Power Station are a state waterfowl refuge, and Lake Anna, next to North Anna Power Station, is a well-known fishing site with a state park on its shore.

In order to more fully understand this unique energy source, background information about basic radiation characteristics, risk assessment, reactor operation, effluent control, environmental monitoring, and radioactive waste is provided in this section.

Fundamentals

The Atom

Everything we encounter is made of atoms. Atoms are the smallest parts of an element that still have all the chemical properties of that element. At the center of an atom is a nucleus. The nucleus consists of neutrons and protons. Electrons move in an orbit around the nucleus and are negatively charged. Protons and neutrons are nearly identical in size and weight, and each is about 2000 times heavier than an electron. The proton, however, has a positive charge, while the neutron has no charge, it is electrically neutral. Figure 1 presents a simple diagram of an atom.

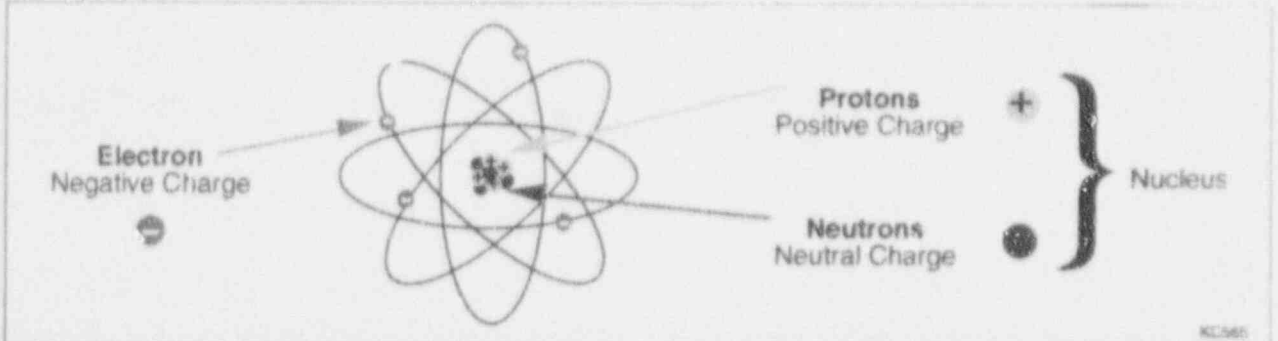


Figure 1. Atomic Structure

Isotopes

The number of protons in the atom of any specific element is always the same. For example, all hydrogen atoms have one proton whereas all oxygen atoms have eight protons. Unlike protons,

the number of neutrons in the nucleus of an element may vary. Atoms with the same number of protons, but a different number of neutrons, are called isotopes. Table 1 lists the isotopes of uranium.

Isotope	Symbols	Number of Protons	Number of Neutrons
Uranium-235	^{235}U	92	143
Uranium-236	^{236}U	92	144
Uranium-237	^{237}U	92	145
Uranium-238	^{238}U	92	146
Uranium-239	^{239}U	92	147
Uranium-240	^{240}U	92	148

Table 1. Uranium Isotopes

Radiation and Radioactivity

Radionuclides

Normally, the parts of an atom are in a balanced or stable state. A small percentage of atoms naturally contain excess energy and therefore are not stable atoms. If the nucleus of an atom contains excess energy, it may be called a radioactive atom, a radioisotope, or radionuclide. The excess energy is usually due to an imbalance in the number of electrons, protons, and/or neutrons which make up the atom.

Radionuclides can be naturally occurring, such as uranium-238, thorium-232 and potassium-40, or man-made, such as iodine-131, cesium-137, and cobalt-60.

Radioactive Decay

Radioactive atoms attempt to reach a stable (non-radioactive) state through a process known as radioactive decay. Radioactive decay is the release of energy from the atom through the emission of particulate and/or electromagnetic radiation. Particulate radiation may be in the form of electrically charged particles such as alpha (2 protons plus 2 neutrons) or beta particles (1 electron), or may be electrically neutral, such as neutrons. Part of the electromagnetic spectrum consists of gamma rays and X-rays which are similar to light and microwaves, but have a much higher energy.

Half-Life

A radioactive half-life is the amount of time required for a radioactive substance to lose half of its activity through the process of radioactive decay. Cobalt-60 has a half-life of about 5 years.

After 5 years, 50% of its radioactivity is gone, and after 10 years, 75% has decayed away. Radioactive half-lives vary from millionths of a second to millions of years.

Radioactive atoms may decay directly to a stable state or may undergo a series of decay stages. During the decay process, several daughter products may be formed which eventually transform into stable atoms. Naturally occurring radium-226, for example, has 10 successive daughter products (including radon) resulting finally with lead-206 as a stable form.

Types Of Radiation

Two types of radiation are considered in the nuclear industry, particulate and electromagnetic. Particulate radiation may come from the nucleus of an atom in the form of an ejected alpha particle. Alpha particles consists of two protons together with two neutrons.

Alpha particles have a very limited ability to penetrate matter. A piece of paper will stop all alpha radiation. For this reason, alpha radiation from sources outside the body are not considered to be a radiation hazard.

A beta particle is like an electron that has been ejected from the nucleus of an atom. Skin or a thin piece of aluminum will stop beta radiation. Exposure to beta radiation can be a hazard to the skin or lens of the eye. Because of their limited ability to penetrate the body, beta and alpha radiation are a health concern primarily if alpha or beta emitters are swallowed or inhaled where they might cause internal radiation exposure. Gamma rays are like X-rays, except that they come from the nucleus of an atom while X-rays come from the electron rings.

Gamma rays can penetrate deep into the body and thus give a "whole-body" radiation dose. Several inches of concrete or lead will stop both gamma and X-rays. Figure 5 shows the approximate penetrating ability of various types of radiation.

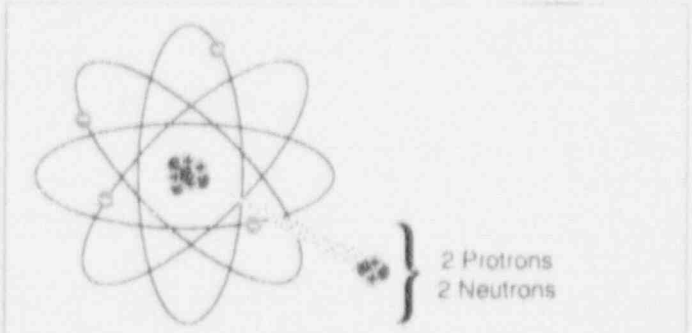


Figure 2. Alpha Particle

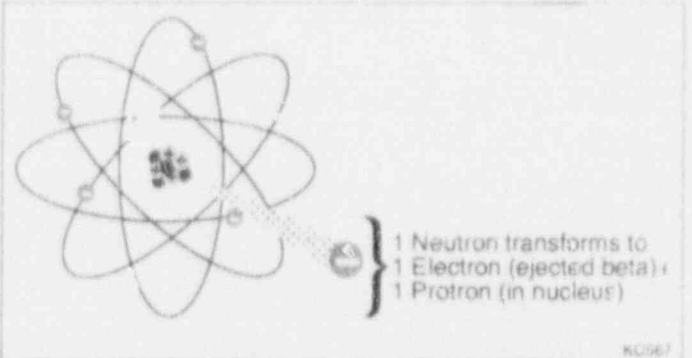


Figure 3. Beta Particle

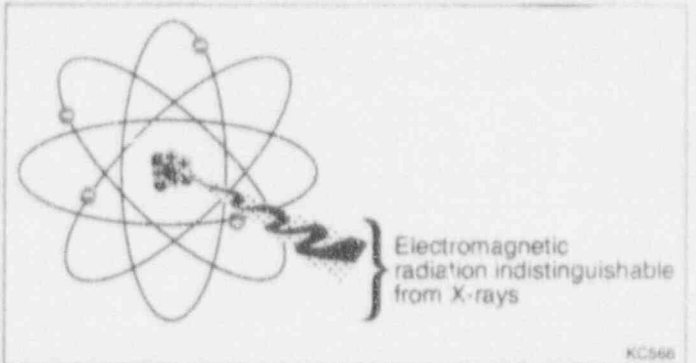
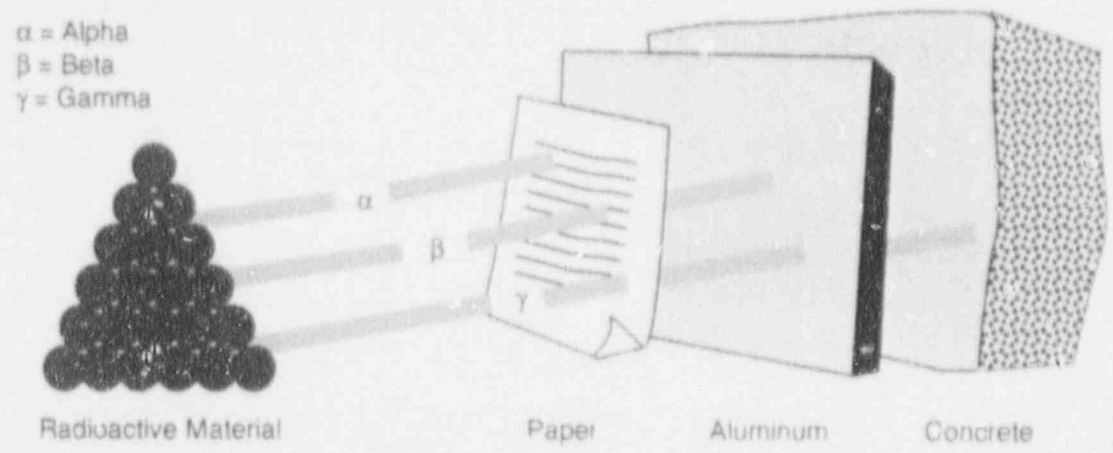


Figure 4. Gamma Ray



As radiation travels, it collides with other atoms and loses energy. Alpha particles can be stopped by a sheet of paper, beta particles by a thin sheet of aluminum, and gamma radiation by several inches of concrete or lead.

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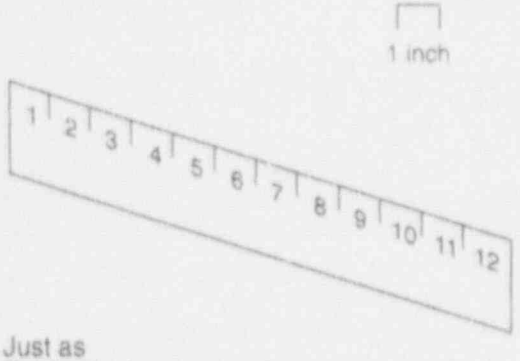
Figure 5. The Penetrating Ability of Various Types of Radiation

Quantities And Units Of Radioactive Measurement

Several quantities and units are used to describe radioactivity and its effects. In the following sections two terms, rem and activity, will be used to describe amounts of radiation.

Rem measures the potential effect of radiation exposure on human cells. Small doses are counted in millirem. Each millirem is equal to one thousandth of a rem. Federal standards limit exposure for an individual member of the public to 500 millirem annually. This annual limit does not include the average 300 millirem received from natural sources and approximately 60 millirem from medical applications.



Just as
Twelve inches
equals one foot

1 millirem

1000 millirem equals 1 rem

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Figure 6. Unit Comparison

Activity is the number of nuclei in a sample that disintegrate (decay) every second. Each time a nucleus disintegrates, radiation is emitted. The unit of activity is the curie. A Curie (Ci) is the amount of radioactive material which decays at a rate of 37 billion atoms per second. Smaller units of the Curie are often used. Two common units are the microCurie (uCi), one millionth of a Curie, and the picoCurie (pCi), one trillionth of a Curie. A Curie is a measurement of radioactivity, not a quantity of material. The amount of material necessary to make one Curie varies. For example, one gram of radium-226 is one Curie of radioactivity, but it would take 9,170,000 grams (about 10 tons) of thorium-232 to obtain one Curie.

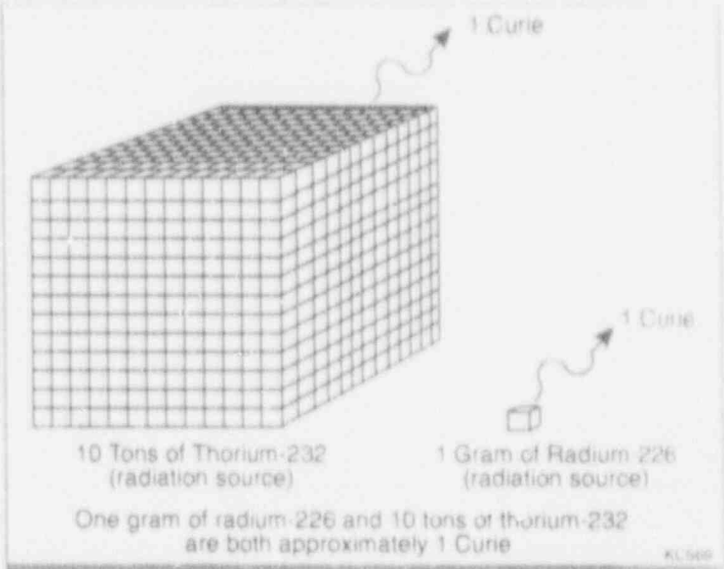

Figure 7. The Curie, a Measurement of Activity

Sources Of Radiation

Background Radiation

Radiation is not a new creation of the nuclear power industry, it is a natural occurrence on the earth. Mankind has always lived with radiation and always will. Every second of our lives, over 7,000 atoms undergo radioactive decay in the body of the average adult. Radioactivity exists naturally in the soil, water, air and space. All of these common sources of radiation contribute to the natural background radiation that we are exposed to each day.

The earth is constantly showered by a steady stream of high energy gamma rays. These rays come from space and are known as cosmic radiation. Our atmosphere shields out most of this radiation, but everyone still receives about 20 to 50 millirem each year from this source. At high altitudes, the air is thinner and provides less protection from cosmic radiation. Because of this, people living at higher altitudes or even flying in an airplane are exposed to more radiation. Radioactive atoms commonly found in the atmosphere as a result of cosmic ray interactions include beryllium-7, carbon-14, tritium, and sodium-22.

Other natural sources of radiation include radionuclides naturally found in soil, water, food, building materials and even people. People have always been radioactive, in part because the carbon found in our bodies is a mixture of all carbon isotopes, both non-radioactive and radioactive. Approximately two-thirds of the whole body dose from natural sources is contributed by Radon gas. About one-third of the naturally occuring external terrestrial and internal whole body radiation dose is attributable to a naturally radioactive isotope of potassium, potassium-40.

Man-Made

In addition to naturally occurring radiation, people are also exposed to man-made radiation. The largest sources of these exposures are from medical X-rays, fluoroscopic examinations, radioactive drugs, and tobacco. Small doses are received from consumer products such as television, smoke alarms, and fertilizers. Very small doses result from the production of nuclear power. Fallout from nuclear weapons tests is another source of man-made exposure. Fallout radionuclides include strontium-90, cesium-137, carbon-14, and tritium.

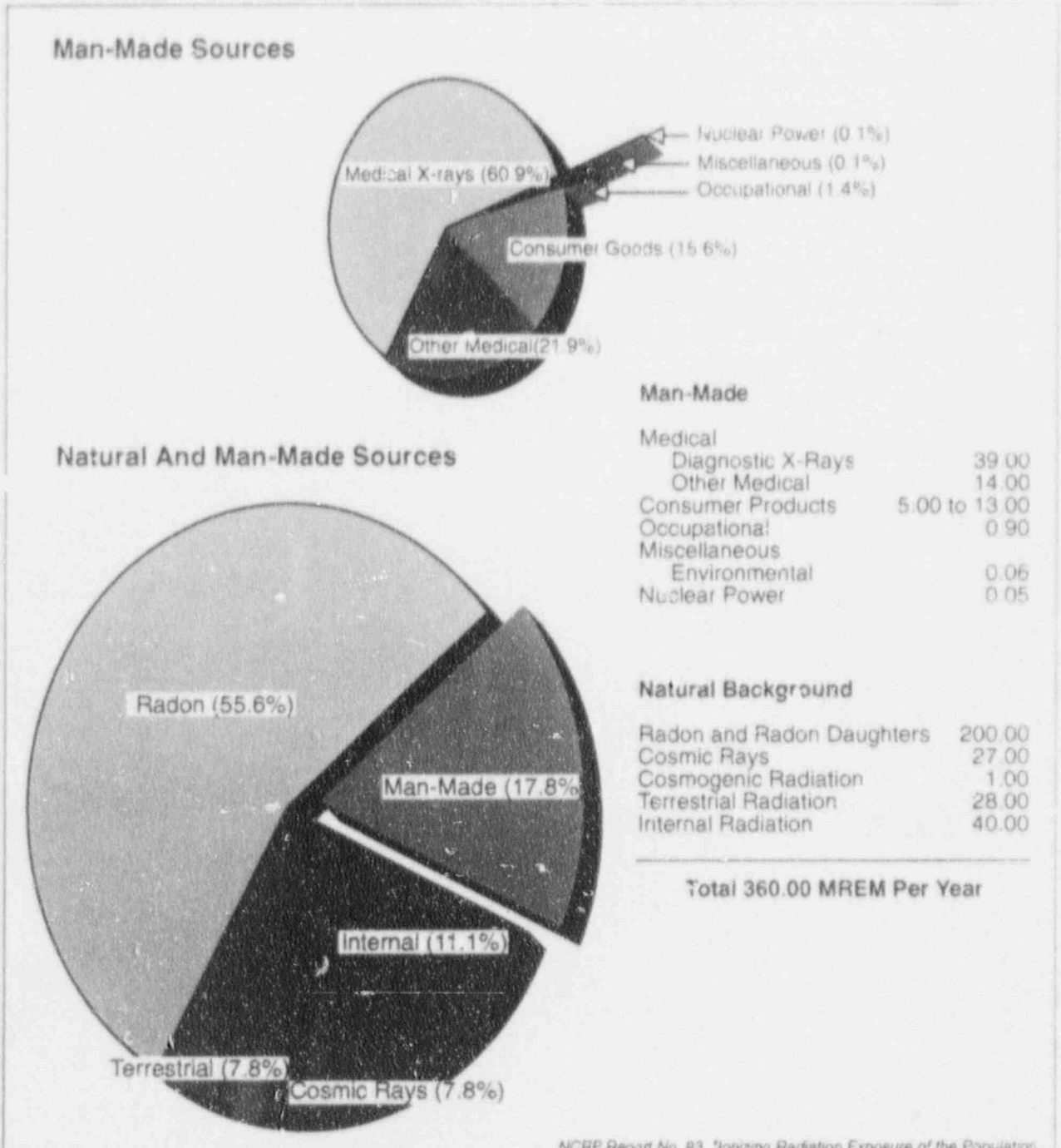

Figure 8. Average Annual Dose Equivalent To Persons In The U.S. From Various Radiation Sources

Effects Of Radiation

Studies

The effects of ionizing radiation on human health have been under study for more than eighty years. Scientists have obtained valuable knowledge through the study of laboratory animals that were exposed to radiation under controlled conditions. It has proven difficult, however, to relate the biological effects of irradiated laboratory animals to the potential health effects on humans. Because of this, human populations irradiated under various circumstances have been studied in great depth. These groups include:

- Survivors of the atomic bomb.
- Persons undergoing medical radiation treatment.
- Radium dial painters during World War I who ingested large amounts of radioactivity by "tipping" the paint brushes with their lips.
- Uranium miners, who inhaled large amounts of radioactive dust while mining pitchblende (uranium ore).
- Early radiologists, who accumulated large doses of radiation from early X-ray equipment while being unaware of the potential hazards.

Analysis of these groups has increased our knowledge of health effects resulting from large radiation doses. Less is known about the effects of low doses of radiation. To be on the conservative side, we assume that health effects occur proportionally to those observed following a large dose of radiation. That is, if one dose of radiation causes an effect, then half the dose will cause half the effect. Radiation scientists agree that this assumption overestimates the risks associated with low level radiation exposure. The effects predicted in this manner have not been actually observed in individuals exposed to low level radiation.

Health Risks

Since the actual effects of exposure to low level radiation are difficult to measure, scientists often refer to the possible risk involved. The problem is one of evaluating alternatives, of comparing risks and weighing them against benefits. People make decisions involving risks every day, such as deciding whether to wear seat belts or smoke cigarettes. Risks are a part of everyday life. The question is to determine how great the risks are.

We accept the inevitability of automobile accidents. Building safer cars or wearing seat belts will reduce the risk of injury. You could choose to not drive to be even safer, but pedestrians and bicyclists are also injured by cars. Reducing the risk of injury from automobiles to zero requires moving to a place where there are no automobiles.

While accepting the many daily risks of living, some people feel that their demands for energy should be met on an essentially risk-free basis. Attention is focused on safeguarding the public, developing a realistic assessment of the risks, and placing them in perspective.

Because you cannot see, feel, taste, hear, or smell radiation, it is often a source of concern. We have the same lack of sensory perception for things such as radio waves, carbon monoxide, and small concentrations of numerous cancer causing substances. Although these risks are just as real as the risks associated with radiation, they have not generated the same degree of concern as radiation.

Most risks are with us throughout our lives, and their effects can be added up over a lifetime to obtain a total effect on our life span. The typical life span for an American woman is now 78 years, whereas men average 71 years of age. Figure 9 shows a number of different factors that decreased our average life expectancy.

Activity

1. Smoking 1 Pack of Cigarettes a Day
2. Being 20% Overweight
3. Construction
4. Agriculture
5. Auto Accidents
6. Avg Alcohol Consumption per Person
7. Home Accidents
8. All Industry Hazards
9. Radiation Dose of 6.5 Millirem per Year for 30 Years

NCRP Report No. 95, "Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources," National Council on Radiation Protection and Measurements, 30 Dec 1987, Bethesda, MD 20814

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Figure 9. Estimated Average Days Of Life Expectancy Lost Due To Various Health Risks

The American Cancer Society estimates that about 30 percent of all Americans will develop cancer at some time in their lives from all possible causes. So, in a group of 10,000 people it is expected that 3,000 of them will develop cancer. If each person were to receive a radiation exposure of one rem in addition to natural background radiation, then it is expected that three more may develop cancer during their lifetime. This increases the risk from 30 percent to 30.03 percent. Hence, the risks of radiation exposure are small when compared to the risks of everyday life.

These comparisons should give you some idea of the risk involved in activities that you are familiar with. They give a basis for judging what smoking, eating, or driving a car could mean to your health and safety. Everyone knows that life is full of risks. If you have the basis for judgment you can decide what to do or what not to do.

Nuclear Reactor Operation

Electricity in the United States is being produced using fossil fuel, uranium, or falling water. A fossil-fueled power station burns coal, oil or natural gas in a boiler to produce energy. Nuclear power stations use uranium fuel and the heat produced from the fission process to make energy. In both cases, they heat and boil water to produce steam. The steam is used to drive a turbine which turns a generator and produces electricity.

Nuclear Fuel

Uranium (U) is the basic ingredient in nuclear fuel, consisting of U-235 and U-238 atoms. Natural uranium contains less than one percent U-235 when it is mined. Commercial nuclear power plants use fuel with a U-235 content of approximately three percent. The process used to increase the U-235 concentration is known as enrichment.

Reactor Operation

After enrichment, the uranium fuel is chemically changed to uranium dioxide, a dry black powder. This powder is compressed into small ceramic pellets. Each fuel pellet is about 3/4 inches long and 3/8 inches in diameter. The pellets are placed into 12 foot long metal tubes made of zirconium alloy to make a fuel rod. About five pounds of pellets are used to fill each rod. A total of 204 fuel rods make a single fuel assembly. Virginia Power nuclear reactors contains 157 fuel assemblies (Figure 10).

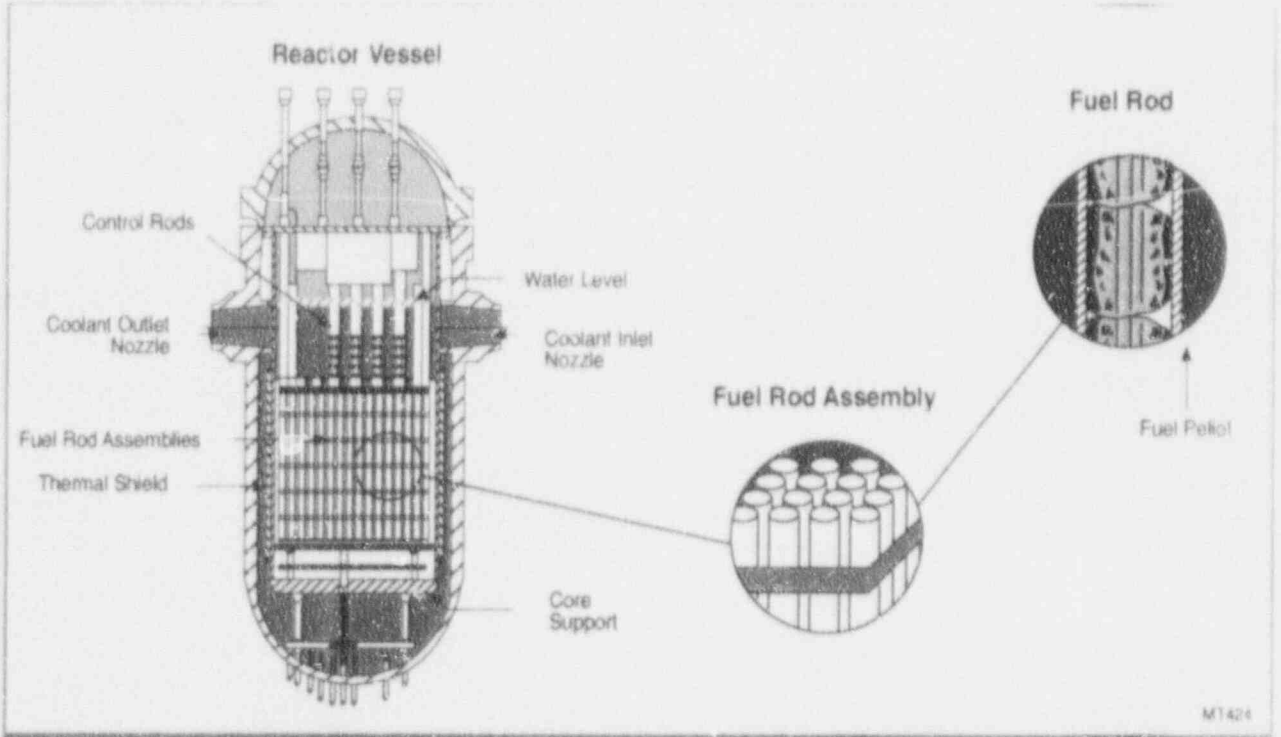


Figure 10. Reactor Vessel With Fuel Assemblies, Rods, and Fuel Pellets

Fission

Nuclear energy is produced by a process called fission. Fission occurs in a reactor when uranium is split into fragments producing heat and releasing neutrons. These neutrons strike other uranium atoms, causing them to split (fission) and release more heat and neutrons. This is called a chain reaction (Figure 11) and is controlled by the use of reactor control rods.

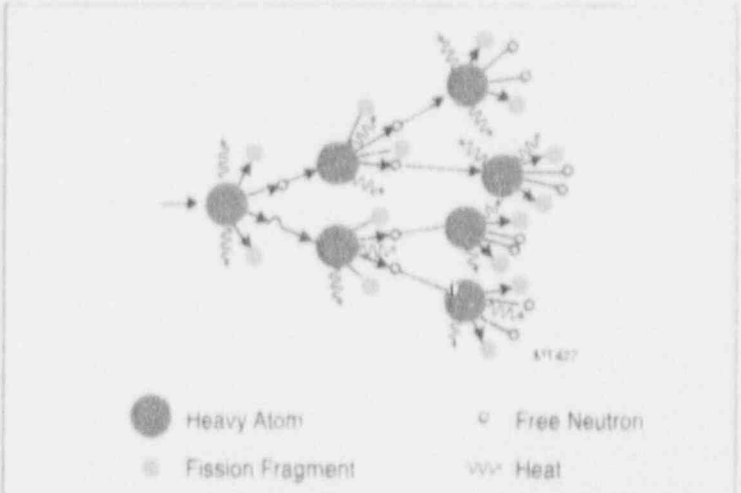


Figure 11. Fission: A Chain Reaction

Control rods are an essential part of the nuclear reactor. Control rods contain cadmium, indium, and silver metals which absorb and control the amount of neutrons produced in the reactor. The control rods act to slow down or stop the chain reaction. A chain reaction cannot occur when the control rods are inserted completely into the core. When the control rods are withdrawn, the chain reaction begins and heat is generated.

Design & Operation

Surry Power Station and North Anna Power Station use a Pressurized Water Reactor (PWR) system to generate electricity. There are two complete and independent PWR systems on site at both Surry and North Anna Power Stations. These are referred to as Unit-1 and Unit-2.

The reactor core is inside a large steel container called the Reactor Pressure Vessel. The reactor core is always surrounded by water. The fissioning of the uranium fuel makes the fuel rods get hot. The hot fuel rods heat the water, which serves as a coolant that carries away heat.

In a pressurized water reactor, heat is moved from place to place by moving water, the reactor's coolant. The water flows in closed loops. As (primary) water moves through the core it gets very hot (605°F), but because it is under such high pressure, 2235 pounds per square inch (psi), it doesn't boil. The hot water then flows to the steam generator. The steam generator is a heat exchanger. Reactor coolant passes through it but doesn't mix with the steam generator (secondary) water. Instead, heat from the primary water is transferred through thousands of tubes to the cooler secondary water. The water in the steam generator is under much less pressure, and the heat boils the secondary water to steam. At Virginia Electric and Power stations, each unit has 3 steam generators.

The steam is piped to a steam turbine that turns an electric generator. The exhausted steam from the turbine is cooled and converted back to water in a condenser. The condenser is also a heat exchanger; in it heat passes from the steam to a third loop of water. In Surry's case the James River provides the third loop water. At North Anna Power Station third loop water is from Lake Anna. The steam turns back to liquid and is pumped back to the steam generator. Figure 12 is a diagram of typical nuclear reactor systems.

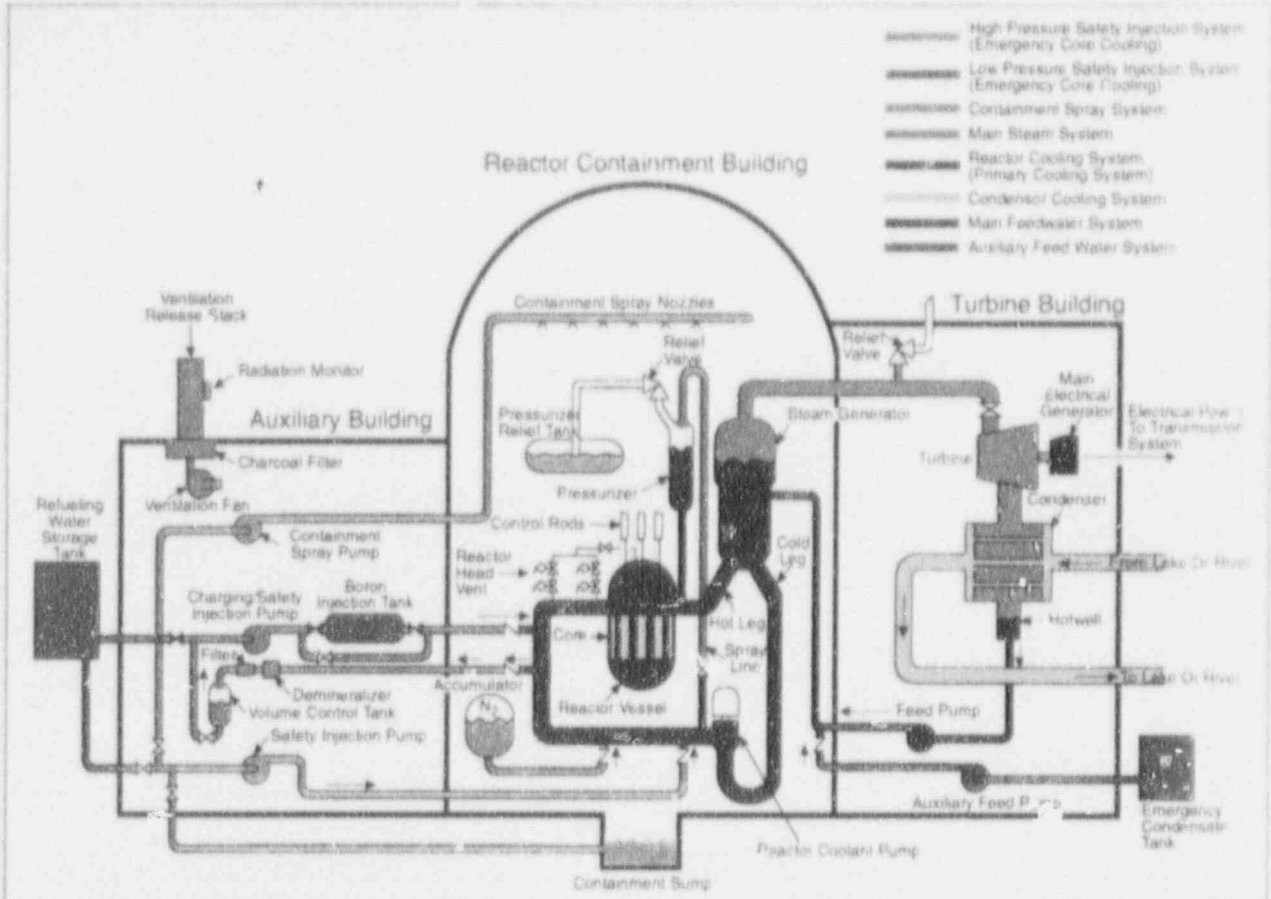


Figure 12. PWR System Diagram

Containment

Nuclear power plants are designed to prevent the escape of large quantities of radiation and radioactive substances. Two principles are used. First, thick, heavy walls are used as shielding to absorb radiation and prevent its escape. Second, strong, airtight walls called containment are used to prevent the escape of radioactive materials.

The reactor pressure vessel and the containment building that houses it are enormously strong (Figure 13). Strong enough, in fact, to withstand a direct hit from a 707 jetliner. The reactor core lies within a sealed pressure vessel. Like all boilers its walls must be very strong because the water inside must be kept under high pressure. The reactor pressure vessel in a nuclear power plant is even heavier than an ordinary steam boiler because of the need to minimize the chance of rupture and release of any radioactive materials. The reactor pressure vessel is made from a stainless steel alloy 6 to 8 inches thick.

Around the reactor pressure vessel is a thick concrete wall. This wall acts as shielding, protecting workers by absorbing radiation resulting from the nuclear chain reaction. Next an airtight 1/2 inch steel liner surrounds the entire interior of the containment. If the reactor pressure vessel or any of the primary piping should break, the escaping steam would be trapped inside the liner.

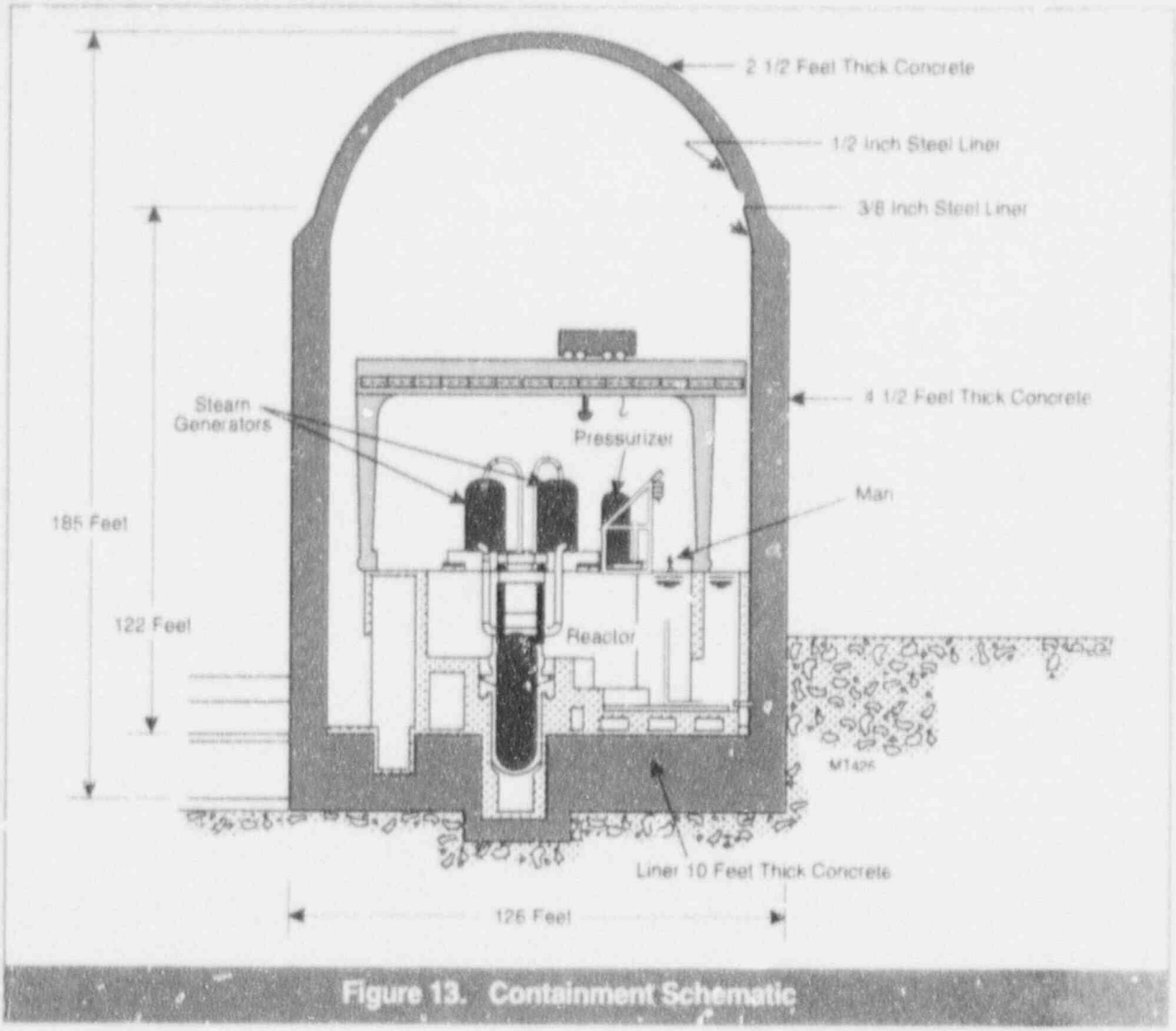


Figure 13. Containment Schematic

Finally, the building's reinforced concrete outer wall is 4 1/2 feet thick tapering to 2 1/2 feet at the top of the dome. It is designed to act as shielding and is also intended to withstand natural and man-made events like earthquakes and even the direct impact from a large commercial jet aircraft.

Operating the Reactor Safely

Accidents

The most serious accident that could happen in a nuclear power plant involves overheating in the nuclear reactor core. Such an accident would result from a loss-of-coolant accident or LOCA. During a LOCA, primary coolant would no longer circulate through the reactor core to remove heat. Circulation could be lost if a combination of pipes burst, for example. Conceivably, a dry, overheated reactor core could melt through the pressure vessel.

The reactor itself is designed to respond automatically to such an emergency. Operators are also trained to make corrections for any system failure. The automatic and operator responses have two goals: to prevent damage to the reactor, and prevent the release of radiation. Shutting the reactor down is relatively easy. Control rods drop in and chemical to stop the nuclear reaction are injected into the coolant. Losing the coolant itself tends to stop the chain reaction because the coolant is needed to keep the nuclear chain reaction going. Within 10 seconds of shutdown, the amount of heat is less than 5 percent of the amount produced at full power and within 15 minutes, less than 1 percent.

To carry heat away during an accident, all reactors have Emergency Core Cooling Systems (ECCS). The ECCS consists of primary and back-up pumps and reservoirs of coolant that operate separately from those that normally circulate through the system. A nuclear reactor has many different back-up safety systems designed so that if one fails another is always available.

Workers

There are many different jobs at a nuclear power plant and they are filled by people with diverse backgrounds. All employees are initially trained and then retrained annually by the company. Virginia Power's Training centers are fully accredited by the National Academy for Nuclear Training and the Institute for Nuclear Power Operations. The operators are tested and certified by the United States Nuclear Regulatory Commission (NRC).

Safety Statistics

Job safety is another measure of assurance that the station is being properly operated. Surry Power Station attained 1,000,000 man hours without a lost time accident and is continuing that record into 1992, while North Anna reached 6,000,000 man hours without a lost time accident.

Summary

- Nuclear energy provides an alternate source of energy which is readily available. The operation of a nuclear power station has a very small impact on the environment.
- Radiation is not a new creation of the nuclear power industry; it is a natural occurrence on the earth. Mankind has always lived with radiation and always will. Radioactivity exists naturally in the soil, water, air and space. All these common sources of radiation contribute to the natural background radiation to which we are exposed.
- In addition to naturally occurring radiation and radioactivity, people are also exposed to man-made radiation. Very small doses result from the production of nuclear power.
- Nuclear power plants are designed to prevent the escape of radiation and radioactive substances.
- A nuclear reactor has many different back-up safety systems designed so that if one fails another is available.

III. Sampling And Analysis Program

A. Sampling Program

1. Table 1 summarizes the sampling program for North Anna Power Station during 1991. The maps indicate the locations of the environmental monitoring stations.

2. For routine TLD measurements, two dosimeters made of $CaSO_4$:Dy in a teflon card are deployed at each sampling location. Several TLDs are co-located with NRC and Commonwealth of Virginia direct radiation recording devices. These are indicated as "co-location" samples.

3. In addition to the Radiological Environmental Monitoring Program required by North Anna Technical Specifications, Virginia Electric and Power Company (VEPCO) splits samples with the Commonwealth of Virginia. All samples listed in Table 1 are collected by VEPCO personnel except for those labeled state split. All samples are shipped to Teledyne Isotopes in Westwood, New Jersey.

4. All samples listed in Table 1 are taken at indicator locations except those labeled "control".

Table 2
(Page 1 of 5)
North Anna Power Station - 1991
Radiological Sampling Station
Distance And Direction From Unit No. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
Environmental Thermoluminescent Dosimetry (TLD)	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Quarterly & Annually	On-site, State Split
	Fredericks Hall	02	5.30	SSW	225°	Quarterly & Annually	State Split
	Mineral, Va	03	7.10	WSW	243°	Quarterly & Annually	
	Wares Crossroads	04	5.10	WNW	287°	Quarterly & Annually	State Split
	Route 752	05	4.20	NNE	20°	Quarterly & Annually	
	Sturgeon's Creek Marina	05A	3.20	N	11°	Quarterly & Annually	
	Levy, VA	06	4.70	ESE	115°	Quarterly & Annually	State Split, Co-Location
	Bumpass, VA	07	7.30	SSE	167°	Quarterly & Annually	State Split
	End of Route 685	21	1.00	WNW	301°	Quarterly & Annually	Exclusion Boundary State Split, Co-Location
	Route 700	22	1.00	WSW	242°	Quarterly & Annually	Exclusion Boundary State Split
	"Aspen Hills"	23	0.93	SSE	158°	Quarterly & Annually	Exclusion Boundary State Split, Co-Location
	Orange, VA	24	22.00	NW	325°	Quarterly & Annually	Control
	Bearing Cooling Tower	N-1/33	0.06	N	10°	Quarterly	On-Site
	Sturgeon's Creek Marina	N-2/34	3.20	N	11°	Quarterly	
	Parking Lot "C" (on-site)	NNE-3/35	0.25	NNE	32°	Quarterly	On-Site
	Good Hope Church	NNE-4/36	4.96	NNE	25°	Quarterly	State Split
	Parking Lot "B"	NE-5/37	0.20	NE	42°	Quarterly	On-Site
	Lake Anna Marina	NE-6/38	1.49	NE	34°	Quarterly	
	Weather Tower Fence	ENE-7/39	0.36	ENE	74°	Quarterly	On-Site
	Route 699	ENE-8/40	2.43	ENE	65°	Quarterly	
	Near Training Facility	E-9/41	0.30	E	91°	Quarterly	On-Site

Table 2
(Page 2 of 5)
North Anna Power Station - 1991
Radiological Sampling Stations
Distance And Direction From Unit No. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
Environmental Thermoluminescent Dosimetry (TLD)	"Morning Glory Hill"	E-10/42	2.85	E	93°	Quarterly	
	Island Dike	ESE-11/43	0.12	ESE	103°	Quarterly	On-Site
	Route 622	ESE-12/44	4.70	ESE	115°	Quarterly	
	VEPCO Biology Lab	SE-13/45	0.75	SE	138°	Quarterly	On-Site
	Route 701 (Dam Entrance)	SE-14/46	5.88	SE	137°	Quarterly	
	"Aspen Hills"	SSE-15/47	0.93	SSE	158°	Quarterly	Exclusion Boundary
	Elk Creek	SSE-16/48	2.33	SSE	165°	Quarterly	
	Warehouse Compound Gate	S-17/49	0.22	S	173°	Quarterly	On-Site
	Elk Creek Church	S-18/50	1.55	S	178°	Quarterly	
	NAPS Access Road	SSW-19/51	0.36	SSW	197°	Quarterly	On-Site
	Route 618	SSW-20/52	5.30	SSW	205°	Quarterly	
	NAPS Access Road	SW-21/53	0.50	SW	218°	Quarterly	On-Site
	Route 700	SW-22/54	4.36	SW	232°	Quarterly	
	500 kv Tower	WSW-23/55	0.40	WSW	237°	Quarterly	On-Site
	Route 700 (Exclusion Boundary)	WSW-24/56	1.00	WSW	242°	Quarterly	Exclusion Boundary
	NAPS Radio Tower	W-25/57	0.31	W	279°	Quarterly	On-Site
	Route 685	W-26/58	1.55	W	274°	Quarterly	
	End of Route 685	WNW-27/59	1.00	WNW	301°	Quarterly	Exclusion Boundary
	H. Purcell's Private Rd.	WNW-28/60	1.52	WNW	303°	Quarterly	Co-Location
	End of #1/#2 Intake	NW-29/61	0.15	NW	321°	Quarterly	On-Site
	Lake Anna Campground	NW-30/62	2.54	NW	319°	Quarterly	
	#1/#2 Intake	NNW-31/63	0.07	NNW	349°	Quarterly	On-Site
	Route 208	NNW-32/64	3.43	NNW	344°	Quarterly	
	Bumpass Post Office	C-1/2	7.50	SSE	167°	Quarterly	Control
	Orange, VA	C-3/4	22.00	NW	325°	Quarterly	Control
	Mineral, VA	C-5/6	7.10	WSW	243°	Quarterly	Control
	Louisa, VA	C-7/8	11.54	WSW	257°	Quarterly	Control

Table 2
(Page 3 of 5)
North Anna Power Station - 1991
Radiological Sampling Stations
Distance And Direction From Unit No. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
Airborne Particulate and Radioiodine	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Weekly	On-Site, State Split
	Fredericks Hall	02	5.30	SSW	205°	Weekly	
	Mineral, VA	03	7.10	WSW	243°	Weekly	
	Wares Crossroads	04	5.10	WNW	287°	Weekly	
	Route 752	05	4.20	NNE	20°	Weekly	
	Sturgeon's Creek Marina	05A	3.20	N	11°	Weekly	
	Levy, VA	06	4.70	ESE	115°	Weekly	
	Bumpass, VA	07	7.30	SSE	167°	Weekly	
	End of Route 685	21	1.00	WNW	301°	Weekly	Exclusion Boundary
	Route 700	22	1.00	WSW	242°	Weekly	Exclusion Boundary
	State Split						
	"Aspen Hills"	23	0.95	SSE	158°	Weekly	Exclusion Boundary
	Orange, VA	24	22.00	NW	325°	Weekly	Control
Surface Water W	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148°	Monthly	State Split
	*Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320°	Monthly	Control, State Split
	*Lake Anna (upstream) (Route 669 Bridge)	09A	12.90	WNW	295°	Monthly	Control
River Water W	North Anna River (downstream)	11	5.80	SE	128°	Monthly	
Ground Water (Well Water) W	Biology Lab	01A	0.75	SE	138°	Quarterly	State Split
Precipitation W	Biology Lab	01A	0.75	SE	138°	Monthly	
Aquatic Sediment	Waste Heat Treatment Facility (Second Cooling Lagoon)	08	1.10	SSE	148°	Semi-Annually	State Split
	Lake Anna (upstream)	09	2.20	NW	320°	Semi-Annually	Control, State Split
	North Anna River (Downstream)	11	5.80	SSE	128°	Semi-Annually	

* In October 1991 the Surface Water Sample location at station 09 was moved to 09A.

Table 2
(Page 4 of 5)
North Anna Power Station - 1991
Radiological Sampling Stations
Distance And Direction From Unit No. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degrees	Collection Frequency	Remarks
Shoreline Soil SS	Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320°	Semi-Annually	State Split
Soil S	NAPS Sewage Treatment Plant	01	0.20	NE	42°	Once/3 years	On-Site
	Fredericks Hall	02	5.80	SSW	205°	Once/3 years	
	Mineral, VA	03	7.10	WSW	243°	Once/3 years	
	Wares Crossroads	04	5.10	WNW	293°	Once/3 years	
	Route 752	05	4.20	NNE	20°	Once/3 years	
	Sturgeon's Creek Marina	05A	3.20	N	11°	Once/3 years	
	Levy, VA	06	4.70	ESE	115°	Once/3 years	
	Bumpass, VA	07	7.50	SSE	167°	Once/3 years	
	End of Route 685	21	1.00	WNW	301°	Once/3 years	Exclusion Boundary
	Route 700 (Exclusion Boundary)	22	1.00	WSW	242°	Once/3 years	Exclusion Boundary
	"Aspen Hills"	23	0.93	SSE	158°	Once/3 years	Exclusion Boundary
	Orange, VA	24	22.00	NW	325°	Once/3 years	Control
Milk ▲	Holladay Dairy (R.C. Goodwin)	12	8.30	NW	310°	Monthly	State Split
	Terrell's Dairy (Fredericks Hall)	13	5.60	SSW	205°	Monthly	State Split
Fish***	Waste Heat	08	1.10	SSE	148°	Semi-Annually	State Split
F	Treatment Facility (Second Cooling Lagoon)						
	Lake Anna (upstream) (Route 208 Bridge)	09	2.20	NW	320°	Semi-Annually	State Split
	Lake Orange *	25	16.5	NW	312°	Semi-Annually	Control
Food Products (Broadleaf Vegetation)	Route 715	14	1.20	NE	45°	Monthly if available or at harvest	
	Route 614	15**	1.70(1.37)	SE	133°	Monthly if available or at harvest	

* Added as result of 1990 Quality Assurance Audit.
** Location changed as a result of 1991 Land Use Census (garden at 1.37 miles October 1991.
*** Fish sample no longer obtained at station, #09.

Table 2
(Page 3 of 5)
North Anna Power Station - 1991
Radiological Sampling Stations
Distance And Direction From Unit No. 1

Sample Media	Location	Station	Distance Miles	Compass Direction	Degree	Collection Frequency	Remarks
Food Products (Broadleaf Vegetation)	Route 629/522	16	12.60	NW	314°	Monthly if available or at harvest	
	End of Route 685	21	1.00	WNW	301°	Monthly if available or at harvest	
	Aspen Hills	23	0.93	SSE	158°	Monthly if available or at harves	

* Added as result of 1990 Quality Assurance Audit

Legend For The North Anna Power Station
Environmental Monitoring Stations Overview Maps

Map Designation	Environmental Station Identification	Map Designation	Environmental Station Identification
1	N-1/33	24	WSW-24/56,22
2	N-2/34,05A	25	W-25/57
3	NNE-3/35	26	W-26K/58
4	NNE-4/36	27	WNW-27/59,21
5	NE-5/37,01	28	WNW-28/60
6	NR-6/38,14	29	NE-29/61
7	ENE-7/39	30	NW-30/62,09
8	ENE-8/40	31	NNW-31/63
9	E-9/41	32	NNW-32/64
10	E-10/42	33	O3, C-5&6
11	ESE-11/43	34	O4
12	ESE-12/44,06	35	O5
13	SE-13/45,01A	36	07, C-1&2
14	SE-14/46	37	08
15	SSE-15/47,23	38	11
16	SSE-16/48	39	12
17	S-17-49	40	13
18	S-18-50	41	15
19	SSW-19/51	42	16
20	SSW-20/52,02	43*	24, C-3&4
21	SW-21/53	44	C-7&8
22	SW-22/54	45*	25
23	WSW-23/55	46	09A

* Stations 24 and 25 are located in Lake Orange and are not shown on the following maps

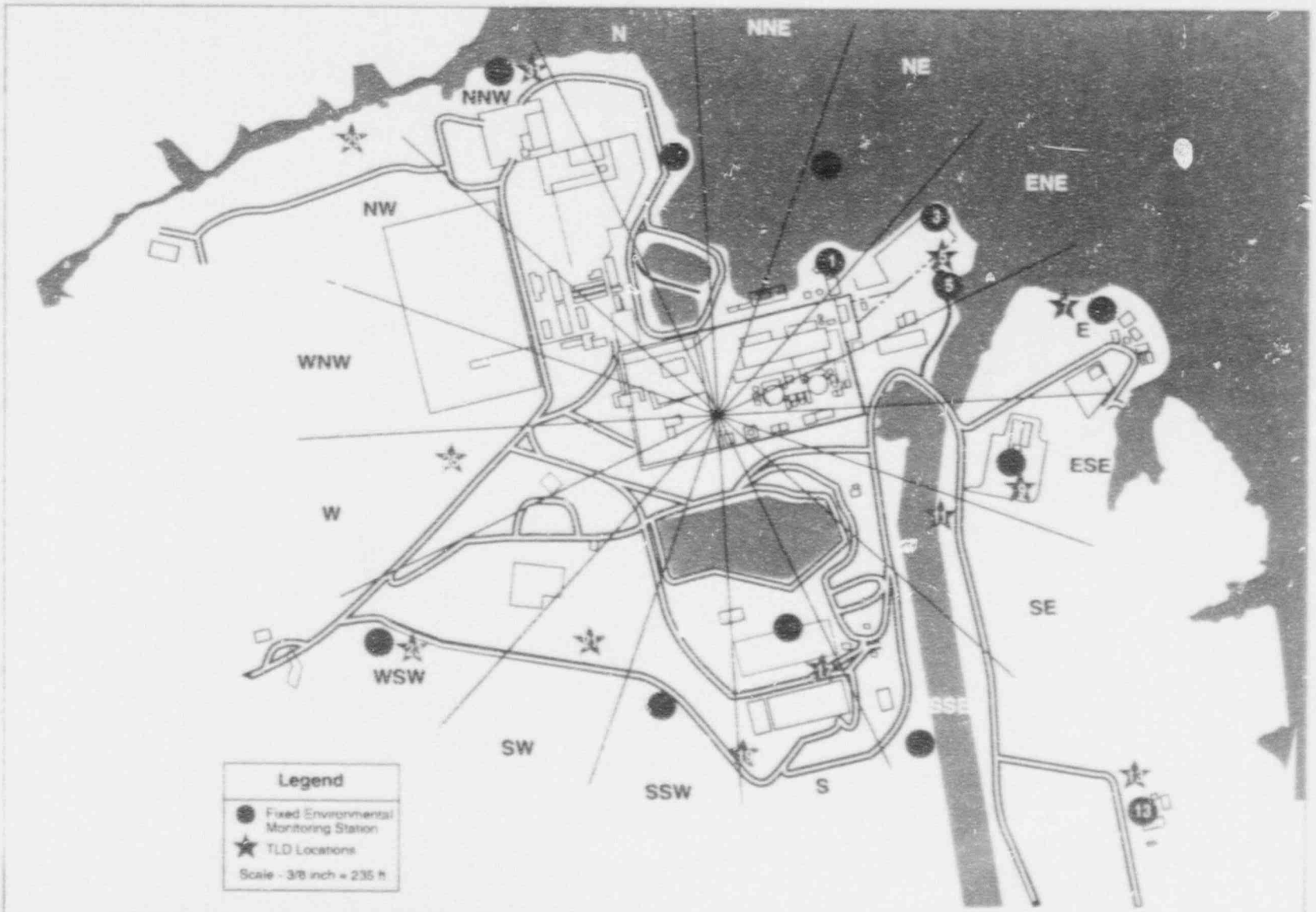
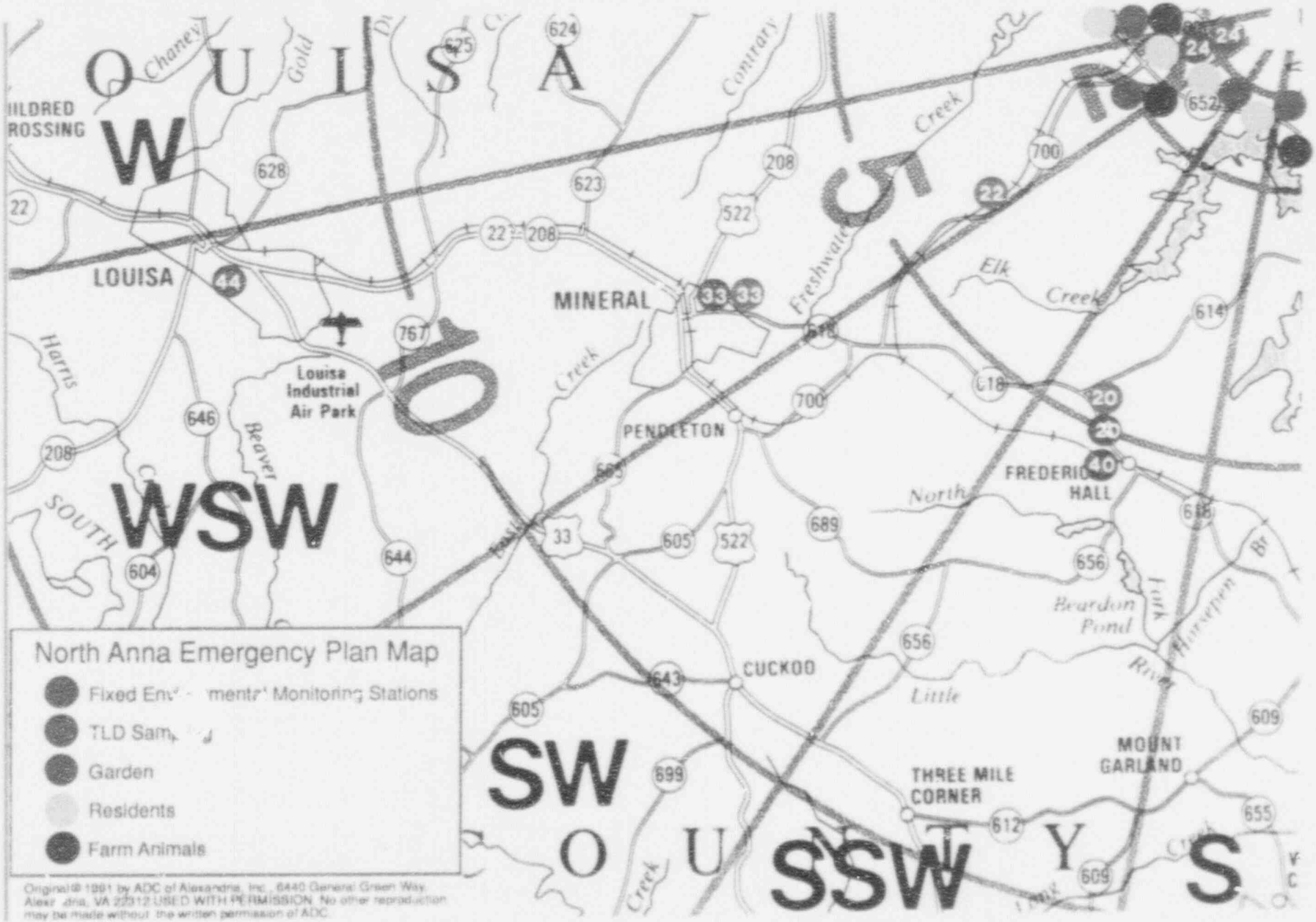
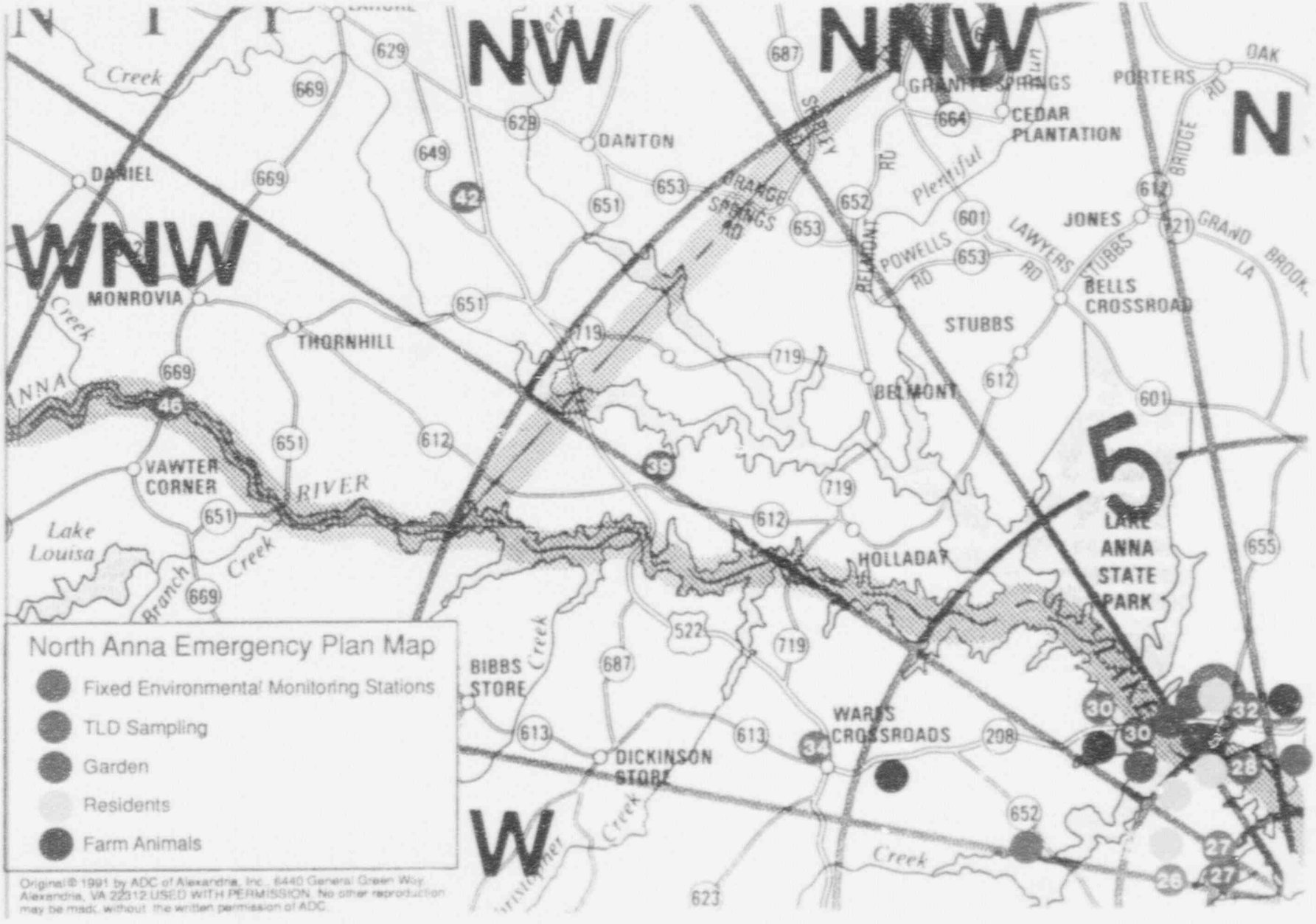
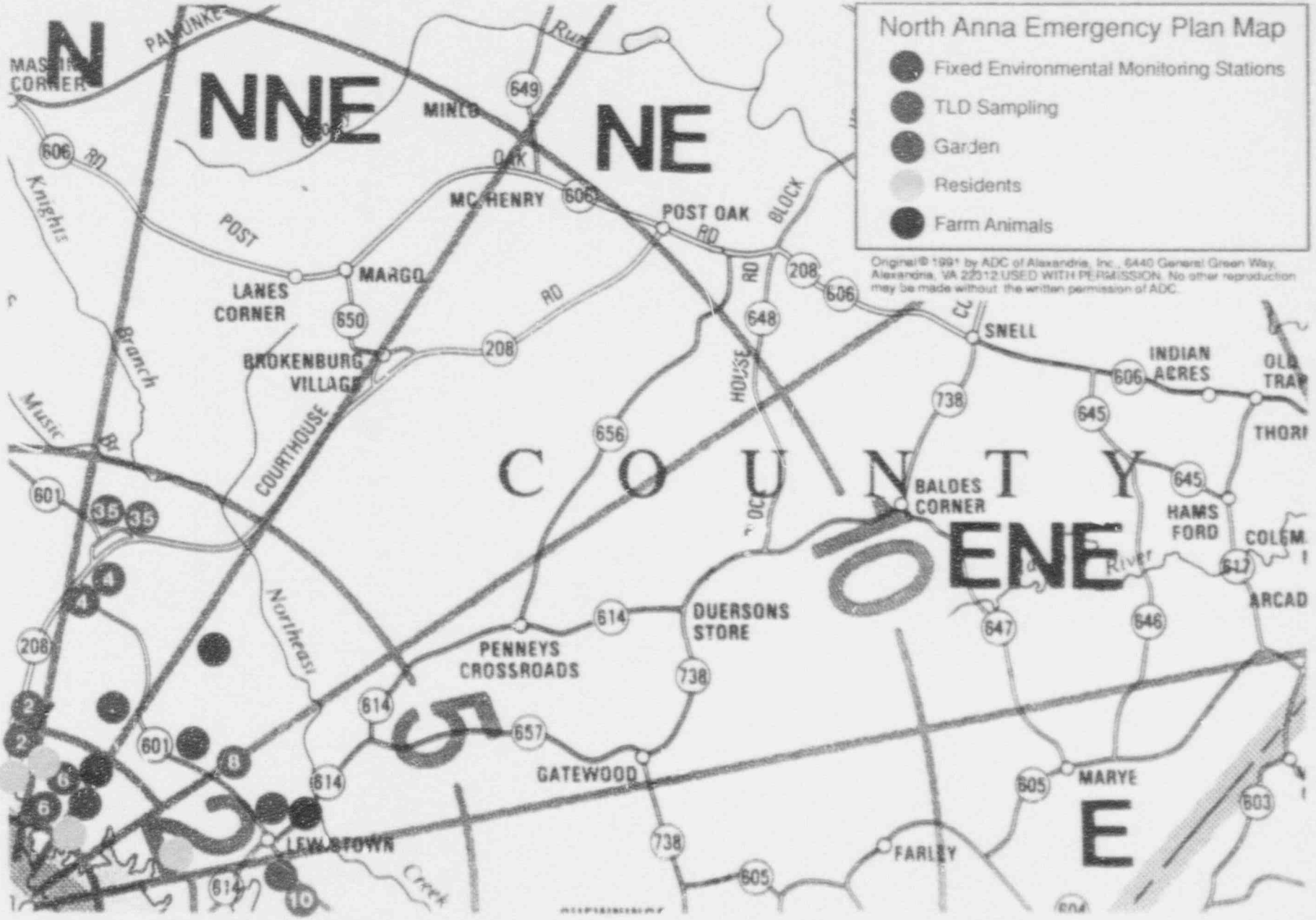
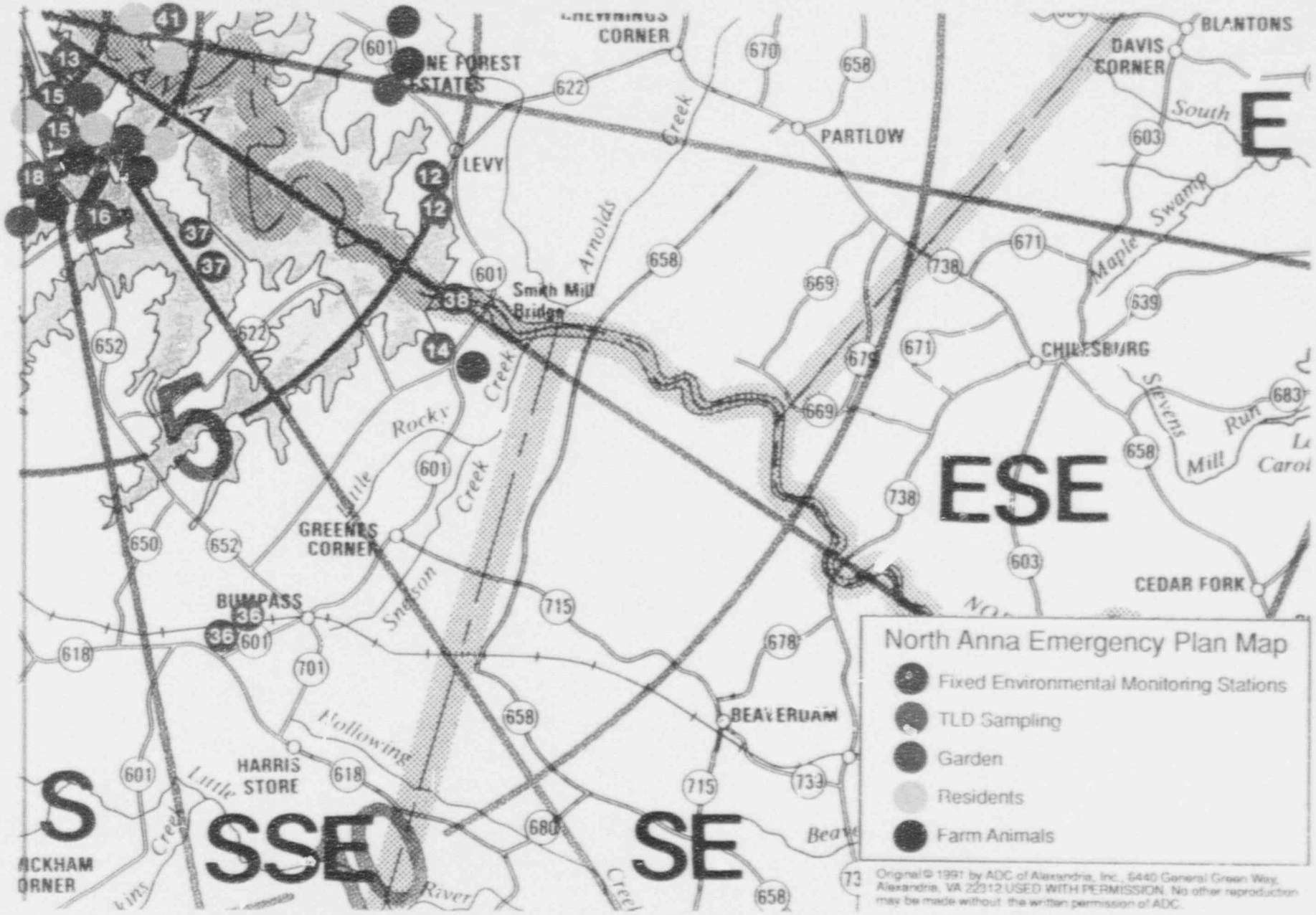


Figure 14. North Anna Site Radiological Monitoring Locations






North Anna Emergency Plan Map
Fixed Environmental Monitoring Stations
TLD Sampling
Garden
Residents
Farm Animals
Original© 1991 by ADC of Alexandria, Inc., 6440 General Green Way, Alexandria, VA 22312 USED WITH PERMISSION. No other reproduction may be made without the written permission of ADC.
N
NNE
NE
ENE
E
LOUISA COUNTY
MINERAL
MC HENRY
POST OAK
SNELL
INDIAN ACRES
LANES CORNER
MARGO
BROKENBURG VILLAGE
COURTHOUSE
BALDES CORNER
HAMS FORD
DUERSONS STORE
PENNEYS CROSSROADS
GATEWOOD
LEWISTOWN
FARLEY
MARYE
Northeast
Branch
Creek
River


North Anna Emergency Plan Map
Fixed Environmental Monitoring Stations
TLD Sampling
Garden
Residents
Farm Animals
ESE
SE
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CHEWINGS CORNER
DAVIS CORNER
BLANTONS
PARTLOW
LEVY
Smith Mill Bridge
CHILESBURG
GREENES CORNER
BUMPASS
HARRIS STORE
BEAVERDAM
CEDAR FORK
Arnolds Creek
Rocky Creek
Little Creek
Snagson Creek
Hollowing
Maple Swamp
Stevens Mill Run
South
Original© 1991 by ADC of Alexandria, Inc., 5440 General Green Way, Alexandria, VA 22312 USED WITH PERMISSION. No other reproduction may be made without the written permission of ADC.

B. Analysis Program

1. Table 2 summarizes the analysis program conducted by Teledyne Isotopes for North Anna Power Station during 1991.

Table 3
(Page 1 of 3)
North Anna Power Station
Sample Analysis Program

Sample Media	Frequency	Analysis	LLD*	Report Units
Thermoluminescent Dosimetry (TLD) (84 Routine Station TLD's)	Quarterly	Gamma Dose	2mR±2mR	mR/std. month
12 Station TLD's	Annually	Gamma Dose	2 mR	mR/std. month
Airborne Radioiodine	Weekly	I-131	0.07	pCi/m³
Airborne Particulate	Weekly	Gross Beta	0.01	pCi/m³
	Quarterly (1)	Gamma Isotopic		pCi/m³
		Cs-134	0.05	
		Cs-137	0.06	
	Annually (2nd Quarter Composite)	Sr-89	0.005	pCi/m³
		Sr-90	0.0002	
Surface Water	Monthly	I-131	1	pCi/l
		Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58, 60	15	
		Zn-65	30	
		Zr-Nb-95	15	
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
	Quarterly (1)	Tritium (H-3)	2000	pCi/l
	2nd Quarterly	Sr-89	5	pCi/l
	Composite	Sr-90	1	

(1) Quarterly Composites of each location's samples will be used for the required analysis.

* LLD's indicate those levels that the environmental samples should be analyzed to, in accordance with the North Anna Radiological Environmental Program. Actual analysis of the samples by Teledyne Isotopes may be lower than those listed.

Table 3
(Page 2 of 3)
North Anna Power Station
Sample Analysis Program

Sample Media	Frequency	Analysis	LLD*	Repo : Units
River Water	Monthly	I-131	1	pCi/l
		Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58,60	15	
		Zn-65	30	
		Zr-Nb-95	15	
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
	Quarterly	Tritium (H-3)	2000	pCi/l
	2nd Quarter	Sr-89	5	pCi/l
	Sample	Sr-90	1	
Ground Water (Well Water)	Quarterly	Gamma Isotopic		pCi/l
		Mn-54	15	
		Fe-59	30	
		Co-58,60	15	
		Zn-65	30	
		Zr-Nb-95	15	
		I-131	1	
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
		Tritium (H-3)	2000	
	2nd Quarter	Sr-89	5	pCi/l
	Composite	Sr-90	1	
Aquatic Sediment	Semi-Annually	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Annually	Sr-89	200	pCi/kg (dry)
		Sr-90	40	
Shoreline Soil	Semi-Annual	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Annually	Sr-89	200	pCi/kg (dry)
		Sr-90	40	

* LLD's indicate those levels that the environmental samples should be analyzed to, in accordance with the North Anna Radiological Environmental Program. Actual analysis of the samples by Teledyne Isotopes may be lower than those listed.

Table 3
(Page 3 of 3)
North Anna Power Station
Sample Analysis Program

Sample Media	Frequency	Analysis	LLD*	Report Units
Soil	Once per 3 yrs.	Gamma Isotopic		pCi/kg (dry)
		Cs-134	150	
		Cs-137	180	
	Once per 3 yrs.	Sr-89	200	pCi/kg (dry)
		Sr-90	40	
	Monthly	I-131	1	pCi/l
	Monthly	Gamma Isotopic		pCi/l
		Cs-134	15	
		Cs-137	18	
		Ba-La-140	15	
	Quarterly	Sr-89	5	pCi/l
		Sr-90	1	
Fish	Semi-Annual	Gamma Isotopic		pCi/kg (wet)
		Mn-54	130	
		Fe-59	260	
		Co-58, 60	130	
		Zn-65	260	
		Cs-134	130	
		Cs-137	150	
Food Products (Broadleaf Vegetation)	Monthly if available or at harvest	Gamma Isotopic		pCi/kg (wet)
		Cs-134	60	
		Cs-137	80	
		I-131	60	

Note:

This table is not a complete listing of nuclides which can be detected and reported. Other peaks that are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

* LLD's indicate those levels that the environmental samples should be analyzed to, in accordance with the North Anna Radiological Environmental Program. Actual analysis of the samples by Teledyne Isotopes may be lower than those listed.

IV. Program Exceptions

The REMP program exceptions for 1991 are provided in this section. These program exceptions pertain to the samples not obtained and LLDs not met during 1991. The REMP deviations are provided in the data tables.

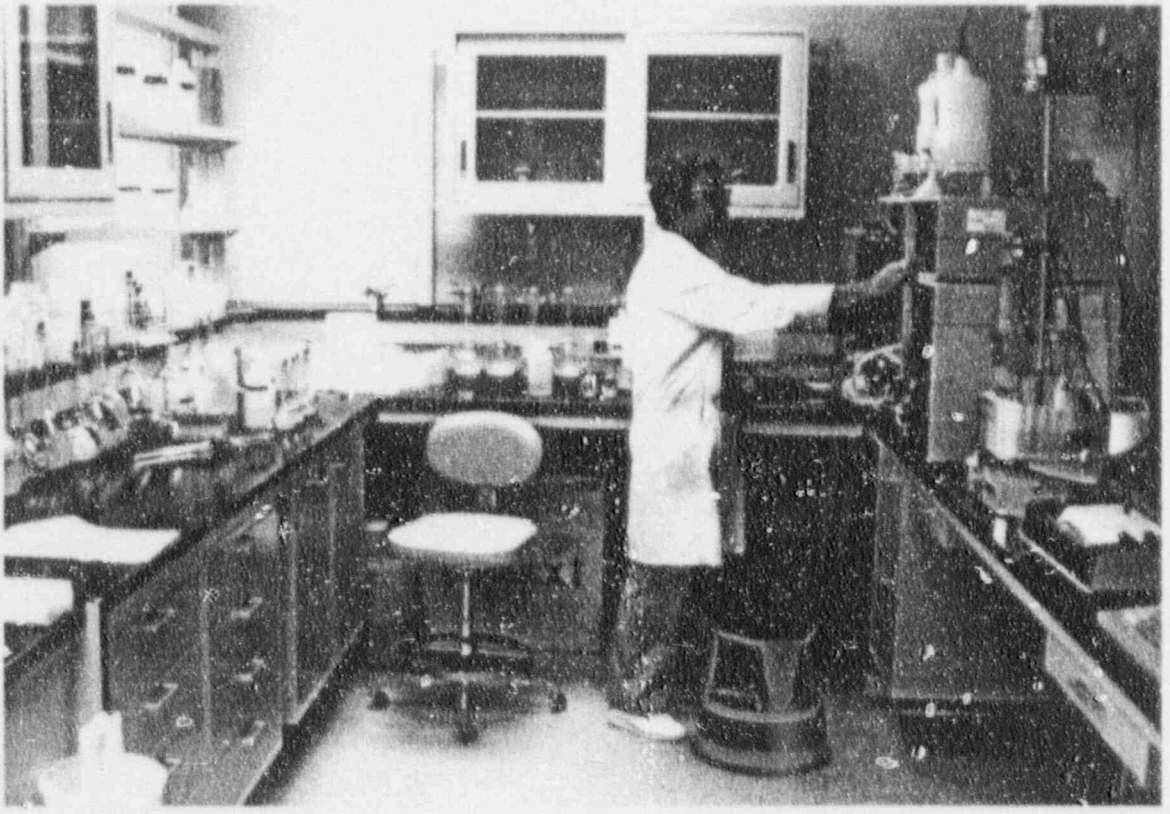
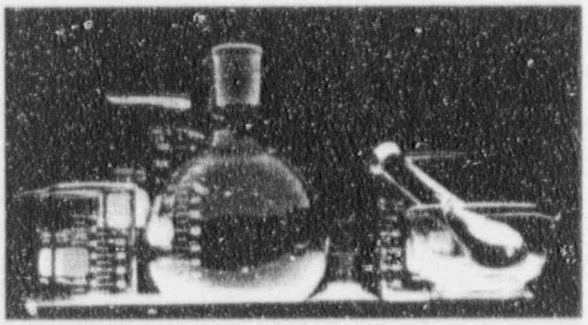


Table 4
REMP Exceptions For Scheduled
Sampling And Analysis During 1991 - North Anna

Location	Description	Date of Sampling	Reason(s) for Loss/Exception
W-26	Direct Radiation/ TLD	First Quarter	TLD could not be found at collection
Sta-23	Vegetation	03/21/91	Only 48g of vegetation could be loaded into a 1 liter Marinelli, the largest calibrated sample container in use at Teledyne Isotopes. The sample was counted for 37 hours, more than two time the normal count time. The LLD for Cs-134 was not met.
Sta-06	Air Particulate/ Air Radioiodine	02/27/91 - 03/06/91	Air sampler malfunctioned, but timer functioned for 168 hours. Unable to estimate sample volume to determine if LLD could be met..

V. Summary And Discussion Of 1991 Analytical Results

Data from the radiological analyses of environmental media collected during the report period are tabulated and discussed below. The procedures and specifications followed in the laboratory for these analyses are as required in the Teledyne Isotopes Quality Assurance Manual and are explained in the Teledyne Isotopes Analytical Procedures. A synopsis of analytical procedures used for the environmental samples is provided in Appendix D. In addition to internal quality control measures performed by Teledyne, the laboratory also participates in the Environmental Protection Agency's Interlaboratory Comparison Program. Participation in this program ensures that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed. The results of the EPA Interlaboratory Comparison are provided in Appendix E.



Radiological analyses of environmental media characteristically approach and frequently fall below the detection limits of state-of-the-art measurement methods. The "less than" values in the data tables were calculated for each specific analysis and are dependent on sample size, detector efficiency, length of counting time, chemical yield, when appropriate, and the radioactive decay factor from time of counting to time of collection. Teledyne Isotopes analytical methods meet the Lower Limit of Detection (LLD) requirements given in Table 2 of the USNRC Branch Technical Position of Radiological Monitoring (November 1979, Revision 1) and the ODCM.

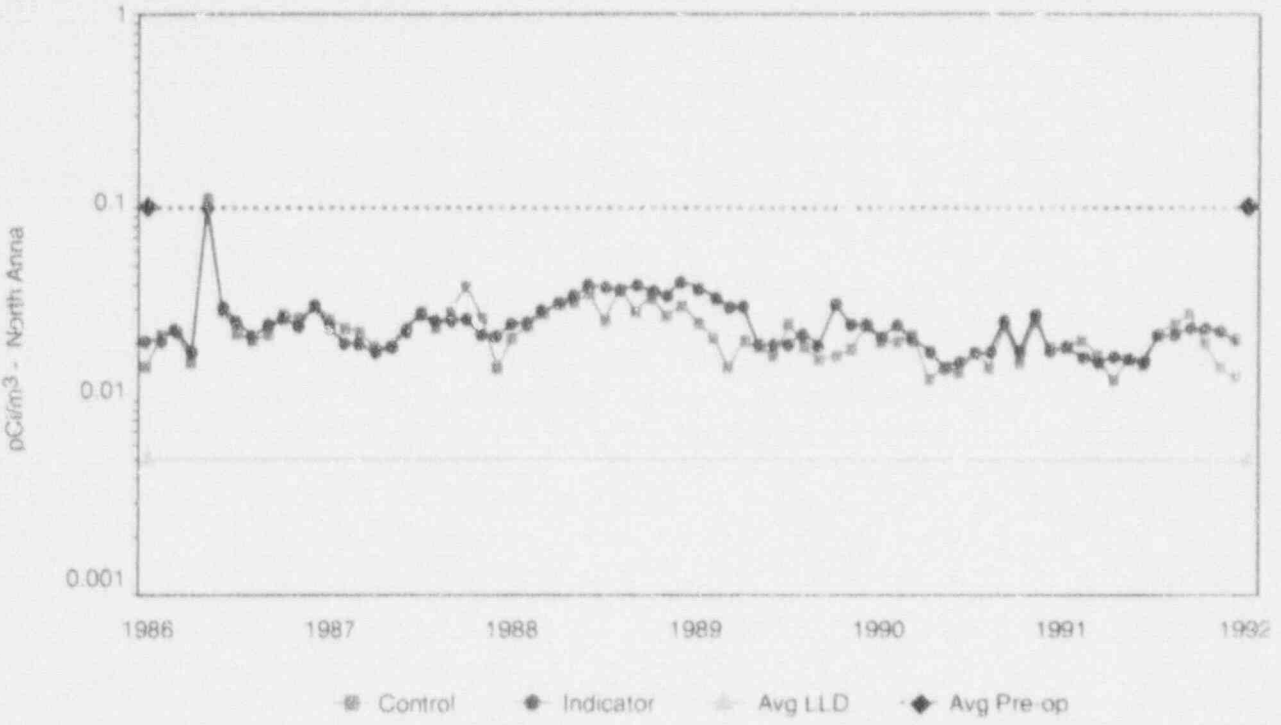
The following is a discussion and summary of the results of the environmental measurements taken during the 1991 reporting period.

A. Airborne Exposure Pathway

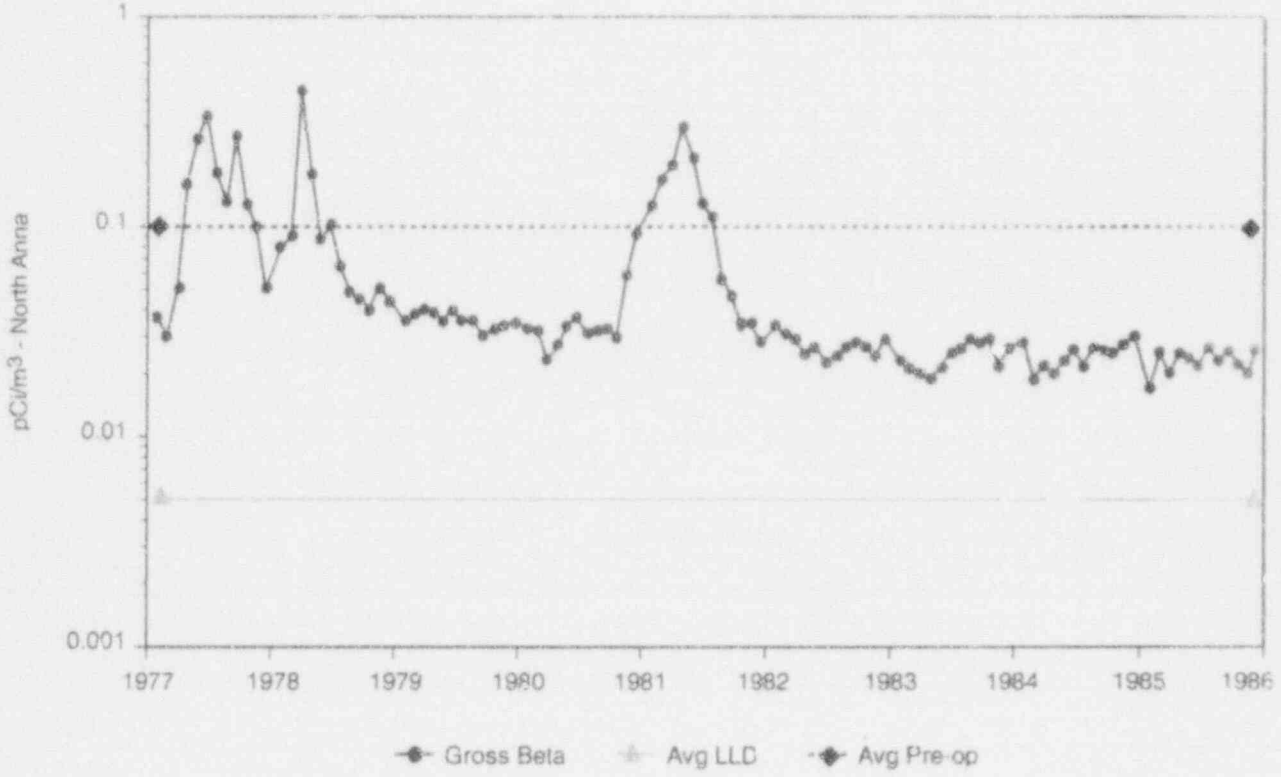
1. Air Iodine/Particulates

Charcoal cartridges used to collect airborne iodine were collected weekly and analyzed by a radiochemical separation procedure for iodine-131. The results are presented in Table B-1. All results were below the required lower limit of detection. Gross beta activity was observed in fifty-one of fifty-two control samples with an average concentration of 0.019 pCi/m^3 and a range of 0.009 to 0.035 pCi/m^3. The average measurement for the indicator locations was 0.021 pCi/m^3 with a range of 0.003 to 0.041 pCi/m^3. The results of the gross beta activities are presented in Table B-2. The gross beta activities for 1991 were comparable to levels measured in the 1982-1990 period. Prior to that period the gross beta activities were higher due to atmospheric nuclear weapons testing by other countries. During the preoperational period of July 1, 1974 through March 31, 1978 gross beta activities ranged from a low of 0.005 pCi/m^3 to a high of 0.75 pCi/m^3.

Air particulate filters were composited by locations on a quarterly basis and were analyzed by gamma ray spectroscopy. The results are listed in Table B-3. Beryllium-7, which is



Trending Graph - 1: Gross Beta In Air Particulates



Trending Graph - 1: Gross Beta In Air Particulates

produced continuously in the upper atmosphere by cosmic radiation, was measured in all 48 composite samples. The average measurement for the control location was 0.093 pCi/m^3 with a range of 0.069 to 0.169 pCi/m^3. The indicator locations had an average concentration of 0.113 pCi/m^3 and a range of 0.063 to 0.186 pCi/m^3. During the preoperational period, beryllium-7 was measured at comparable levels, as would be expected. Naturally occurring potassium-40 was detected in one indicator sample with an activity of 0.022 pCi/m3. All other gamma emitters were below the detection limits. During the preoperational period gamma ray spectroscopy measured several fission products in numerous air particulate filters. All isotopes were attributed to atmospheric nuclear weapons testing conducted before the preoperational period. Among the isotopes measured were zirconium-95, ruthenium-103, ruthenium-106, cesium-137, cerium-141 and cerium-144.

The second quarter composites of air particulate filters from all twelve stations were analyzed for strontium-89 and 90. There was no detection of these fission products at any of the eleven indicator stations nor at the control stations.

2. Precipitation

A sample of rain water was collected monthly at station 01A, on-site, 0.75 miles, 138 degrees SE and analyzed for gross beta activity. The results are presented in Table B-4. The average gross beta activity for 1991 in eleven of the twelve samples was 11.6 pCi/liter with a range from 1.6 to 35 pCi/liter. Semi-annual composites were prepared and analyzed for gamma emitting isotopes and tritium. All gamma emitters were below their detection limits. Tritium was not detected in the semi-annual composite samples. These results were comparable to or lower than those measured in 1986 thru 1990. During the preoperational period gross beta activity in rain water was expressed in nCi per square meter of the collector surface, thus a direct comparison can not be made to the 1991 period. Tritium was measured in over half of the few quarterly composites made. The tritium activity ranged from 100 to 330 pCi/liter.

3. Soil

Soil samples are collected and analyzed every three years from twelve stations. Since the samples were collected in 1989 they were not collected during 1991.

B. Waterborne Exposure Pathway

1. Ground/Well Water

Water was sampled quarterly from the on-site well at the biology laboratory. These samples were analyzed for gamma radiation and for tritium. The results are presented in Table B-6. No gamma emitting isotopes or tritium were detected. The second quarter sample was analyzed for strontium-89 and strontium-90. There were no detections of these isotopes above the detection level. No gamma emitting isotopes were detected during the preoperational period. Tritium was measured in most of the samples during that period with concentrations between 80 and 370 pCi/liter.

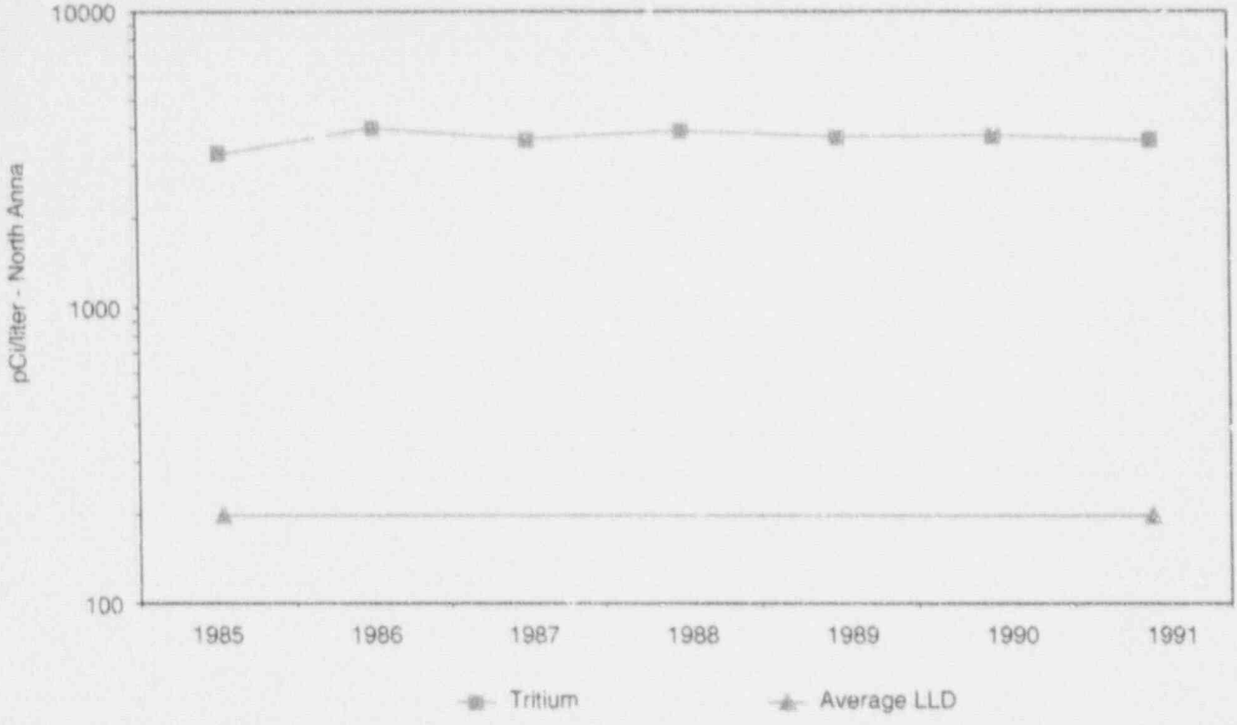
2. River Water

A sample of water from the North Anna River was collected monthly at station 11, 5.8 miles downstream from the discharge lagoon, 128 degrees SSE. The results are presented in Table B-7. The samples were analyzed by gamma spectroscopy, and for tritium. The second quarter samples were analyzed in addition for strontium-89 and strontium-90.

All gamma emitters were below the detection level. No detections of strontium-89 or strontium-90 occurred. Tritium was measured in eleven of the twelve samples with an average level of 3645 pCi/liter and a range of 3100 to 4400 pCi/liter. This compares favorably with the average tritium activity for 1989 of 3749 pCi/liter and 1988 was 3925 pCi/liter. No river water samples were collected in the preoperational period.

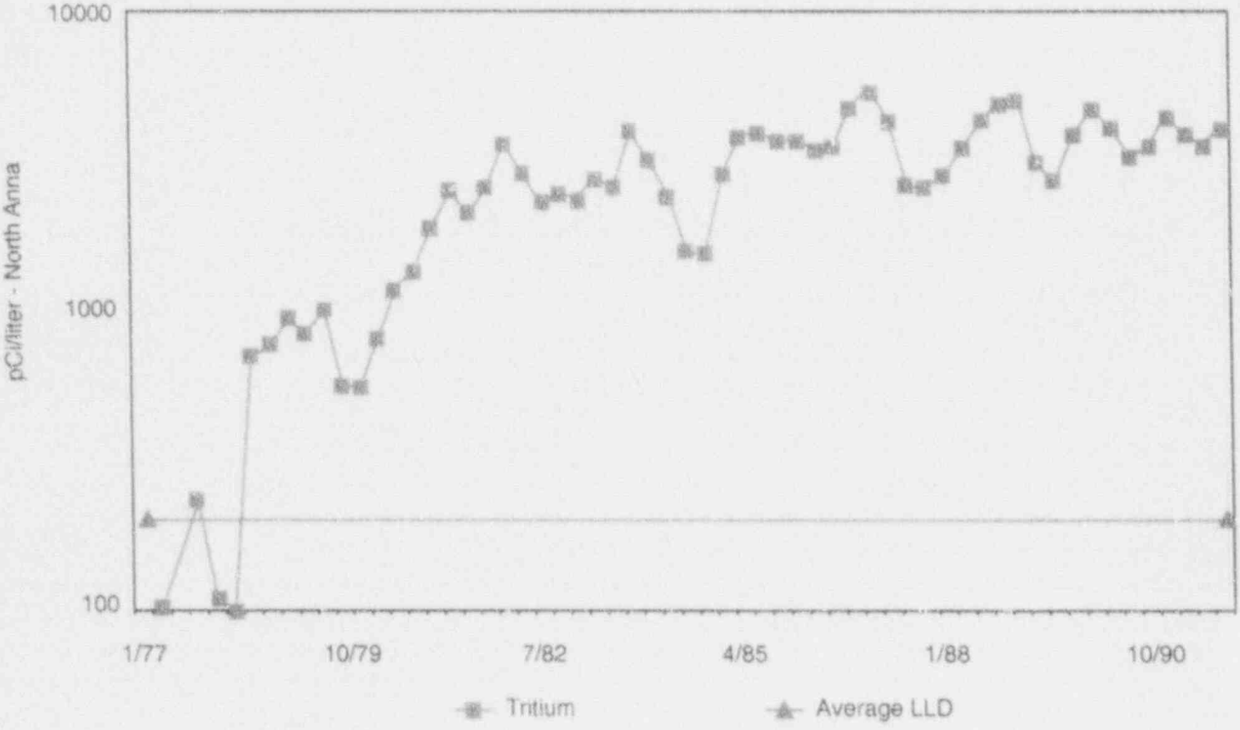
3. Surface Water

Samples of surface water were collected monthly from two stations. Station 08 is at the discharge lagoon, 1.1 miles, 148 degrees SSE on Lake Anna. Station 09 is 2.2 miles upstream on Lake Anna, 320 degrees NW. In October of 1991, Station 09 was replaced with Station 09A, which is 12.9 miles WNW. The samples were analyzed for iodine-131 by radiochemical separation. No iodine was detected in the 24 samples analyzed. The results are presented in Table B-8. The samples were also analyzed by gamma ray spectrometry. Potassium-40, a naturally occurring radionuclide was measured at 82.4 pCi/liter in one sample from station 09A. All gamma emitters were below their detection levels at both stations.



During pre-operational period tritium in river water was not measured.

Trending Graph 2 : Tritium In River Water - Station 11



Unit 1 critical on 06/06/78.15
Unit 2 critical on 12/14/80.

Trending Graph 3 : Tritium In Surface Water - Sta 08

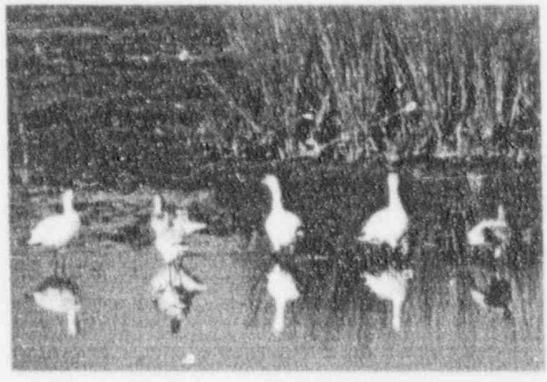
A quarterly composite from each station was prepared and analyzed for tritium. The tritium activity at station 08 for the quarterly composites was at an average level of 4025 pCi/liter with a range of 3600 to 4500 pCi/liter. The tritium level had been increasing since the middle of 1978 when the average level was below 300 pCi/liter. However, during 1991 the results were within the same range as those measured in 1986 thru 1990. During the preoperational period tritium was measured in several samples with concentrations between 90 and 250 pCi/liter.

The tritium activity from station 09 was at an average level of 2933 pCi/liter with a range of 2200 to 3300 pCi/liter. The level of tritium for 1991 for station 09 is also within the same range as those measured in 1986 thru 1990.

Samples of surface water were collected by the Commonwealth of Virginia from two stations. Station W-33 is located at the discharge lagoon while station W-27 is located on the North Anna River at the Rt. 208 Bridge, which is upstream of the site. Twenty-four samples were collected and analyzed by gamma ray spectroscopy and for tritium. The results are presented in Table B-9. All other gamma emitters were below their detection levels.

Since the tritium level had been increasing during the last several years, four samples from each station were analyzed for tritium during 1991. The average activity at station W-33 in all four samples was 3550 pCi/liter with a range of 3200 to 3800 pCi/liter. This is slightly higher than the 3200 pCi/liter measured during 1990 at this station. Tritium was measured in two of the four samples at station W-27 with an average activity of 2250 pCi/liter and a range of 1800 to 2700 pCi/liter. This is also higher than the average of 1098 pCi/liter measured at station W-27 during 1990.

C. Aquatic Exposure Pathway



1. Sediment/Silt

Sediment samples were collected during March and September from each of three locations and were analyzed by gamma spectrometry. The results are presented in Table B-10. A number of man-made and naturally occurring radioisotopes were detected in these samples. Cesium-137 was detected in two samples with an average activity of 153 pCi/kg (dry weight) and a range

from 112 to 194 pCi/kg (dry weight). The highest reading for cesium-137 was obtained from station 08 located 1.10 miles downstream in the second cooling lagoon, 148° SSE.

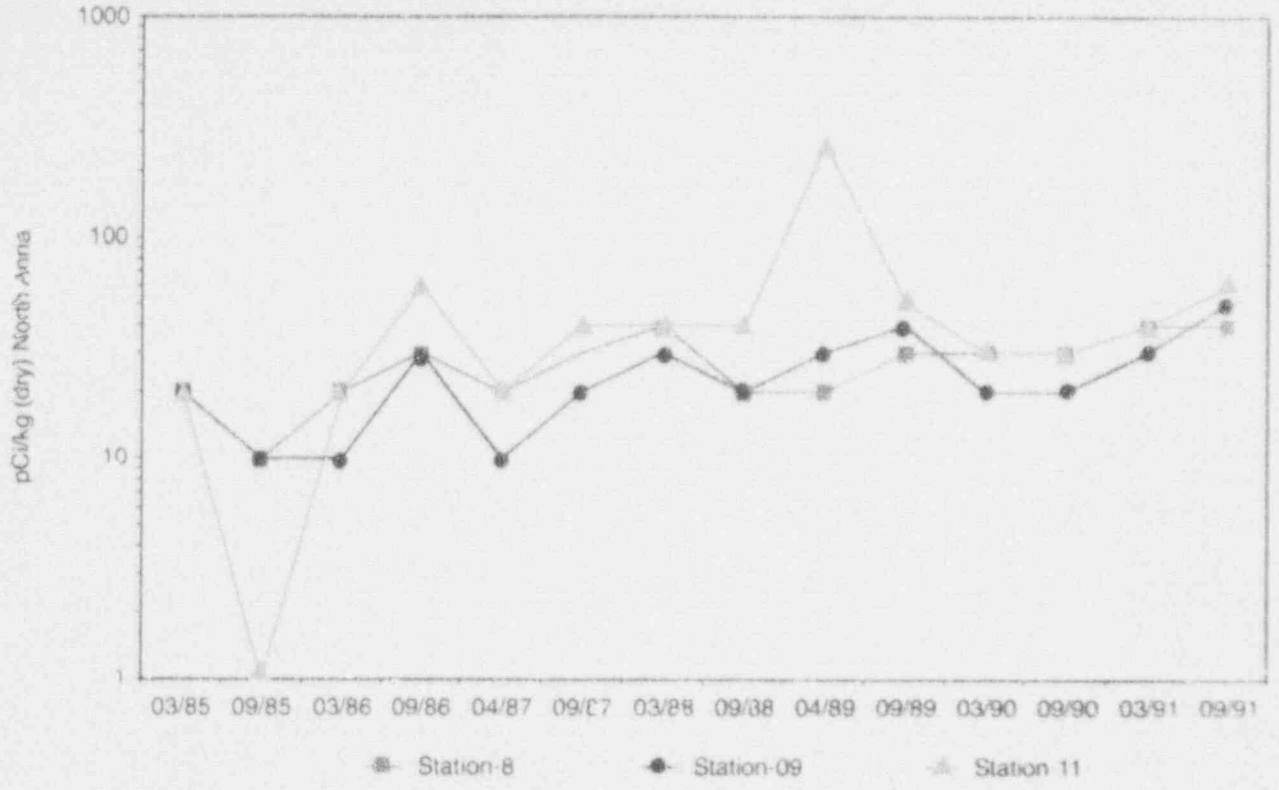
Naturally occurring potassium-40 was observed in all six samples with an average activity of 10955 pCi/kg (dry weight) and a range from 6580 to 16800 pCi/kg (dry weight). Radium-226 was measured in five samples with an average concentration of 1638 pCi/kg (dry weight) and a range of 1040 to 2090 pCi/kg (dry weight). Cobalt-60 was measured in one indicator sample from station 08 with an activity of 64.2pCi/kg (dry weight). Also naturally occurring, thorium-228 was observed in all six samples with an average concentration of 1069 pCi/kg (dry weight) and a range of 575 to 1750 pCi/kg (dry weight). The September samples were analyzed for strontium-89 and strontium-90. There were no detections of strontium-89 in aquatic sediment/silt. Strontium-90 was measured in two samples with an average concentration of 175 pCi/kg (dry weight) and a range of 160 to 190 pCi/kg (dry weight).

During the preoperational period sediment samples were analyzed by gamma ray spectroscopy. Cesium-137 was measured in most of the samples with concentrations between 33 and 1210 pCi/kg (dry weight). Strontium-90 was measured in most of the samples with concentrations between 60 and 540 pCi/kg (dry weight). Strontium-89 was not measured. Potassium-40, radium-226, and thorium-228, all naturally occurring, were measured at background levels.

2. Shoreline Soil

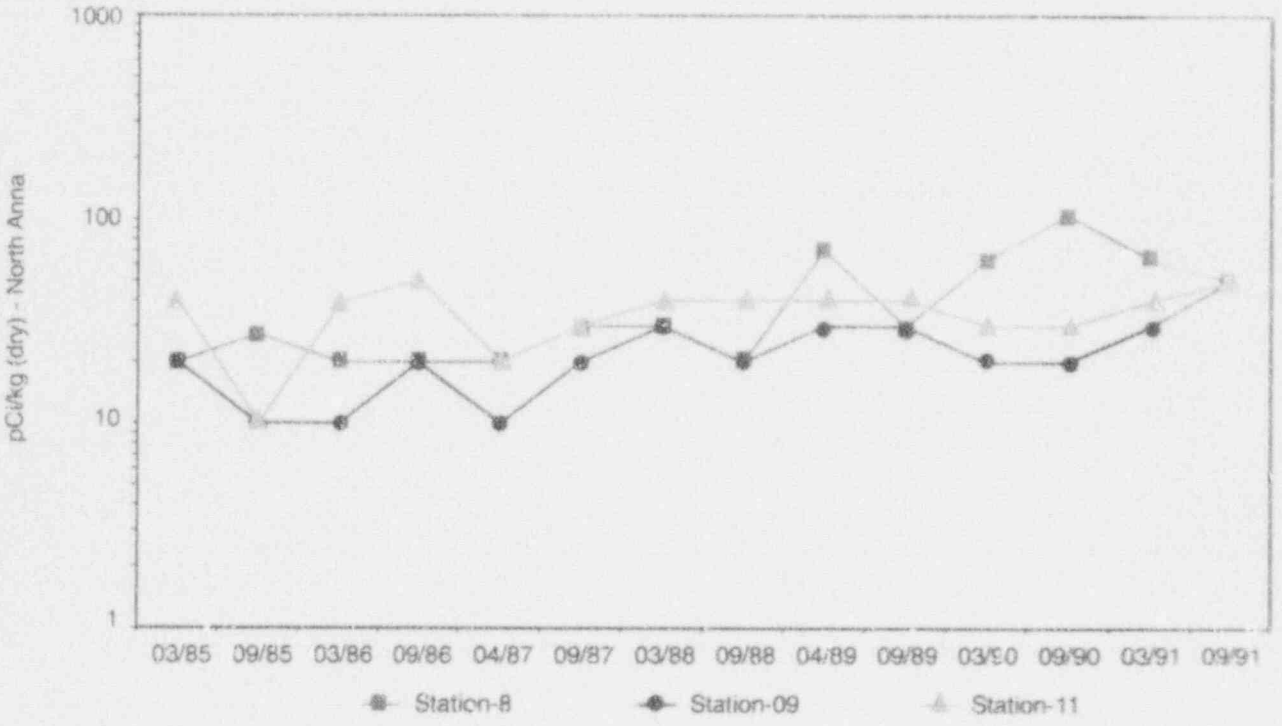
A sample of shoreline sediment was collected in March and September from station 09, 2.2 miles upstream of the North Anna Power Station. The samples were analyzed by gamma ray spectrometry. The results are presented in Table B-11. The naturally occurring nuclide potassium-40 was measured in both samples with an average activity of 5305 pCi/kg (dry weight) and a range of 4160 to 6450 pCi/kg (dry weight). Thorium-228 was measured in both samples at an average of 839 pCi/kg (dry weight) and a range of 799 to 879 pCi/kg (dry weight). Radium-226 was measured in both samples with an average activity of 1435 pCi/kg (dry weight) and a range of 1170 pCi/kg (dry weight) to 1700 pCi/kg (dry weight). Cesium-137, a fission product, was monitored in one sample with an activity of 502 pCi/kg (dry weight).

The September sample was analyzed for strontium and there were no detections of strontium-89 or strontium-90.



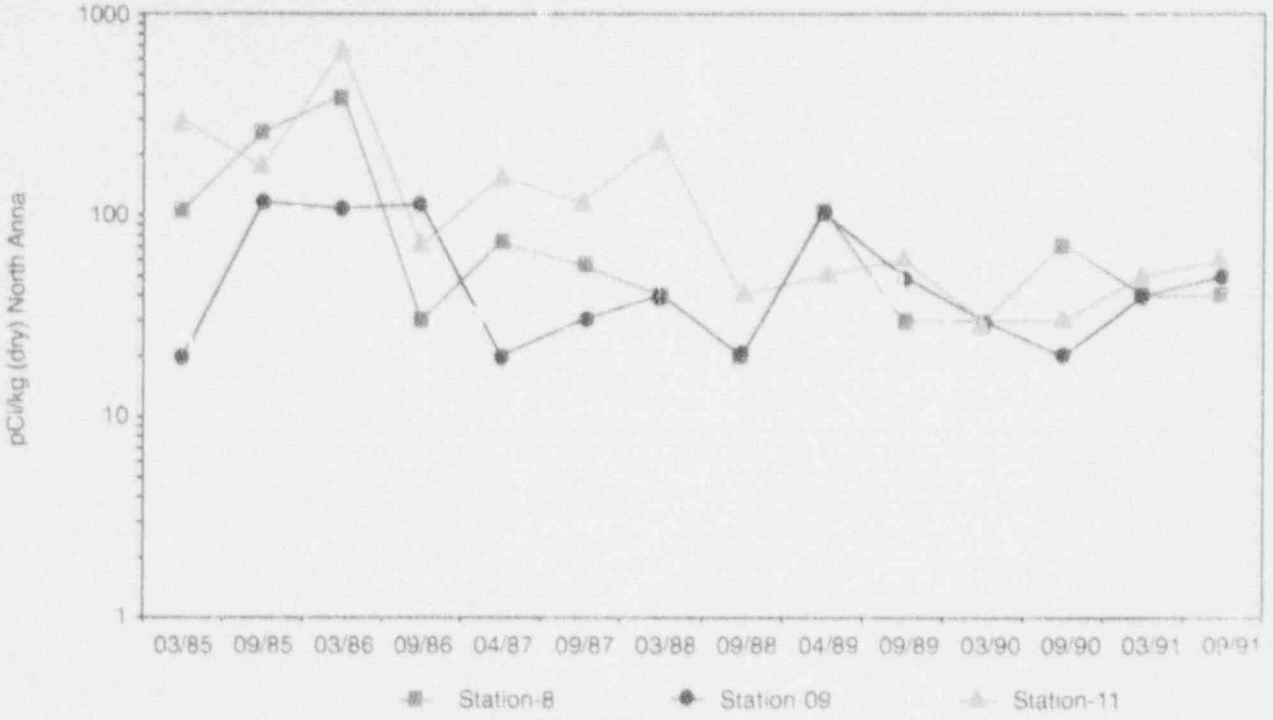
No cobalt-58 measured during pre-operational period

Trending Graph - 4 : Cobalt-58 In Sediment Silt



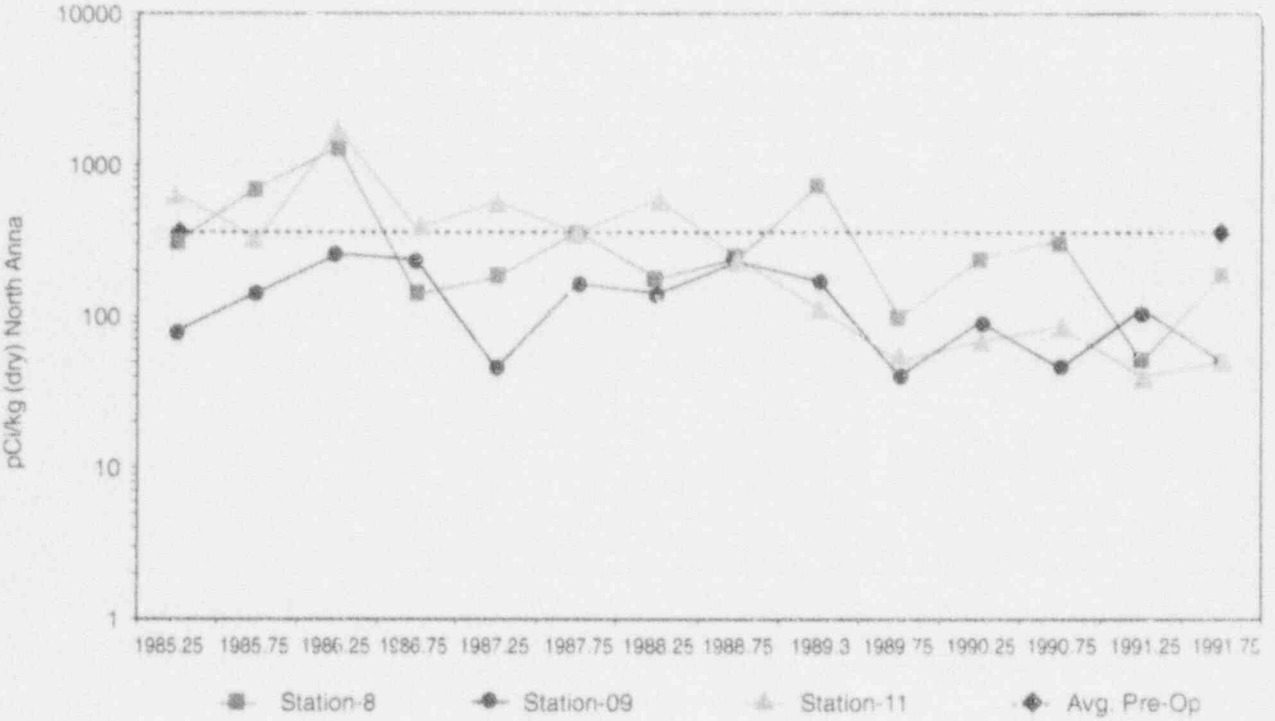
No cobalt-60 measured during pre-operational period

Trending Graph - 5 : Cobalt-60 In Sediment Silt



No cesium-134 measured during pre-operational period

Trending Graph - 6 : Cesium-134 In Sediment Silt



No cobalt-58 measured during pre-operational period

Trending Graph - 7 : Cesium-137 In Sediment Silt

D. Ingestion Exposure Pathway

1. Milk

The results of the iodine-131 analysis of milk samples are presented in Table B-12. A sample was collected monthly from two stations. A total of 24 samples were analyzed during 1991. There were no measurements of iodine-131 above the detection limits.

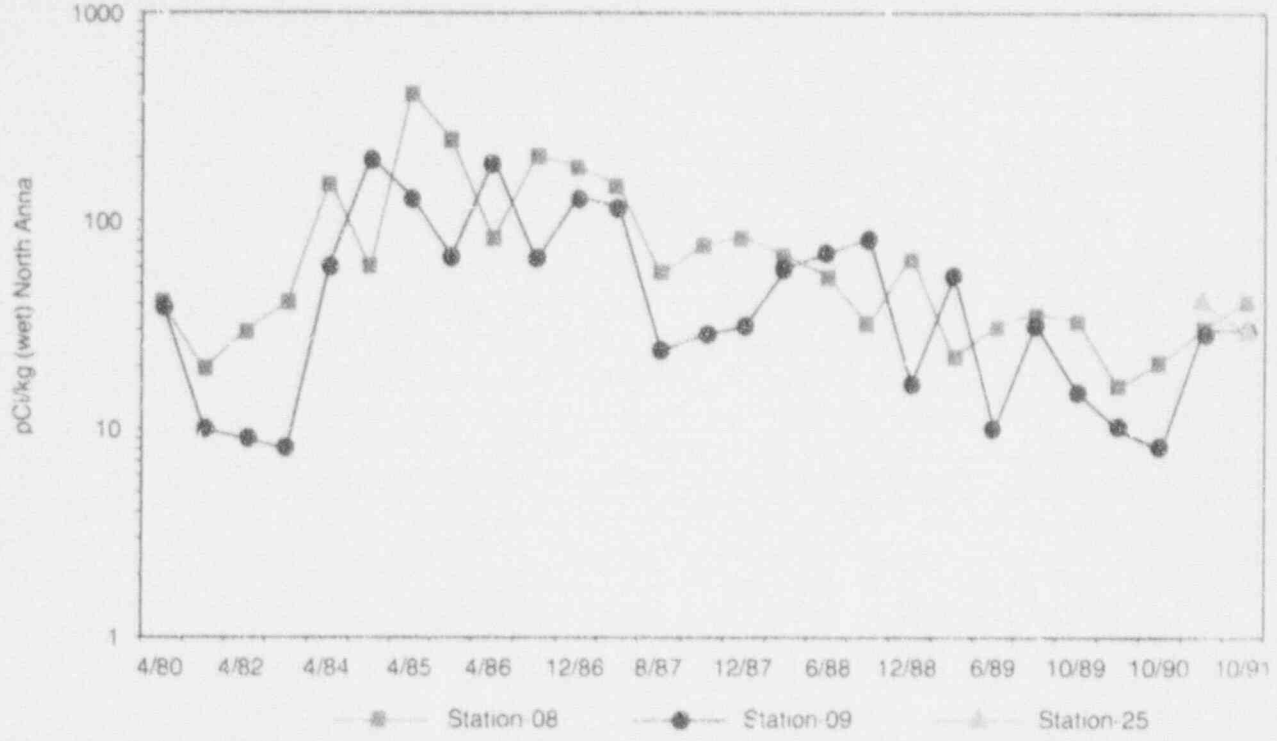
The milk samples were also analyzed by gamma ray spectroscopy and the results are also presented in Table B-12. A total of 24 samples were analyzed. Naturally occurring potassium-40 was measured in all of the samples with an average of 1291 pCi/liter and a range of 1010 to 1480 pCi/liter. The fission product cesium-137 has been detected sporadically in recent years and the activity has been attributed to global fallout from past atmospheric weapons testing. However, cesium-137 was not detected at levels above LLD in any milk samples in 1991. All other gamma emitters were below their detection levels. A quarterly composite was prepared from each of the two collection stations and analyzed for strontium-89 and strontium-90. Strontium-89 was not detected at levels above LLD in any of the samples monitored. Strontium-90 was detected in seven of the eight samples monitored with an average level of 0.91 pCi/liter and a range of 0.55 to 1.4 pCi/liter. This is similar to activities determined in previous years and lower than the preoperational levels of 2.2 to 5.4 pCi/liter.

2. Fish

Aquatic biota can be sensitive indicators of radionuclide accumulation in the environment because of their ability to concentrate certain chemical elements which have radioactive isotopes. The results are presented in Table B-13. Ten samples of fish were collected during 1991. These samples were analyzed by gamma ray spectroscopy and the naturally occurring isotope potassium-40 was found in all samples at an average of 1409 pCi/kg (wet weight) with a range of 831 to 2160 pCi/kg (wet weight). The fission product cesium-137 was measured in three samples at an average of 76.7 pCi/kg (wet weight) and a range of 57.9 to 99.4 pCi/kg (wet weight). During the preoperational period cesium-137 was measured in one-fourth of the fish samples collected with concentrations between 31 and 66 pCi/kg (wet weight).

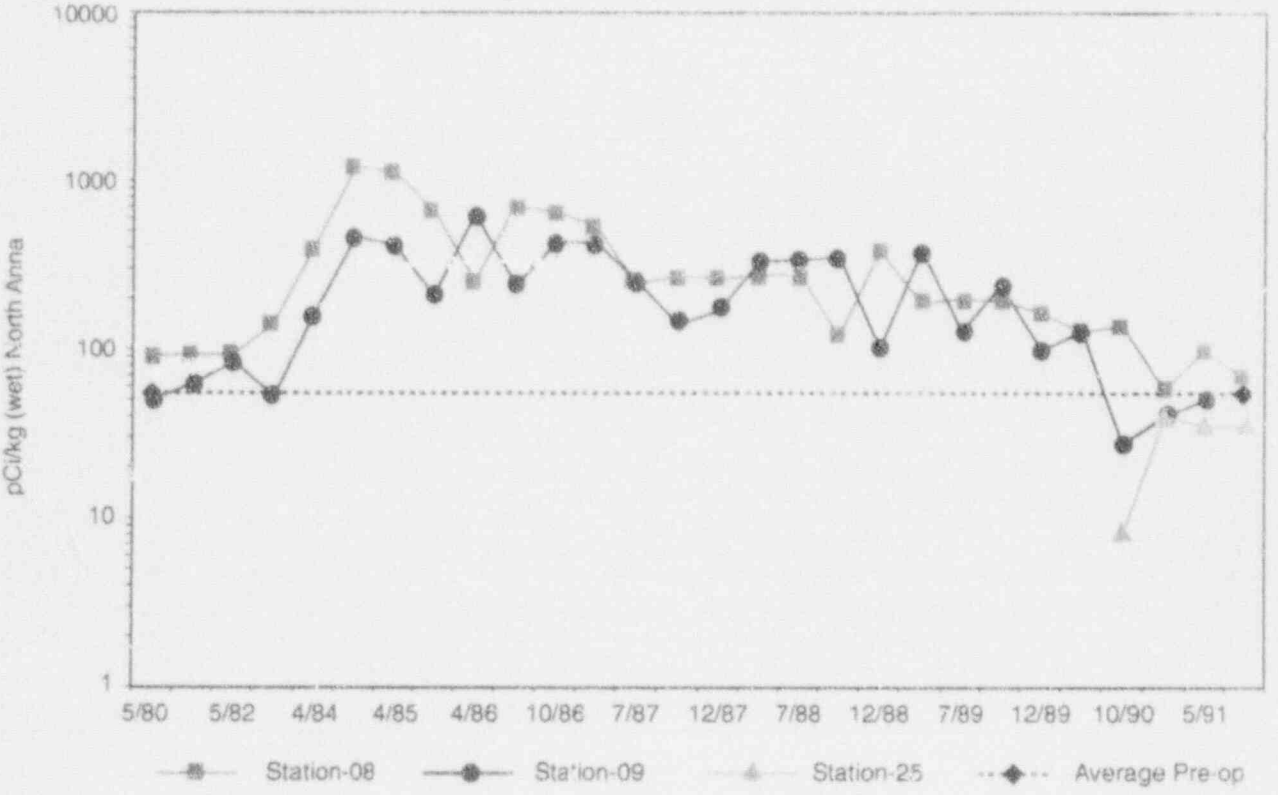
3. Food/Vegetation

Forty food samples were collected from five locations and analyzed by gamma spectrometry. The results are presented in Table B-14. Naturally occurring potassium-40 was monitored in all of the samples with an average activity level of 8969 pCi/kg (wet weight)



During the pre-operational period cesium-134 was not measured

Trending Graph - 8 : Cesium-134 In Fish



Trending Graph - 9 : Cesium-137 In Fish

and a range of 383 to 30500 pCi/kg (wet weight). Cosmogenic beryllium-7 was detected in 32 of the 40 samples with an average concentration of 1400 pCi/kg (wet weight) and a range of 252 to 7710 pCi/kg (wet weight). The terrestrial nuclide thorium-228 was detected in nine of the samples at an average activity of 370 pCi/kg (wet weight) and a range of 29.5 to 844 pCi/kg (wet weight).

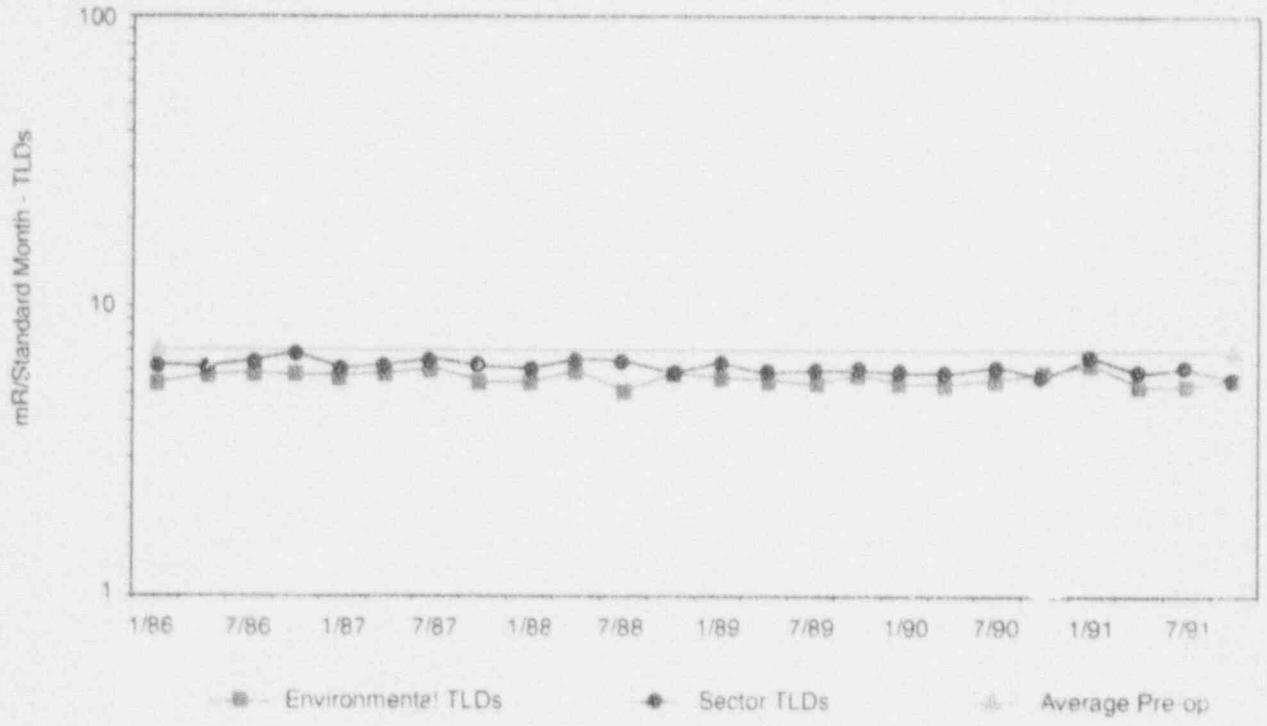
The fission product cesium-134 was not detected at levels above LLD during 1991. Cesium-137 was detected in fourteen of the forty samples with an average activity of 168 pCi/kg (wet weight) and a range of 23.5 to 448 pCi/kg (wet weight). These results are consistent with those measured in previous years. Cesium-137 was measured in broadleaf garden vegetation during the preoperational period with concentrations between 53 and 98 pCi/kg (wet weight).

E. Direct Radiation Exposure Pathway

1. TLD Dosimeters

Thermoluminescent dosimeters (TLDs) determine environmental radiation doses and the results are presented in Table B-15. Individual measurements of external radiation levels in the environs of the North Anna site had an average dose of 5.6 mR/standard month with a range of 4.1 to 9.1 mR/standard month. The control station, No 24 had an average reading of 3.8 mR/standard month with a range of 3.4 to 4.4 mR/standard month.

Sector TLDs are deployed quarterly at thirty-two locations in the environs of the North Anna site. Two badges are placed at each location. The results are presented in Table B-16. The average level of the 32 locations (two badges at each location) was 6.2mR/standard month with a range of 3.1 to 10.6 mR/standard month. The thirty-two control TLDs from eight locations showed an average reading of 5.1 mR/standard month with a range of 3.4 to 7.4 mR/standard month. One of the badges from the first quarter was missing. Although a thorough search was made of the area the TLD could not be located. During the part (starting in 1977) of the preoperational period that the calculation of the TLD dose included a correction for the in-transit dose, the doses were measured between 4.3 and 8.8 mR/standard month.



Trending Graph - 10 : Environmental Radiation - TLDs

VI. Conclusions

The results of the 1991 Radiological Environmental Monitoring Program for the North Anna Nuclear Power Station have been presented. The following sections discuss each pathway individually followed by a program summary.

Airborne Exposure Pathway

Air particulate gross beta concentrations of all the indicator locations for 1991 followed the gross beta concentrations at the control location. The gross beta concentrations were comparable to levels observed since 1982 except for a five week period in 1986 which was influenced by the Chernobyl accident. Gross beta concentrations in the preoperational period were highly variable, ranging from 0.0043 to 0.75 pCi/CuM. This variation is due to occasional atmospheric nuclear weapons tests. Gamma isotopic analysis of the particulate samples identified natural isotopes (beryllium-7 and potassium-40). There were no detections above the LLD for fission products nor other man-made isotopes in the particulate media during 1991. Iodine-131 was not detected in the 624 charcoal filters analyzed during 1991.

A precipitation sample was collected monthly during 1991 and analyzed for gross beta activity. All gross beta activities were comparable to those measured in previous years. During the preoperational period the average gross beta activity was 0.92 pCi/liter. Semi-annual composites were analyzed for gamma emitting isotopes and tritium. All gamma emitters were below detection limits. Tritium was not observed above the LLD during 1991. During the preoperational period, the average tritium activity was 165 pCi/liter.

Waterborne Exposure Pathway

No man-made or natural isotopes were monitored in Lake Anna surface water except for tritium. The average tritium activity in 1991 at the waste heat treatment facility was 4025 pCi/liter, or 20.1% of the water sample reporting level. In 1990 the tritium level was 3900 pCi/liter. The preoperational level of 150 pCi/liter has been rising since 1977. The tritium level upstream of the site was 2933 pCi/liter as compared with 3200 pCi/liter in 1990.

The samples of surface water collected by the Commonwealth of Virginia at the waste heat treatment facility had similar tritium results with a measurement of 3117 as compared to 2230 pCi/liter for 1990. The upstream location had an activity of 2250 pCi/liter as compared to 1098 pCi/liter for 1990. No gamma emitting isotopes were detected.

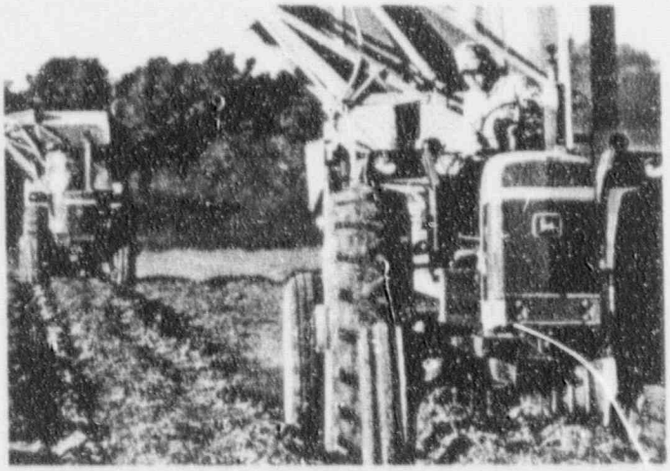
River water collected from the North Anna River, 5.8 miles downstream of the site, had an average tritium level of 3645 pCi/liter. The average tritium in 1990 had been 3783 pCi/liter. No gamma emitters were detected.

Ground water from the environmental well on-site contained no gamma emitters. There were also no detections of tritium in ground/well water during 1991.

Aquatic Pathway

Sediment/silt samples provide a sensitive indicator of discharges from nuclear power stations, although they do not provide a direct dose pathway to man. The sediment from North Anna environmental samples indicated that two man-made isotopes were present. Cesium-137 was detected in two samples at two locations. During the preoperational period, cesium-137 was also measured in samples of aquatic sediment. Cobalt-60 was measured in one sample.

The samples of shoreline soil monitored downstream of the site contained no cesium-134. Cesium-137 was measured in one sample at 502 pCi/kg. This is higher than the 1990 average of 74.6 pCi/kg.



Ingestion Pathway

Iodine-131 was not detected in any of the twenty-four milk samples using the radiochemical separation method. Although cesium-137 has been detected occasionally in previous years and attributed to past atmospheric nuclear weapons testing, there were no detections during 1991. Strontium-90 was measured in seven of the eight milk samples. The values were lower than the levels detected in 1990 and during preoperational years. Strontium-90 from those years is attributed to past atmospheric nuclear weapons testing. No strontium-89 was detected in any of the milk samples. Naturally occurring potassium-40 was measured in all the milk samples at normal environmental levels.

Radioactivity in fish, vegetation, and milk does present a direct dose pathway to man. Fish samples in 1991 showed the presence of one man-made isotope, cesium-137. This isotope was at an activity level somewhat higher than preoperational levels but statistically similar to levels in 1987 through 1990. Only cesium-137 was measured in preoperational environmental fish samples. Due to primary and secondary steam generator problems experienced at North Anna during 1984/1985, a build up in activity levels both in effluents and fish did occur. Repairs to the steam generators and better liquid waste processing have reduced these activity levels in effluents and thus decreased activity levels are now being observed in the fish. The average level of activity in 1991 of cesium-137 was 3.8% of the reporting level.

Vegetation samples contained the man-made isotope cesium-137. The cesium-137 activity levels in 1990 and in preoperational samples were statistically similar to the 1991 level.

Direct Radiation Exposure Pathway

The direct exposure pathway as measured in the environment of the North Anna site by thermoluminescent dosimetry has remained essentially the same since the 1977 preoperational period at 6 milliroentgens per month or 0.2 milliroentgens per day. The average dose levels monitored have shown a normal fluctuation about these levels, and are less than the estimated whole body dose due to natural terrestrial and cosmic radiation and the internal dosage from natural radionuclides.

Program Conclusions

The results were as expected for normal environmental samples. Naturally occurring activity was observed in sample media in the expected activity ranges. Occasional samples of nearly all media showed the presence of man-made isotopes. These have been discussed individually in the text. Observed activities were at very low concentrations and had no significant dose consequence.

As a method of referencing the measured radionuclide concentrations in sample media to the dose consequence, the data may be compared to the Reporting Level Concentrations listed in the Offsite Dose Calculation Manual. These concentrations are based upon 25% of the annual dose commitment recommended by 10CFR50, Appendix I, to meet the criterion "As Low as is Reasonably Achievable." Based upon the evidence of the environmental monitoring program the station is operating within regulatory limits. Thus, no unusual radiological characteristics were observed in the environs of the North Anna Nuclear Power Station in 1991.

VII. References

1. Virginia Electric and Power Company, North Anna power Station Technical Specifications, Units 1 and 2.

2. Virginia Electric and Power Company, Station Administrative Procedure, VPAP-2103, "Offsite Dose Calculation Manual," Rev. 2, September, 1 1991.

3. Title 10 Code of Federal Regulation, Part 50 (10CFR50), "Domestic Licensing of Production and Utilization Facilities."

4. United States Nuclear Regulatory Commission Regulatory Guide 1.109, Rev. 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR50, Appendix I," October, 1977.

5. United States Nuclear Regulatory Commission, Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants," December, 1975.

6. USNRC Branch Technical Position, "Acceptable Radiological Environmental Monitoring Program," Rev.1, November 1979.

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RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1991

Docket No. 50-338/339 January 1 to December 31, 1991

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD[1]	All Indicator Locations Mean Range	Location with Highest Mean Name	Distance Direction	Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Air Iodine (pCi/m^3)	I-131	624	0.04	-(0/572) -	NA		NA	-(0/52) -	0
Airborne Particulates (1E-03 pCi/m^3)	Gross Beta	624	5	20.7(570-572) (2.8-41)	05	4.20 mi. NNE	22.4(52/52) (13-35)	19.4(51/52) (8.9-35)	0
	Gamma	48							
	Be-7	48	10	113(44/44) (62.7-186)	05	4.20 mi. NNE	143(4/4) (107-186)	93.2(4/4) (68.7-169)	0
	K-40	48	10	21.8(1/44) -	05A	3.20 mi. N	21.8(1/4) -	-(0/4) -	0
	Sr-89	12	3	-(0/11) -	NA		NA	-(0/1) -	0
	Sr-90	12	0.4	-(0/11) -	NA		NA	-(0/1) -	0
Ground Well Water (pCi/liter)	Gamma	4							
	K-40	4	60	-(0/4) -	N/A		N/A	NONE	0
	Tritium	4	2000	-(0/4) -	N/A		N/A	NONE	0
River Water (pCi/liter)	Gamma	12							
	K-40	12	200	-(0/12) -	N/A		N/A -	NONE	0
	Tritium	12	2000	3645(11/12) (3100-4400)	11	5.8 mi. SSE	3645(11/12) (3100-4400)	NONE	0

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD[1]	All Indicator Locations Mean Range	Location with Highest Mean Name	Location with Highest Mean Distance Direction	Location with Highest Mean Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Precipitation (pCi/liter)	Monthly								
	Gross Beta	12	4	11.6(11/12) (1.6-35)	01A	0.2 mi. NE	11.6(11/12) (1.6-35)	NONE	0
	Gamma (Semi-Annually)	2							
	Be-7	2	70	-(0/2) -	N/A		N/A	NONE	0
	Tritium	2	2000	-(0/2)	N/A		N/A	NONE	0
Surface Water (pCi/liter) Regular Monthlies	I-131	24	0.5	-(0/12) -	N/A		N/A	-(0/12) -	0
	Gamma	24							
	K-40	24	200	-(0/12) -	09		82.4(1/12) -	82.4(1/12) -	0
	Tritium	8	2000	4025(4/4) (3600-4500)	8	1.1 mi. SSE	4025(4/4) (3600-4500)	2933(3/4) (2200-3300)	0
Surface Water (pCi/liter) Regular Monthlies	Sr-89	1	2000	-(0/1) -	N/A		N/A	-(0/1) -	0
	Sr-90	1	2000	0.73(1/1) -	8	1.1 mi. SSE	0.73(1/1) -	-(0/1) -	0
Surface Water (pCi/liter) State Splits	Gamma	24							
	K-40	24	200	-(0/24) -	N/A		N/A	NONE	0
	Tritium	14	2000	3117(6/8) (1800-3800)	W33		3550(4/4) (3200-3800)	NONE	0

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD[1]	All Indicator Locations Mean Range	Location with Highest Mean Name	Location with Highest Mean Distance Direction	Location with Highest Mean Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Sediment Silt	Gamma	6							
(pCi/kg (dry))	K-40	6	200	11328(4/4) (6580-16800)	11	5.8 mi SSE	16000(2/2) (15200-16800)	10210(2/2) (6620-13800)	0
	Co-60	6	150	64.2(1/4) -	8	1.1 mi SSE	64.2(1/2) -	-(0/2) -	0
	Cs-137	6	194	194(1/4) -	8	1.1 mi SSE	194(1/2) -	112(1/2) -	0
	Ra-226	6	100	1843(3/4) (1680-2090)	11	5.8 mi SSE	1925(2/2) (1760-2090)	1330(2/2) (1040-1620)	0
	Th-228	6	30	1207(4/4) (816-1750)	11	5.8 mi. SSE	1475(2/2) (1200-1750)	793(2/2) (575-1010)	0
	Sr-89 (Annually)	3	4.0	-(0/2) -	N/A		N/A	-(0/1) -	0
	Sr-90 (Annually)	3	0.8	190(1/2) -	11	5.8 mi. SSE	190(1/2) -	160(1/1) -	0
Shoreline Soil	Gamma	2							
(pCi/kg (dry))	K-40	2	200	5305(2/2) (4160-6450)	9	2.2 mi. NW	5305(2/2) (4160-6450)	NONE	0
	Cs-137	2	40	502(1/2) -	9	2.2 mi. NW	502(1/2) -	NONE	0
	Ra-226	2	100	1435(2/2) (1170-1700)	9	2.2 mi. NW	1435(2/2) (1170-1700)	NONE	0
	Th-228	2	30	839(2/2) (799-879)	9	2.2 mi. NW	839(2/2) (799-879)	NONE	0
	Sr-89 (Annually)	1	4.0	-(0/2)	NA		NA	NONE	0
	Sr-90 (Annually)	1	0.8	-(0/2) -	NA		NA	NONE	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1991

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD[1]	All Indicator Locations Mean Range	Location with Highest Mean Name	Distance Direction	Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Milk (pCi/liter)	I-131	24	0.5	-(0/24) -	N/A		N/A	NONE	0
	Gamma	24							
	K-40	24	100	1291(24/24) (1010-1480	12	8.3 mi. NW	1303(12/12) (1010-1480)	NONE	0
	Sr-89 (Quarterly)	8	5	-(0/8) -	N/A		N/A	NONE	0
	Sr-90 (Quarterly)	8	0.8	0.91(7/8)	12	8.3 mi. NW	0.92(3/4) (0.55-1.4)	NONE (0.71-1.1)	0
Fish pCi/kg (wet)	Gamma	10							
	K-40	10	200	1395(6/6 (831-2160)	25	16.5 mi. NW	1430(4/4) (1100-2050)	1430(4/4) (1100-2050)	0
	Cs-137	10	40	76.7(3/6) (57.9-99.4)	08	1.10 mi. SSE	76.7(3/4) (57.9-99.4)	-(0/4) -	0
Food Vegetation (pCi/kg (wet))	Gamma Dose	40							
	Be-7	40	-	1400(32/40) (252-3600)	23	0.93 mi. SSE	2564(5/8) (404-7710)	NONE	0
	K-40	40	-	8969(40/40) (383-30500)	23	0.93 mi. SSE	11095(8/8) (383-29100)	NONE	0
	Cs-137	40	80	168(14/40) (23.5-448)	15	1.37 mi. SE	243(2/8) (37.0-448)	NONE	0
	Ra-226	40	80	580(3/40) (233-1070)	16	12.60 mi. NW	1070(1/8) -	NONE	0
	Th-228	40	-	370(9/40) (29.5-844)	15	1.37 mi. SE	844(1/8) -	NONE	0
Direct Radiation (mR/std. month) (Regular TLDs)	Gamma Dose	48	0.2	5.74(44/44) (4.1-9.1)	01	0.2 mi. NE	7.48(4/4) (6.5-9.1)	3.78(4/4) (3.4-4.4)	0

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

North Anna Nuclear Power Station, Louisa County, Virginia - 1991

Medium or Pathway Sampled (Unit)	Analysis Type	Analysis Total No.	LLD[1]	All Indicator Locations Mean Range	Location with Highest Mean Name	Location with Highest Mean Distance Direction	Location with Highest Mean Mean Range	Control Location Mean Range	Non-routine Reported Measurements
Direct Radiation (mR/std. Month) (Annual TLDs)	Gamma Dose	12	0.2	5.28(11/11) (3.9-6.8)	01	0.2 mi NE	6.8(1/1) -	3.4(1/1) -	0
Direct Radiation (mR/std. Month) (Sector TLDs)	Gamma Dose	287	0.2	6.20(255/255) (3.1-10.6)	21/53	0.30 mi SW	8.99(8/8) (7.9-10.6)	5.12(32/32) (3.4-7.4)	0

[1] LLD is the Lower Limit of Detection as defined and required in USNRC Branch Technical Position on an Acceptable Radiological Environmental Monitoring Program, Revision 1, November 1979.

TABLE B-1: IODINE-131 CONCENTRATION IN FILTERED AIR

North Anna Power Station, Louisa County, Virginia - 1991

$pCi/m^3 \pm 2$ Sigma January 1 to December 31, 1991

Collection Date	STATIONS 01	02	03	04	05	05A	06	07	21	22	23	24
JANUARY												
01/02-01/09	< .008	< .009	< .009	< .01	< .01	< .01	< .009	< .009	< .01	< .009	< .01	< .009
01/09-01/16	< .03	< .03	< .03	< .01	< .03	< .06	< .03	< .03	< .05	< .02	< .02	< .02
01/16-01/23	< .05	< .06	< .03	< .07[a]	< .03	< .06	< .02	< .02	< .01	< .01	< .02	< .03
01/23-01/30	< .009	< .009	< .009	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02
FEBRUARY												
01/30-02/06	< .009	< .009	< .009	< .009	< .009	< .01	< .01	< .008	< .009	< .01	< .01	< .01
02/06-02/13	< .008	< .01	< .009	< .01	< .009	< .009	< .01	< .01	< .01	< .01	< .01	< .009
02/13-02/20	< .02	< .01	< .01	< .01	< .009	< .01	< .01	< .01	< .01	< .01	< .01	< .005
02/20-02/27	< .007	< .006	< .006	< .006	< .007	< .006	< .007	< .006	< .006a	< .007	< .006	< .006
MARCH												
02/27-03/06	< .008	< .007	< .008	< .008	< .007	< .007	<.2[b]	< .01	< .008	< .008	< .008	< .007
03/06-03/13	< .01	< .02	< .01	< .01	< .01	< .01	< .009	< .01	< .008	< .01	< .02	< .01
03/13-03/21	< .006	< .005	< .005	< .005	< .005	< .005	< .01	< .006	< .005	< .003	< .004	< .003
03/21-03/27	< .01	< .0	< .01	< .01	< .009	< .01	< .05	< .06	< .01	< .01	< .01	< .01
03/27-04/03	< .008	< .008	< .02	< .02	< .01	< .02	< .01	< .01	< .02	< .008	< .006	< .007
APRIL												
04/03-10/91	< .02	< .02	< .01	< .02	< .02	< .01	< .02	< .01	< .02	< .02	< .02	< .02
04/10-17/91	< .01	< .02	< .01	< .02	< .02	< .02	< .02	< .008	< .008	< .008	< .008	< .008
04/17-25/91	< .003	< .003	< .003	< .005	< .005	< .003	< .005	< .003	< .005	< .009	< .006	< .007
04/25-01/91	< .008	< .009	< .01	< .01	< .006	< .007	< .008	< .009	< .009	< .008	< .007	< .008
MAY												
05/01-08/91	< .006[c]	< .007	< .007	<	< .006[c]	< .007	< .007	< .006	< .006	< .008	< .008	< .007
05/08-16/91	< .005	< .007	< .004[d]		< .004[d]	< .004	< .004	< .004	< .003	< .003	< .003	< .003
05/16-22/91	< .005	< .007	< .06[f]	<	< .006[d]	< .007	< .006	< .006	< .007	< .005	< .007	< .003
05/22-30/91	< .004	< .004	< .004	<	< .003	< .003	< .003	< .003	< .003	< .003[g]	< .002	< .002
JUNE												
05/30-05/91	< .006	< .005	< .005	< .005	< .005	< .01	< .003	< .005	< .005	< .006	< .007	< .009
06/05-12/91	< .007	< .007	< .007	< .007	< .005	< .005	< .006	< .005	< .005	< .005	< .005	< .004
06/12-19/91	< .005	< .004	< .004[h]	< .003	< .004	< .004	< .003	< .004	< .004	< .004	< .002	< .002
06/19-26/91	< .004	< .005	< .004[d]	< .004	< .004	< .005	< .004	< .004	< .004	< .004	< .008	< .007
06/26-03/91	< .008	< .007	< .008	< .007	< .007	< .007	< .006	< .007	< .007	< .007	< .004	< .005
JULY												
07/03-10/91	< .004[i]	< .04[j]	< .004	< .004	< .002	< .004	< .004	< .005	< .004	< .002	< .006	< .006
07/10-17/91	< .002	< .002	< .002	< .005	< .005	< .005	< .002	< .005	< .005	< .002	< .005	< .02
07/17-24/91	< .006	< .01	< .01	< .006	< .005	< .004	< .004	< .004	< .004	< .01	< .004	< .004
07/24-31/91	< .01	< .01	< .01	< .01	< .02	< .02	< .01	< .01	< .02	< .01	< .02	< .01
AUGUST												
07/31-07/91	< .03	< .03	< .03	< .03	< .02	< .01	< .03	< .04	< .03	< .03	< .01	< .04
08/07-14/91	< .02	< .02	< .02	< .02	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
08/14-21/91	< .02	< .02	< .01	< .02	< .02	< .02	< .02	< .01	< .006	< .009	< .008	< .007
08/21-28/91	< .01	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02
08/28-04/91	< .008	< .008	< .009	< .009	< .009	< .01	< .008	< .008	< .01	< .009	< .009	< .008

TABLE B-1: IODINE-131 CONCENTRATION IN FILTERED AIR

North Anna Power Station, Louisa County, Virginia - 1991

pCi/m^3 ± 2 Sigma January 1 to December 31, 1991

Collection Date	STATIONS 01	02	03	04	05	05A	06	07	21	22	23	24
SEPTEMBER												
09/04-11/91	< .005	< .007	< .006[k]	< .006	< .006	< .005	< .005	< .005	< .007	< .006	< .008	< .008
09/11-18/91	< .005	< .004	< .004	< .004	< .02	< .006	< .004	< .005	< .005	< .005	< .02	< .02
09/18-25/91	< .003	< .004	< .003	< .002	< .002	< .003	< .003	< .003	< .003	< .002	< .003	< .003
09/25-02/91	< .004	< .006	< .005	< .006	< .005	< .008	< .006	< .006	< .006	< .006	< .006	< .006
OCTOBER												
10/02-09/91	< .007	< .007	< .007	< .007	< .008	< .009	< .007	< .009	< .009	< .009	< .01	< .01
10/09-16/91	< .007	< .006	< .006	< .006	< .005	< .006	< .007	< .006	< .004	< .003	< .006	< .005
10/16-23/91	< .01	< .009	< .02	< .008	< .009	< .01	< .008	< .01	< .009	< .01	< .01	< .01
10/23-30/91	< .005	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
NOVEMBER												
10/30-06/91	< .03	< .02	< .03	< .02	< .02	< .02	< .01	< .01	< .01	< .01	< .01	< .02
11/06-13/91	< .03	< .02	< .02	< .02	< .02	< .02	< .02	< .03	< .02	< .02	< .03	< .03
11/13-20/91	< .02	< .01	< .01	< .01	< .01	< .02	< .01	< .01	< .02	< .02	< .01	< .02
11/20-27/91	< .02	< .02	< .02	< .02	< .02	< .03	< .02	< .02	< .02	< .02	< .02	< .02
DECEMBER												
11/27-04/91	< .03	< .03	< .03	< .02	< .02	< .04	< .03	< .04	< .02	< .02	< .02	< .01
12/04-12/91	< .008	< .005	< .009	< .01	< .009	< .005	< .004	< .004	< .004	< .004	< .004	< .005
12/12-19/91	< .02	< .01	< .01	< .01	< .01	< .02	< .01	< .02	< .02	< .01	< .01	< .01
12/18-26/91	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
12/26-1/2/92	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .02	< .01	< .02	< .02

a Sampler malfunction causing low volume.
b Pump malfunction; results in total pCi.
c Samplers not running on arrival although pumps were hot. Volumes estimated.
d Timer malfunctioned; estimated volumes using start/stop times.
e Volumes low due to decrease flow rate.
f Volume low due to malfunction of pump.
g Pump not running on arrival.. Volumes determined by timer.
h Timer malfunction; sampler operating properly and volume satisfactory.
i Pump not running on arrival; estimated volume.
J Pump vanes broke resulting in low volume.
k Timer malfunction; volume estimated by start/stop times.

TABLE B-2

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NORTH ANNA - 1991

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE	1991 01	02	03	04	05	05A	06	07	21	22	23	[illegible]	AVERAGE ± 2 s.d.
JANUARY													
01/02-01/09	21 ± 3	26 ± 5	22 ± 3	17 ± 3	31 ± 5	35 ± 5	24 ± 3	22 ± 3	26 ± 5	32 ± 5	21 ± 3	24 ± 3	25 ± 10
01/09-01/16	12 ± 3	13 ± 3	11 ± 3	10 ± 3	21 ± 3	17 ± 3	16 ± 3	11 ± 3	14 ± 3	18 ± 3	14 ± 3	14 ± 3	14 ± 7
01/16-01/23	23 ± 3	20 ± 3	20 ± 3	41 ± 8 (a)	26 ± 5	24 ± 5	20 ± 3	17 ± 3	18 ± 3	25 ± 5	18 ± 3	23 ± 3	23 ± 13
01/23-01/30	22 ± 5	25 ± 5	28 ± 5	30 ± 5	35 ± 5	29 ± 5	25 ± 5	21 ± 3	12 ± 3	31 ± 5	30 ± 5	25 ± 5	26 ± 12
FEBRUARY													
01/30-02/06	21 ± 3	23 ± 3	20 ± 3	20 ± 3	31 ± 5	[illegible]	21 ± 3	18 ± 3	16 ± 3	28 ± 5	31 ± 5	28 ± 5	24 ± 10
02/06-02/13	18 ± 3	16 ± 3	23 ± 5	23 ± 5	29 ± 5	[illegible]	[illegible] ± 5	14 ± 3	21 ± 5	18 ± 3	24 ± 6	21 ± 5	21 ± 8
02/13-02/20	14 ± 3	20 ± 5	21 ± 3	21 ± 3	23 ± 5	2[illegible]	[illegible] ± 3	13 ± 3	15 ± 3	17 ± 3	17 ± 3	25 ± 5	19 ± 8
02/20-02/27	17 ± 3	17 ± 3	17 ± 3	18 ± 3	22 ± 5	17 ± [illegible]	[illegible] ± 3	14 ± 3	< 5 (a)	21 ± 3	18 ± 3	21 ± 5	18 ± 5
MARCH													
02/27-03/06	14 ± 3	17 ± 3	[illegible]6 ± 3	15 ± 3	21 ± 3	16 ± 3	2.8 ± 0.7 (b)	15 ± 2	11 ± 3	20 ± 3	17 ± 3	[illegible]8 ± 3	15 ± 9
03/06-03/13	25 ± 5	25 ± 5	24 ± 5	18 ± [illegible]	26 ± 5	31 ± 5	14 ± 3	18 ± 3	14 ± 3	30 ± 5	30 ± 5	26 ± 5	23 ± 12
03/13-03/21	22 ± 3	14 ± 3	15 ± 3	14 ± 3	20 ± 3	15 ± 3	15 ± 6	10 ± 3	13 ± 3	16 ± 3	14 ± 3	17 ± 3	15 ± 6
03/21-03/27	26 ± 5	24 ± 5	22 ± 5	20 ± 5	25 ± 5	26 ± 5	16 ± 5	13 ± 3	21 ± 5	23 ± 5	18 ± 5	25 ± 5	22 ± 8
03/27-04/03	16 ± 5	14 ± 3	16 ± 5	17 ± 5	21 ± 5	17 ± 5	9.3 ± 3.7	17 ± 5	14 ± 3	18 ± 5	13 ± 3	15 ± 3	16 ± 6
Average ± 2 s.d.	19 ± 9	20 ± 9	20 ± 9	20 ± 16	25 ± 10	23 ± 13	16 ± 12	16 ± 7	16 ± 9	23 ± 11	20 ± 13	22 ± 9	20 ± 6

(a) Sampler malfunction (hose came off) causing low volume.
(b) Pump malfunction causing low volume; results in total pCi.

TABLE B-2

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NORTH ANNA - 1991

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE	1991 01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
APRIL													
04/03-04/10	22 ± 5	28 ± 5	20 ± 5	22 ± 5	26 ± 5	30 ± 5	18 ± 5	30 ± 5	22 ± 5	28 ± 5	21 ± 5	14 ± 3	23 ± 10
04/10-04/17	17 ± 3	14 ± 3	14 ± 3	13 ± 3	17 ± 3	16 ± 3	14 ± 3	17 ± 3	21 ± 3	16 ± 3	15 ± 3	13 ± 3	16 ± 5
04/17-04/25	14 ± 3	16 ± 3	14 ± 3	13 ± 3	15 ± 6	16 ± 3	12 ± 3	14 ± 3	17 ± 3	18 ± 3	15 ± 3	15 ± 3	15 ± 3
04/25-05/01	24 ± 5	20 ± 5	23 ± 5	20 ± 5	30 ± 6	32 ± 6	20 ± 5	22 ± 5	24 ± 5	23 ± 5	20 ± 5	17 ± 5	23 ± 9
MAY													
05/01-05/08	18 ± 4 (a)	19 ± 4	16 ± 3	20 ± 4	17 ± 4 (a)	17 ± 4	18 ± 4	14 ± 3	16 ± 3	18 ± 4	9.5 ± 3.0	16 ± 3	17 ± 6
05/08-05/16	10 ± 3	22 ± 4	22 ± 4 (b)	12 ± 5 (c)	18 ± 3 (b)	24 ± 4	22 ± 4	20 ± 3	22 ± 4	20 ± 2	11 ± 3	18 ± 3	18 ± 10
05/16-05/22	24 ± 4	22 ± 4	125 ± 50 (d)	16 ± 4	16 ± 4 (b)	16 ± 4	17 ± 4	12 ± 4	18 ± 4	16 ± 4	13 ± 4	17 ± 4	17 ± 7
05/22-05/30	12 ± 3	18 ± 3	17 ± 3	16 ± 3	20 ± 3	20 ± 3	17 ± 3	21 ± 3	23 ± 4	13 ± 3 (e)	15 ± 3	16 ± 3	17 ± 7
JUNE													
05/30-06/05	20 ± 4	23 ± 4	22 ± 4	20 ± 4	18 ± 4	22 ± 4	16 ± 4	22 ± 4	20 ± 4	19 ± 4	21 ± 4	19 ± 4	20 ± 4
06/05-06/12	17 ± 3	19 ± 3	20 ± 4	18 ± 3	22 ± 4	16 ± 3	17 ± 3	21 ± 3	27 ± 4	19 ± 3	19 ± 3	21 ± 4	20 ± 6
06/12-06/19	11 ± 3	15 ± 3	17 ± 4 (f)	11 ± 3	13 ± 3	18 ± 4	17 ± 4	15 ± 3	17 ± 4	17 ± 4	14 ± 3	9.1 ± 3.0	15 ± 6
06/19-06/26	9.2 ± 2.7	14 ± 3	16 ± 3 (b)	9.3 ± 2.8	14 ± 3	14 ± 3	18 ± 3	17 ± 3	14 ± 3	14 ± 3	12 ± 3	16 ± 3	14 ± 6
06/26-07/03	9.0 ± 2.9	6.4 ± 2.7	19 ± 4	18 ± 3	18 ± 3	14 ± 3	16 ± 3	15 ± 3	16 ± 3	16 ± 3	14 ± 3	12 ± 3	15 ± 8
Average ± 2 s.d.	**16 ± 11**	**18 ± 11**	**18 ± 6**	**16 ± 8**	**19 ± 10**	**20 ± 12**	**17 ± 5**	**18 ± 10**	**20 ± 8**	**18 ± 8**	**15 ± 8**	**16 ± 6**	**18 ± 3**

(a) Samplers not running on arrival although pumps were hot. Volumes estimated.
(b) Timer malfunctioned, estimated volumes using start/stop times.
(c) Volumes low due to decrease flow rate.
(d) Volume low due to malfunction of pump. Result not used in averages.
(e) Pump not running on arrival. Volumes determined by timer.
(f) Timer malfunction; sampler operating properly and volume satisfactory.

TABLE B-2

(Page 3 of 4)

NORTH ANNA - 1991

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

$1.0E\text{-}03$ pCi/m^3 ± 2 Sigma

COLLECTION DATE	1991 01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
JULY													
07/03-07/10	13 ± 3 (a)	< 9 (b)	26 ± 4	19 ± 4	23 ± 4	22 ± 4	21 ± 4	27 ± 4	18 ± 4	22 ± 4	23 ± 4	26 ± 4	22 ± 8
07/10-07/17	24 ± 4	25 ± 4	24 ± 4	17 ± 3	23 ± 4	20 ± 4	20 ± 4	22 ± 4	25 ± 4	24 ± 4	22 ± 4	23 ± 4	22 ± 5
07/17-07/24	28 ± 4	21 ± 4	23 ± 4	17 ± 3	24 ± 4	23 ± 4	26 ± 4	29 ± 4	31 ± 4	30 ± 4	33 ± 4	24 ± 4	26 ± 9
07/24-07/31	26 ± 4	14 ± 3	18 ± 4	11 ± 3	13 ± 3	15 ± 3	20 ± 4	15 ± 3	20 ± 4	19 ± 4	16 ± 3	18 ± 4	17 ± 8
AUGUST													
07/31-08/07	25 ± 4	25 ± 4	32 ± 4	26 ± 4	24 ± 4	25 ± 4	22 ± 4	26 ± 4	27 ± 4	20 ± 4	26 ± 4	25 ± 4	25 ± 6
08/07-08/14	19 ± 4	15 ± 3	20 ± 4	15 ± 3	18 ± 3	20 ± 4	19 ± 4	23 ± 4	19 ± 4	20 ± 4	19 ± 4	19 ± 4	19 ± 4
08/14-08/21	27 ± 4	25 ± 4	30 ± 4	15 ± 3	31 ± 4	26 ± 4	29 ± 4	33 ± 4	34 ± 4	32 ± 4	29 ± 4	35 ± 4	29 ± 11
08/21-08/28	26 ± 4	21 ± 3	22 ± 4	22 ± 4	24 ± 4	21 ± 3	28 ± 4	24 ± 4	27 ± 4	26 ± 4	24 ± 4	29 ± 4	[illegible] ± 5
08/28-09/04	13 ± 3	13 ± 3	13 ± 3	11 ± 3	15 ± 3	19 ± 4	14 ± 3	18 ± 3	18 ± 4	16 ± 3	16 ± 3	18 ± 3	15 ± 5
SEPTEMBER													
09/04-09/11	25 ± 4	25 ± 4	26 ± 4 (c)	13 ± 3	29 ± 4	25 ± 4	30 ± 4	29 ± 4	30 ± 4	27 ± 4	30 ± 4	< 3	26 ± 10
09/11-09/18	27 ± 4	25 ± 4	21 ± 4	24 ± 4	34 ± 4	28 ± 4	33 ± 4	29 ± 4	26 ± 4	29 ± 4	26 ± 4	33 ± 4	28 ± 8
09/18-09/25	19 ± 4	20 ± 4	15 ± 3	8.6 ± 2.9	17 ± 4	16 ± 3	25 ± 4	23 ± 4	20 ± 4	26 ± 4	16 ± 3	22 ± 4	19 ± 10
09/25-10/02	19 ± 4	20 ± 4	23 ± 4	17 ± 3	24 ± 4	19 ± 3	28 ± 4	26 ± 4	23 ± 4	24 ± 4	24 ± 4	29 ± 4	23 ± 7
Average ± 2 s.d.	**22 ± 10**	**21 ± 9**	**23 ± 11**	**17 ± 10**	**23 ± 12**	**21 ± 8**	**24 ± 11**	**25 ± 10**	**24 ± 11**	**24 ± 9**	**23 ± 11**	**25 ± 11**	**21 ± 14**

(a) Pump not running on arrival; estimated volume.
(b) Pump vanes broke resulting in low volume.
(c) Timer malfunction; volume estimated by start/stop time.

TABLE B-2

(Page 4 of 4)

NORTH ANNA - 1991

CONCENTRATIONS OF GROSS BETA IN AIR PARTICULATES

1.0E-03 pCi/m^3 ± 2 Sigma

COLLECTION DATE 1991	01	02	03	04	05	05A	06	07	21	22	23	24	AVERAGE ± 2 s.d.
OCTOBER													
10/02-10/09	18 ± 4	20 ± 4	20 ± 4	22 ± 4	26 ± 4	23 ± 4	18 ± 4	22 ± 4	23 ± 4	18 ± 4	18 ± 4	24 ± 4	21 ± 6
10/09-10/16	17 ± 3	26 ± 4 (a)	27 ± 4	36 ± 4	35 ± 4	35 ± 4	22 ± 4	26 ± 4	29 ± 4	26 ± 4	29 ± 4	21 ± 3	27 ± 12
10/16-10/23	20 ± 4	30 ± 4	25 ± 4	26 ± 4	27 ± 4	24 ± 4	24 ± 4	23 ± 4	27 ± 4	15 ± 3	24 ± 4	18 ± 3	24 ± 8
10/23-10/30	16 ± 4	24 ± 4	17 ± 4	26 ± 4	29 ± 4	27 ± 4	19 ± 4	19 ± 4	29 ± 4	22 ± 4	20 ± 4	17 ± 4	22 ± 10
NOVEMBER													
10/30-11/06	38 ± 5	35 ± 4	27 ± 4	35 ± 4	31 ± 4	32 ± 4	29 ± 4	31 ± 4	27 ± 4	28 ± 4	23 ± 4	20 ± 4	30 ± 10
11/06-11/13	27 ± 4	33 ± 4	20 ± 4	22 ± 4	29 ± 4	33 ± 4	19 ± 4	30 ± 4	25 ± 4	32 ± 4	15 ± 3	20 ± 4	25 ± 12
11/13-11/20	17 ± 3	24 ± 4	15 ± 3	23 ± 4	21 ± 4	28 ± 4	25 ± 4	21 ± 4	18 ± 3	21 ± 4	21 ± 4	10 ± 3	20 ± 10
11/20-11/27	14 ± 3	15 ± 3	14 ± 3	14 ± 3	14 ± 3	13 ± 3	17 ± 3	17 ± 3	18 ± 4	16 ± 3	21 ± 4	8.9 ± 2.9	15 ± 6
DECEMBER													
11/27-12/04	12 ± 3	18 ± 3	14 ± 3	14 ± 3	11 ± 3	18 ± 3	15 ± 3	18 ± 3	18 ± 3	19 ± 3	20 ± 3	13 ± 3	16 ± 6
12/04-12/12	25 ± 4	29 ± 4	19 ± 3	14 ± 3	19 ± 3	25 ± 4	24 ± 4	22 ± 4	23 ± 4	29 ± 4	24 ± 4	12 ± 3	22 ± 11
12/12-12/18	22 ± 4	20 ± 4	21 ± 4	32 ± 5	21 ± 4	27 ± 5	25 ± 4	23 ± 4	23 ± 4	23 ± 4	25 ± 4	11 ± 3	23 ± 10
12/18-12/26	18 ± 3	20 ± 3	15 ± 3	18 ± 3	19 ± 3	20 ± 3	21 ± 3	19 ± 3	16 ± 3	18 ± 3	20 ± 3	13 ± 3	18 ± 5
12/26-01/02	21 ± 4	20 ± 4	12 ± 3	26 ± 4	27 ± 4	32 ± 4	18 ± 4	24 ± 4	17 ± 4	23 ± 4	21 ± 4	17 ± 4	22 ± 11
Qtr Average ± 2 s.d.	**20 ± 13**	**24 ± 12**	**19 ± 10**	**24 ± 15**	**24 ± 14**	**26 ± 13**	**21 ± 8**	**23 ± 9**	**23 ± 9**	**22 ± 10**	**22 ± 7**	**16 ± 10**	**22 ± 12**
Ann Average ± 2 s.d.	**20 ± 12**	**21 ± 11**	**20 ± 10**	**19 ± 14**	**23 ± 12**	**22 ± 12**	**20 ± 11**	**20 ± 11**	**21 ± 11**	**22 ± 11**	**20 ± 11**	**19 ± 12**	**21 ± 15**

(a) Timer malfunction, volume estimated.

TABLE B-3: GAMMA EMITTER[1], STRONTIUM-89, AND STRONTIUM-90 CONCENTRATIONS IN AIR PARTICULATES

North Anna Power Station, Louisa County, Virginia - 1991

1.0 e-03 pCi/m^3 ± 2 Sigma | January 1 to December 31, 1991 |

Station	Nuclide	First Quarter 01/02-04/03	Second Quarter 04/03-07/03	Third Quarter 07/03-10/02	Fourth Quarter 10/02-1/02	Average ± 2 s.d.
STA-01	Sr-89	(a)	< 0.9	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	116 ± 17	80.3 ± 17.6	104 ± 17	80.1 ± 11.5	95.1 ± 35.8
	K-40	< 12	< 30	< 30	< 10	-
	Co-60	< 1	< 0.8	< 0.9	< 0.7	-
	Ru-103	< 2	< 3	< 2	< 1	-
	Cs-134	< 0.8	< 1	< 0.9	< 0.6	-
	Cs-137	< 0.9	< 0.9	< 0.9	< 0.7	-
	Th-228	< 1	< 1	< 1	< 1	-
STA-02	Sr-89	(a)	< 1	(a)	(a)	
	Sr-90	(a)	< 0.2	(a)	(a)	
	Be-7	162 ± 21	126 ± 19	102 ± 16	112 ± 12	126 ± 52
	K-40	< 12	< 10	< 10	< 20	-
	Co-60	< 1	< 0.8	< 0.8	< 0.6	-
	Ru-103	< 2	< 2	< 2	< 2	-
	Cs-134	< 0.8	< 0.7	< 0.8	< 0.7	-
	Cs-137	< 0.8	< 0.7	< 1	< 0.6	-
	Th-228	< 1	< 1	< 1	< 0.9	-
STA-03	Sr-89	(a)	< 1	(a)	(a)	
	Sr-90	(a)	< 0.2	(a)	(a)	
	Be-7	112 ± 22	145 ± 23	103 ± 18	83.8 ± 13.2	111 ± 51
	K-40	< 23	< 40	< 30	< 20	-
	Co-60	< 1	< 1	< 1	< 0.7	-
	Ru-103	< 3	< 4	< 3	< 2	-
	Cs-134	< 1	< 1	< 1	< 0.7	-
	Cs-137	< 1	< 1	< 1	< 0.8	-
	Th-228	< 2	< 2	< 2	< 1	-
STA-04	Sr-89	(a)	< 0.9	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	121 ± 20	101 ± 16	68.2 ± 15.5	103 ± 12	98.3 ± 44.0
	K-40	< 35	< 10	< 30	< 10	-
	Co-60	< 0.9	< 0.8	< 1	< 0.5	-
	Ru-103	< 3	< 2	< 2	< 2	-
	Cs-134	< 0.9	< 0.6	< 1	< 0.5	-
	Cs-137	< 0.9	< 0.6	< 1	< 0.5	-
	Th-228	< 1	< 1	< 11	< 1	-
STA-05	Sr-89	(a)	< 1	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	186 ± 21	145 ± 27	134 ± 18	107 ± 14	143 ± 66
	K-40	< 12	< 20	< 10	< 20	-
	Co-60	< 0.8	< 1	< 0.6	< 0.6	-
	Ru-103	< 2	< 3	< 2	< 2	-
	Cs-134	< 0.7	< 0.9	< 0.7	< 0.7	-
	Cs-137	< 0.7	< 0.8	< 0.7	< 0.7	-
	Th-228	< 1	< 2	< 1	< 1	-

TABLE B-3: GAMMA EMITTER[1], STRONTIUM-89, AND STRONTIUM-90 CONCENTRATIONS IN AIR PARTICULATES

North Anna Power Station, Louisa County, Virginia - 1991

1.0 e-03 pCi/m^3 ± 2 Sigma | January 1 to December 31, 1991 |

Station	Nuclide	First Quarter 01/02-04/03	Second Quarter 04/03-07/03	Third Quarter 07/03-10/02	Fourth Quarter 10/02-1/02	Average ± 2 s.d.
STA-05A	Sr-89	(a)	< 0.8	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	154 ± 23	97.1 ± 16.0	95.2 ± 14.8	132 ± 15	120 ± 57
	K-40	< 35	21.8 ± 8.4	< 30	< 10	21.8 ± 8.4
	Co-60	< 1	< 1	< 1	< 0.7	-
	Ru-103	< 3	< 3	< 2	< 2	-
	Cs-134	< 1	< 1	< 0.9	< 0.5	-
	Cs-137	< 1	< 0.9	< 0.9	< 0.7	-
	Th-228	< 2	< 1	< 1	< 1	-
STA-06	Sr-89	(a)	< 0.8	(a)	(a)	
	Sr-90	(a)	< 0.09	(a)	(a)	
	Be-7	110 ± 25	114 ± 17	110 ± 16	85.0 ± 10.9	105 ± 27
	K-40	< 12	< 10	< 10	< 10	-
	Co-60	< 0.8	< 0.9	< 0.9	< 0.6	-
	Ru-103	< 2	< 2	< 2	< 1	-
	Cs-134	< 0.9	< 0.9	< 0.6	< 0.5	-
	Cs-137	< 0.8	< 1	< 0.7	< 0.4	-
	Th-228	< 1	< 1	< 1	< 0.8	-
STA-07	Sr-89	(a)	< 1	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	101 ± 16	139 ± 19	102 ± 16	114 ± 15	114 ± 35
	K-40	< 12	< 20	< 10	< 10	-
	Co-60	< 0.8	< 0.9	< 0.8	< 0.7	-
	Ru-103	< 2	< 3	< 2	< 2	-
	Cs-134	< 0.6	< 1	< 0.7	< 0.6	-
	Cs-137	< 0.6	< 1	< 0.9	< 0.7	-
	Th-228	< 1	< 2	< 1	< 1	-
STA-21	Sr-89	(a)	< 2	(a)	(a)	
	Sr-90	(a)	< 0.1	(a)	(a)	
	Be-7	62.7 ± 16.9	131 ± 22	120 ± 14	109 ± 14	106 ± 60
	K-40	< 12	< 30	< 20	< 20	-
	Co-60	< 0.7	< 1	< 0.9	< 0.8	-
	Ru-103	< 2	< 3	< 2	< 2	-
	Cs-134	< 0.7	< 1	< 0.8	< 0.7	-
	Cs-137	< 0.7	< 1	< 0.8	< 0.7	-
	Th-228	< 1	< 2	< 1	< 1	-
STA-22	Sr-89	(a)	< 2	(a)	(a)	
	Sr-90	(a)	< 0.2	(a)	(a)	
	Be-7	151 ± 20	83.3 ± 20.9	96.7 ± 16.5	110 ± 13	110 ± 59
	K-40	< 23	< 30	< 30	< 10	-
	Co-60	< 0.9	< 1	< 1	< 0.8	-
	Ru-103	< 2	< 3	< 2	< 2	-
	Cs-134	< 1	< 1	< 0.9	< 0.6	-
	Cs-137	< 0.9	< 1	< 0.9	< 0.9	-
	Th-228	< 1	< 1	< 1	< 1	-

TABLE B-3: GAMMA EMITTER[1], STRONTIUM-89, AND STRONTIUM-90 CONCENTRATIONS IN AIR PARTICULATES

North Anna Power Station, Louisa County, Virginia - 1991

1.0 e-03 pCi/m^3 ± 2 Sigma | January 1 to December 31, 1991 |

Station	Nuclide	First Quarter 01/02-04/03	Second Quarter 04/03-07/03	Third Quarter 07/03-10/02	Fourth Quarter 10/02-1/02	Average ± 2 s.d.
STA-23	Sr-89	(a)	< 2	(a)	(a)	
	Sr-90	(a)	< 0.2	(a)	(a)	
	Be-7	132 ± 20	105 ± 18	105 ± 16	119 ± 14	115 ± 26
	K-40	< 12	< 10	< 10	< 10	-
	Co-60	< 0.9	< 0.8	< 0.7	< 0.6	-
	Ru-103	< 2	< 2	< 2	< 2	-
	Cs-134	< 0.8	< 7	< 0.8	< 0.7	-
	Cs-137	< 1	< 0.9	< 0.8	< 0.8	-
	Th-228	< 1	< 1	< 1	< 0.9	-
STA-24	Sr-89	(a)	< 3	(a)	(a)	
	Sr-90	(a)	< 0.2	(a)	(a)	
	Be-7	169 ± 21	28.1 ± 16.3	107 ± 19	68.7 ± 130	93 ± 120
	K-40	< 23	< 10	< 40	< 30	-
	Co-60	< 0.9	< 0.8	< 1	< 0.8	-
	Ru-103	< 3	< 3	< 3	< 2	-
	Cs-134	< 0.9	< 0.7	< 1	< 0.9	-
	Cs-137	< 1	< 0.6	< 1	< 0.9	-
	Th-228	< 1	< 1	< 2	< 1	-

1 All gamma emitters other than those listed were <LLD.
(a) Strontium-89/90 analyses performed annually.

TABLE B-4: GROSS BETA, TRITIUM, AND GAMMA EMITTER[1] CONCENTRATIONS IN PRECIPITATION

Station 91A -- (On Site)

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 |

COLLECTION DATES	GROSS BETA	RAINFALL (inches)
12/31/90-01/30/91	1.6 ± 0.6	3.26
01/30/91-02/27/91	12 ± 2	0.93
02/27/91-03/27/91	3.4 ± 2.1	2.3
03/27/91-04/25/91	5.1 ± 2.4	2.52
04/25/91-05/30/91	35 ± 3 (a)	1.21
05/30/91-06/26/91	6.9 ± 1.0	1.95
06/26/91-07/31/91	3.1 ± 0.7	6.15
07/31/91-08/28/91	< 4	4.28
08/28/91-09/25/91	14 ± 1	1.8
09/25/91-10/30/91	3.3 ± 0.7	1.93
10/30/91-11/27/91	18 ± 2	0.78
11/27/91-12/26/91	26 ± 7	4.22
Average ± 2 s.d.	**12 ± 22**	

SEMI-ANNUAL PRECIPITATION COMPOSITES

12/31/90-06/24/91	06/26/91-12/26/91
Be-7 = < 60	Be-7 = < 40
H-3 = < 200	H-3 = < 200

1 All gamma emitters other than those listed were <LLD.
(a) Recounted to confirm result.

TABLE B-5 SOIL

Soil samples are collected every three years from twelve stations. Since the samples were collected in 1989, Table B-5 will not be included in the 1991 report.

TABLE B-6: GAMMA EMITTER[1], STRONTIUM, AND TRITIUM CONCENTRATIONS IN GROUND AND WELL WATER

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 | Page 1 of 1

Collection Date	H-3	Sr-89	Sr-90	Be-7	K-40	I-131	Ba-140	Th-228
STATION 01A								
03/27	< 200	(a)	(a)	< 40	< 100	< 0.2	< 9	< 7
06/26	< 200	< 3	< 0.8	< 30	< 60	< 0.2	< 8	< 7
10/04	< 200	(a)	(a)	< 40	< 200	< 0.2	< 9	< 9
12/26	< 200	(a)	(a)	< 30	< 60	< 0.2	< 7	< 6

1 All gamma emitters other than those listed were <LLD.
(a) Strontium-89/90 analyses performed only on second quarter sample.

TABLE B-7: GAMMA EMITTER[1], STRONTIUM, AND TRITIUM CONCENTRATIONS IN RIVER WATER

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 | Page 1 of 1

Collection Dates	Sr-89	Sr-90	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
STATION - 11										
01/22	(a)	(a)	3900 ± 100	< 30	< 50	< 0.2	< 4	< 6	< 80	< 7
02/21			3500 ± 100	< 30	< 40	< 0.3	< 4	< 7	< 60	< 6
03/25			3500 ± 30	< 30	< 50	< 0.2	< 3	< 6	< 70	< 6
04/26			< 200	< 40	< 100	< 0.3	< 5	< 8	< 90	< 8
05/28	< 2	< 0.6	3200 ± 300	< 50	< 100	< 0.2	< 5	< 10	< 90	< 8
06/17	< 2	< 0.5	3600 ± 200	< 30	< 40	< 0.2	< 4	< 10	< 60	< 5
07/24			3100 ± 200	< 40	< 100	< 0.1	< 4	< 10	< 70	< 6
08/21			3600 ± 200	< 30	< 50	< 0.1	< 4	< 9	< 60	< 6
09/16			3900 ± 200	< 40	< 90	< 0.1	< 4	< 8	< 80	< 8
10/21			3600 ± 200	< 20	< 50	< 0.5	< 3	< 6	< 70	< 5
11/13			3800 ± 200	< 30	< 50	< 0.5	< 4	< 5	< 60	< 5
12/17			4400 ± 200	< 30	< 60	< 0.2	< 3	< 8	< 70	< 7
Average ± 2 s.d.			**3645 ± 712**							

1 All gamma emitters other than those listed were <LLD.
(a) Sr-89/90 analyses performed on second quarter samples.

TABLE B-8: GAMMA EMITTER[1], STRONTIUM, AND TRITIUM CONCENTRATIONS IN SURFACE WATER

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 |

Collection Dates	H-3	I-131[2]	Sr-89	Sr-90	Be-7	K-40	Cs-137	Ba-140	Ra-226	Th-228
STATION - 08										
01/22	(a)	< 0.2	(b)	(b)	< 40	< 100	< 5	< 6	< 90	< 8
02/21		< 0.3			< 30	< 40	< 3	< 7	< 70	< 6
03/25	4500 ± 200	< 0.1			< 30	< 50	< 3	< 6	< 60	< 6
04/26		< 0.2			< 50	< 80	< 5	< 10	< 100	< 10
05/28		< 0.2			< 40	< 100	< 5	< 10	< 90	< 8
06/17	3900 ± 200	< 0.2	< 3	0.73 ± 0.40	< 30	< 50	< 3	< 10	< 80	< 7
07/24		< 0.1			< 30	< 40	< 3	< 9	< 50	< 5
08/21		< 0.2			< 40	< 100	< 4	< 9	< 80	< 7
09/16	3600 ± 200	< 0.2			< 30	< 60	< 3	< 9	< 80	< 6
10/21		< 0.5			< 30	< 50	< 3	< 5	< 60	< 6
11/13		< 0.2			< 30	< 60	< 4	< 6	< 90	< 7
12/17	4100 ± 200	< 0.2			< 30	< 80	< 3	< 8	< 50	< 5
Avg. ± 2. s.d.	**4025 ± 755**			**0.73 ± 0.40**						
STATION - 09										
01/22	(a)	< 0.1	(b)	(b)	< 40	< 100	< 5	< 7	< 90	< 8
02/21		< 0.3			< 30	< 60	< 3	< 8	< 90	< 7
03/25	2200 ± 200	< 0.1			< 30	< 40	< 3	< 6	< 60	< 5
04/26		< 0.3			< 40	< 100	< 5	< 8	< 100	< 9
05/28		< 0.1			< 40	< 100	< 5	< 9	< 100	< 9
06/17	3300 ± 200	< 0.2	< 3	< 0.6	< 40	< 80	< 3	< 10	< 70	< 6
07/24		< 0.1			< 40	< 100	< 4	< 10	< 80	< 7
08/21		< 0.1			< 50	< 100	< 5	< 10	< 90	< 8
09/17	3300 ± 200	< 0.1			< 30	< 50	< 3	< 9	< 70	< 6
10/21		< 0.1			< 30	< 40	< 3	< 6	< 50	< 5
11/13		< 0.4			< 30	< 90	< 4	< 6	< 70	< 6
12/17	< 200	< 0.2			< 40	82.4 ± 28.4	< 4	< 7	< 80	< 8
Avg. ± 2 s.d.	**2933 ± 1270**					**82.4 ± 28.4**				

1 All gamma emitters other than those listed were <LLD.
2 I-131 by radiochemistry
(a) Analysis performed quarterly.
(b) Analysis performed only with second quarter.

TABLE B-9: GAMMA EMITTER[1], STRONTIUM, AND TRITIUM CONCENTRATIONS IN SURFACE WATER

State-Split Samples

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 | Page 1 of 1

Collection Dates	H-3	Be-7	K-40	I-131	Cs-137	Ba-140	Ra-226	Th-228
STATION - W-27								
01/31	< 200	< 40	< 50	< 0.5	< 3	< 10	< 70	< 6
02/28		< 40	< 80	< 30 (a)	< 4	< 10	< 80	< 7
03/31		< 50	< 80	< 0.6	< 5	< 10	< 100	< 10
04/30	< 200	< 30	< 40	< 0.3	< 4	< 15	< 60	< 5
05/31		< 30	< 50	< 30 (a)	< 3	< 10	< 70	< 5
06/30		< 30	< 40	< 0.4	< 3	< 10	< 60	< 6
07/31	1800 ± 100	< 30	< 40	< 20 (a)	< 3	< 9	< 60	< 5
08/31		< 30	< 50	< 0.3	< 3	< 10	< 70	< 5
09/30		< 40	< 50	< 0.2	< 4	< 10	< 70	< 6
10/31	2700 ± 200	< 30	< 50	< 0.7	< 3	< 10	< 70	< 6
11/30		< 40	< 60	< 0.5	< 3	< 10	< 80	< 6
12/31		< 40	< 100	< 1	< 4	< 10	< 80	< 7
STATION - W-33								
01/31	3600 ± 300	< 30	< 40	< 0.6	< 3	< 10	< 60	< 5
02/28		< 30	< 40	< 20 (a)	< 3	< 10	< 60	< 5
03/31		< 30	< 50	< 0.6	< 4	< 10	< 60	< 5
04/30	3200 ± 200	< 50	< 100	< 0.3	< 4	< 15	< 80	< 7
05/31		< 30	< 40	< 30 (a)	< 3	< 10	< 50	< 5
06/30		< 40	< 100	< 0.5	< 4	< 15	< 80	< 7
07/31	3800 ± 100	< 30	< 50	< 20 (a)	< 3	< 10	< 80	< 7
08/31		< 30	< 40	< 0.3	< 3	< 10	< 50	< 5
09/30		< 30	< 40	< 0.3	< 3	< 10	< 50	< 5
10/31	3600 ± 200	< 30	< 40	< 0.5	< 3	< 10	< 60	< 5
11/30		< 30	< 40	< 0.5	< 3	< 10	< 50	< 5
12/31		< 40	< 40	< 0.6	< 4	< 10	< 60	< 6
Avg. ± 2 s.d.	**3117 ± 1500**							

1 All gamma emitters other than those listed were <LLD.

(a) LLD could not be met due to delay in receipt of sample from the State of Virginia.

TABLE B-10: GAMMA EMITTER[1] CONCENTRATION IN SEDIMENT SILT

North Anna Power Station, Louisa County, Virginia - 1991

pCi/kg ± 2 Sigma | January 1 to December 31, 1991 | Page 1 of 1

Nuclide	STA-08 03/25	STA-09 03/25	STA-11 03/25	STA-08 09/16	STA-09 09/17	STA-11 09/16	Average ± 2 Sigma
Sr-89	(a)	(a)	(a)	< 300	< 70	< 90	-
Sr-90	(a)	(a)	(a)	< 30	160 ± 30	190 ± 40	175 ± 42
Be-7	< 400	< 300	< 400	< 500	< 600	< 700	-
K-40	6580 ± 660	6620 ± 660	15200 ± 1500	6730 ± 670	13800 ± 1400	16800 ± 1700	10955 ± 9636
Mn-54	< 30	< 30	< 40	< 40	< 40	< 50	-
Co-58	< 40	< 30	< 40	< 40	< 50	< 60	-
Co-60	64.2 ± 33.3	< 30	< 40	< 50	< 50	< 50	64.2 ± 33.3
Cs-134	< 40	< 40	< 50	< 40	< 50	< 60	-
Cs-137	< 50	112 ± 34	< 40	194 ± 42	< 50	< 50	153 ± 116
Ra-226	1680 ± 530	1620 ± 650	1760 ± 600	< 700	1040 ± 600	2090 ± 800	1638 ± 761
Th-228	1060 ± 110	1010 ± 100	1200 ± 120	816 ± 82	575 ± 58	1750 ± 170	1069 ± 796

1 All gamma emitters other than those listed were <LLD.
(a) Strontium 89/90 analyses performed annually.

TABLE B-11: GAMMA EMITTER[1] CONCENTRATION IN SHORELINE SOIL

North Anna Power Station, Louisa County, Virginia - 1991

pCi/kg ± 2 Sigma | January 1 to December 31, 1991 | Page 1 of 1

Nuclide	Station-09 03/21	Station-09 09/16	Average ± 2 Sigma
Sr-89	(a)	< 400	-
Sr-90	(a)	< 30	-
Be-7	< 400	< 600	-
K-40	6450 ± 640	4160 ± 660	5305 ± 3239
Mn-54	< 40	< 40	-
Co-58	< 40	< 30	-
Co-60	< 40	< 40	-
Cs-134	< 40	< 40	-
Cs-137	502 ± 52	< 50	502 ± 52
Ra-226	1700 ± 670	1170 ± 570	1435 ± 750
Th-228	879 ± 88	799 ± 80	839 ± 113

1 All gamma emitters other than those listed were <LLD.
(a) Strontium 89/90 analyses performed annually.

TABLE B-12: GAMMA EMITTER[1] CONCENTRATION IN MILK

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 |

MONTH	NUCLIDE	STATION-12	STATION-13
JANUARY	Sr-89	< 3	< 3
	Sr-90	0.71 ± 0.13	1.0 ± 0.2
	K-40	1420 ± 140	1220 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.1
FEBRUARY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1430 ± 140	1340 ± 130
	Cs-137	< 4	< 4
	I-131	< 0.4	< 0.5
MARCH	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1360 ± 140	1260 ± 130
	Cs-137	< 10	< 5
	I-131	< 0.3	< 0.3
APRIL	Sr-89	< 3	< 5
	Sr-90	< 0.4	1.4 ± 0.7
	K-40	1340 ± 130	1260 ± 130
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.4
MAY	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1220 ± 120	1240 ± 120
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
JUNE	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1390 ± 140	1430 ± 140
	Cs-137	< 4	< 4
	I-131	< 0.2	< 0.2
JULY	Sr-89	< 1	< 1
	Sr-90	1.1 ± 0.1	0.63 ± 0.12
	K-40	1150 ± 110	1200 ± 120
	Cs-137	< 6	< 5
	I-131	< 0.2	< 0.1

TABLE B-12: GAMMA EMITTER[1] CONCENTRATION IN MILK

North Anna Power Station, Louisa County, Virginia - 1991

pCi/l ± 2 Sigma | January 1 to December 31, 1991 | Page 2 of 2

MONTH	NUCLIDE	STATION-12	ST..TION-13
AUGUST	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1480 ± 150	1280 ± 130
	Cs-137	< 4	< 4
	I-131	< 0.1	< 0.2
SEPTEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1340 ± 130	1310 ± 130
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.1
OCTOBER	Sr-89	< 2	< 1
	Sr-90	0.96 ± 0.16	0.55 ± 0.13
	K-40	1250 ± 120	1200 ± 120
	Cs-137	< 4	< 5
	I-131	< 0.1	< 0.1
NOVEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1240 ± 120	1320 ± 130
	Cs-137	< 4	< 5
	I-131	< 0.3	< 0.3
DECEMBER	Sr-89	(a)	(a)
	Sr-90	(a)	(a)
	K-40	1010 ± 100	1300 ± 130
	Cs-137	< 5	< 5
	I-131	< 0.4	< 0.2

1 All gamma emitters other than those listed were <LLD.
(a) Strontium 89/90 analyses performed quarterly.

TABLE B-13: GAMMA EMITTER[1] CONCENTRATION IN FISH

North Anna Power Station, Louisa County, Virginia - 1991

pCi/kg ± 2 Sigma | January 1 to December 31, 1991 | Page 1 of 1

Collection Date	Station	Sample Type	K-40	Co-58	Cs-134	Cs-137
04/11/91	08	Sport Species	1240 ±530	< 50	< 30	57.9 ± 31.5
05/08/91	08	Catfish	831 ±329	< 40	< 40	99.4 ± 35.0
10/23/91	08	Catfish	2160 ±380	< 30	< 30	72.8 ± 29.6
10/25/91	08	Game Fish	1400 ±400	< 50	< 50	< 60
04/09/91	09	Sport Species	1660 ±430	< 40	< 30	< 40
04/09/91	09	Catfish	1080 ±340	< 40	< 30	< 50
04/08/91	25	Sport Species	1100 ±410	< 50	< 40	< 40
05/08/91	25	Catfish	1200 ±340	< 40	< 30	< 40
10/23/91	25	Catfish	1370 ±380	< 20	< 30	< 30
10/24/91	25	Game Fish	2050 ±480	< 40	< 40	< 40
Average ± 2 s.d.			**1409 ± 856**			**76.7 ± 42.0**

1 All gamma emitters other than those listed were <LLD.

TABLE B-14: GAMMA EMITTER[1] CONCENTRATION IN FOOD/VEGETATION

North Anna Power Station, Louisa County, Virginia - 1991

pCi/kg ± 2 Sigma | January 1 to December 31, 1991 |

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
STATION 14								
03/21	3600 ± 360	2820 ± 280	< 10	< 20	< 10	< 10	< 200	75.1 ±26.7
04/26	327 ± 64	5510 ± 550	< 5	< 9	< 7	< 8	< 100	< 10
05/22	< 90	7420 ± 740	< 7	< 10	< 8	< 8	< 100	< 10
06/19	807 ± 237	8080 ± 810	< 10	< 40	< 30	< 20	< 500	< 40
07/24	252 ± 131	5370 ± 540	< 10	< 20	< 10	23.5 ± 12.0	< 300	< 20
08/21	515 ± 156	4490 ± 450	< 20	< 20	< 10	< 10	< 200	< 20
09/18	< 500	4240 ± 420	< 10	< 60	< 30	< 30	< 500	< 60
10/16	2250 ± 230	4500 ± 450	< 9	< 30	< 20	< 20	< 400	< 40
STATION 15								
03/21	1100 ± 140	3600 ± 370	< 30	< 20	< 10	37.0 ± 12.2	< 200	< 20
04/26	990 ± 99	7790 ± 780	< 6	< 10	< 10	< 9	< 200	< 20
05/22	490 ± 234	10400 ± 1000	< 10	< 40	< 30	< 30	< 600	< 50
06/19	1540 ± 560	10200 ± 1000	< 10	< 80	< 50	448 ± 51	< 900	844 ± 84
07/24	< 5.6	7450 ± 750	< 20	< 70	< 40	< 40	< 900	< 80
08/21	748 ± 99	13000 ± 1300	< 50	< 10	< 9	< 9	233 ± 102	< 10
09/18	1010 ± 370	30500 ± 3100	< 9	< 70	< 40	< 40	< 600	< 60
10/16	3370 ± 340	5000 ± 500	< 20	< 30	< 20	< 20	< 400	< 30
STATION 16								
03/21	1820 ± 180	3350 ± 340	< 10	< 10	< 9	< 10	< 200	29.5 ± 14.0
04/26	1160 ± 120	15300 ± 1500	< 5	< 10	< 9	< 9	< 100	< 10
05/22	360 ± 131	6410 ± 640	< 8	< 20	< 10	< 20	< 300	< 20
06/19	745 ± 227	16200 ± 1600	< 30	< 40	< 30	161 ± 21	1070 ± 320	641 ± 64
07/24	< 200	7250 ± 720	< 30	< 30	< 20	< 20	< 300	< 30
08/21	1100 ± 350	3380 ± 340	< 10	< 60	< 30	< 30	< 700	< 60
09/18	567 ± 246	10400 ± 1000	< 8	< 40	< 20	< 20	< 500	< 40
10/16	692 ± 143	4810 ± 480	< 10	< 20	< 10	< 10	< 300	< 30
STATION 21								
03/21	974 ± 225	3210 ± 320	< 20	< 30	< 20	256 ± 26	< 500	154 ± 19
04/26	1250 ± 150	10400 ± 1000	< 7	< 20	< 20	355 ± 36	437 ± 252	191 ± 19
05/22	321 ± 111	10100 ± 1000	< 10	< 20	< 10	71.7 ± 1.3	< 200	< 20
06/19	3140 ± 810	17500 ± 1800	< 30	< 100	< 30	389 ± 66	< 1000	723 ± 116
07/24	456 ± 207	6810 ± 680	< 10	< 40	< 20	51.3 ± 20.1	< 400	< 40
08/21	981 ± 200	9790 ± 980	< 10	< 30	< 20	165 ± 18	< 300	< 30
09/18	< 700	10000 ± 1000	< 20	< 90	< 40	230 ± 46	< 900	< 90
10/16	1420 ± 150	4700 ± 470	< 10	< 20	< 10	< 20	< 200	< 20

TABLE B-14: GAMMA EMITTER[1] CONCENTRATION IN FOOD/VEGETATION

North Anna Power Station, Louisa County, Virginia - 1991

pCi/kg ± 2 Sigma | January 1 to December 31, 1991 |

Collection Date	Be-7	K-40	I-131	Ru-103	Cs-134	Cs-137	Ra-226	Th-228
STATION 23								
03/21[a]	7710 ± 770	20000 ± 2000	< 10	< 100	< 80	< 80	< 1000	617 ± 105
04/26	1240 ± 120	6460 ± 650	< 8	< 10	< 9	77.0 ± 8.0	< 200	53.4 ± 11.6
05/22	404 ± 116	5930 ± 590	< 8	< 10	< 10	48.5 ± 10.2	< 200	< 20
06/19	< 70	383 ± 52	< 20	< 9	< 6	< 6	< 100	< 10
07/24	< 700	29100 ± 2900	< 10	< 90	< 50	< 50	< 800	< 80
08/21	406 ± 147	6530 ± 650	< 10	< 20	< 10	< 10	< 200	< 20
09/18	< 600	12700 ± 1300	< 8	< 80	< 40	< 40	< 600	< 60
10/16	3060 ± 310	7660 ± 770	< 30	< 30	< 20	35.4 ± 18.2	< 400	< 40
Avg. ± 2 s.d.	**1100 ± 2958**	**8969 ± 12873**				**168 ± 291**	**580 ± 873**	**370 ± 658**

1 All gamma emitters other than those listed were <LLD.

a Only 48 gm. could be packed into a marinelli; sample counted for 37 hours.

TABLE B-15: DIRECT RADIATION MEASUREMENTS -- QUARTERLY AND ANNUAL TLD RESULTS

North Anna Power Station, Louisa County, Virginia - 1991

mR/Std. Month (30.4 days) ± 2 Sigma January 1 to December 31, 1991

Station Number	First Qtr 12/27/90 03/27/91	Second Qtr 03/27/91 06/26/91	Third Qtr 06/26/91 09/27/91	Fourth qtr 09/27/91 12/28/91	Quarterly Average	Annual TLD 06/27/90 07/03/91
01	9.1 ± 0.6	7.4 ± 0.4	6.5 ± 1.2	6.9 ± 0.3	7.5 ± 2.3	6.8 ± 0.3
02	5.1 ± 0.2	5.2 ± 0.5	4.1 ± 0.1	4.4 ± 0.2	4.7 ± 1.1	4.3 ± 0.2
03	5.1 ± 0.2	4.9 ± 0.7	4.3 ± 0.6	4.4 ± 0.3	4.7 ± 0.7	3.9 ± 0.2
04	5.0 ± 0.1	4.2 ± 0.2	4.2 ± 0.1	4.9 ± 0.4	4.6 ± 0.9	4.6 ± 0.2
05	6.3 ± 0.2	5.2 ± 0.3	5.4 ± 0.2	5.6 ± 0.3	5.6 ± 1.0	5.4 ± 0.3
05A	6.2 ± 0.2	4.7 ± 0.2	5.1 ± 0.4	5.5 ± 0.2	5.4 ± 1.3	5.0 ± 0.3
06	8.3 ± 0.7	6.3 ± 0.4	6.5 ± 0.7	6.9 ± 0.4	7.0 ± 1.8	5.8 ± 0.1
07	5.7 ± 0.1	4.9 ± 0.3	5.1 ± 0.2	4.3 ± 0.3	5.0 ± 1.2	5.0 ± 0.6
21	5.6 ± 0.2	4.8 ± 0.2	5.0 ± 0.2	5.4 ± 0.3	5.2 ± 0.7	5.2 ± 0.3
22	6.9 ± 0.6	6.3 ± 0.5	6.8 ± 0.3	6.3 ± 1.0	6.6 ± 0.6	5.7 ± 0.2
23	7.4 ± 0.6	6.7 ± 0.3	6.6 ± 0.5	7.0 ± 1.7	6.9 ± 0.7	6.4 ± 0.3
24	4.4 ± 0.8	3.4 ± 0.2	3.5 ± 0.2	3.8 ± 0.4	3.8 ± 0.9	3.4 ± 0.1
Average ± 2 s.d.	**6.3 ± 2.9**	**5.3 ± 2.3**	**5.3 ± 2.2**	**5.3 ± 2.2**	**5.6 ± 0.9**	**5.1 ± 2.0**

TABLE B-16: DIRECT RADIATION MEASUREMENTS -- SECTOR QUARTERLY TLD RESULTS

North Anna Power Station, Louisa County, Virginia - 1991

mR/Std Month (30.4 days) ± 2 Sigma January 1 to December 31, 1991

Station Number	First Qtr 12/27-03/27 (a)	Second Qtr 03/28-06/27	Third Qtr 06/27-09/27	Fourth qtr 09/27-12/28	Average ± 2 S.d.
N-1	7.0 ± 0.3	6.8 ± 0.4	5.6 ± 0.5	6.5 ± 0.1	6.5 ± 1.2
N-2	6.4 ± 0.3	4.4 ± 0.2	4.4 ± 0.3	5.5 ± 0.2	5.2 ± 1.9
NNE-3	7.2 ± 0.2	6.7 ± 0.2	6.5 ± 0.6	6.5 ± 0.2	6.7 ± 0.7
NNE-4	6.2 ± 0.4	5.1 ± 0.3	5.8 ± 0.7	4.7 ± 0.1	5.5 ± 1.4
NE-5	8.8 ± 0.4	6.9 ± 0.3	9.0 ± 1.1	7.8 ± 1.4	8.1 ± 1.9
NE-6	4.6 ± 0.2	3.9 ± 0.3	3.7 ± 0.2	3.9 ± 0.3	4.0 ± 0.8
ENE-7	7.1 ± 0.6	5.7 ± 0.2	6.0 ± 0.7	6.5 ± 1.1	6.3 ± 1.2
ENE-8	5.4 ± 0.8	3.8 ± 0.3	4.4 ± 0.1	4.6 ± 0.5	4.6 ± 1.3
E-9	7.3 ± 0.4	6.7 ± 0.7	7.7 ± 0.6	7.0 ± 0.4	7.2 ± 0.9
E-10	6.0 ± 0.3	5.9 ± 0.5	5.0 ± 0.3	4.7 ± 0.4	5.4 ± 1.3
ESE-11	6.1 ± 0.3	6.1 ± 0.1	5.5 ± 0.2	6.7 ± 0.2	6.1 ± 1.0
ESE-12	7.7 ± 0.3	6.8 ± 0.4	6.3 ± 0.6	6.1 ± 0.4	6.7 ± 1.4
SE-13	6.7 ± 0.1	6.1 ± 0.1	6.6 ± 0.2	5.9 ± 0.4	6.3 ± 0.8
SE-14	8.6 ± 0.5	8.9 ± 0.7	7.8 ± 0.2	8.7 ± 1.3	8.5 ± 1.0
SSE-15	7.2 ± 0.2	6.6 ± 0.5	6.2 ± 0.7	6.4 ± 0.1	6.6 ± 0.9
SSE-16	5.8 ± 0.3	5.5 ± 0.4	5.3 ± 1.5	4.2 ± 0.2	5.2 ± 1.4
S-17	8.1 ± 0.3	7.6 ± 0.4	8.0 ± 0.2	7.7 ± 0.3	7.9 ± 0.5
S-18	5.0 ± 0.5	3.3 ± 0.1	3.8 ± 0.3	3.5 ± 0.4	3.9 ± 1.5
SSW-19	8.6 ± 0.4	8.6 ± 0.5	8.1 ± 0.3	8.0 ± 0.1	8.3 ± 0.6
SSW-20	4.8 ± 0.3	4.4 ± 0.2	4.4 ± 0.2	4.0 ± 0.6	4.4 ± 0.7
SW-21	9.9 ± 0.3	8.8 ± 0.8	8.4 ± 0.4	7.9 ± 0.3	8.9 ± 1.7
SW-22	6.6 ± 0.4	7.4 ± 1.2	5.6 ± 0.3	5.6 ± 0.2	6.3 ± 1.7
W-23	6.2 ± 0.2	5.6 ± 0.4	5.6 ± 0.7	4.6 ± 0.3	5.5 ± 1.3
W-24	7.2 ± 0.3	5.9 ± 0.1	6.0 ± 0.2	5.9 ± 0.3	6.3 ± 1.3
W-25	8.2 ± 0.5	6.5 ± 0.4	7.4 ± 0.9	6.5 ± 0.5	7.2 ± 1.6
W 26	(b)	4.4 ± 0.1	4.5 ± 0.3	4.2 ± 0.2	4.4 ± 0.3
WNW-27	6.5 ± 0.2	4.7 ± 0.1	4.7 ± 0.5	4.7 ± 0.2	5.2 ± 1.8
WNW-28	5.8 ± 0.1	5.1 ± 0.3	5.7 ± 0.5	4.6 ± 0.3	5.3 ± 1.1
NW-29	8.2 ± 0.2	7.0 ± 0.2	7.5 ± 0.2	6.8 ± 0.3	7.4 ± 1.2
NW-30	5.3 ± 0.4	4.3 ± 0.2	5.3 ± 0.5	4.1 ± 0.1	4.9 ± 1.7
NNW-31	7.4 ± 0.2	5.0 ± 0.2	6.1 ± 0.5	4.5 ± 0.3	5.8 ± 2.6
NNW-32	6.2 ± 0.1	4.9 ± 0.2	5.5 ± 0.8	4.5 ± 0.3	5.3 ± 1.5
N-33	6.6 ± 0.1	6.5 ± 0.6	6.5 ± 0.5	5.4 ± 0.3	6.3 ± 1.1
N-34	6.7 ± 1.0	4.8 ± 0.5	5.9 ± 0.3	4.5 ± 0.4	5.5 ± 2.0
NNE-35	7.1 ± 0.3	6.1 ± 0.4	7.2 ± 0.3	6.1 ± 0.1	6.6 ± 1.2
NNE-36	6.3 ± 0.1	6.1 ± 1.0	5.1 ± 0.1	4.9 ± 0.3	5.6 ± 1.4
NE-37	8.6 ± 0.9	7.4 ± 0.2	7.8 ± 0.8	7.4 ± 0.4	7.8 ± 1.1
NE-38	3.9 ± 0.1	4.0 ± 0.3	4.2 ± 0.2	3.1 ± 0.1	3.8 ± 1.0
ENE-39	7.7 ± 0.4	5.9 ± 0.2	6.7 ± 0.5	6.0 ± 0.2	6.6 ± 1.7
ENE-40	5.7 ± 0.3	3.9 ± 0.3	4.5 ± 0.1	4.8 ± 0.4	4.7 ± 1.5
E-41	7.0 ± 0.7	6.2 ± 0.3	7.3 ± 0.5	7.4 ± 0.5	7.0 ± 1.1
E-42	6.5 ± 1.8	5.0 ± 0.2	5.0 ± 0.4	5.7 ± 0.2	5.6 ± 1.4
ESE-43	6.6 ± 0.1	5.6 ± 0.3	7.3 ± 0.5	6.4 ± 0.6	6.5 ± 1.4
ESE-44	7.5 ± 0.4	6.4 ± 0.1	7.8 ± 0.4	6.4 ± 0.8	7.0 ± 1.5
SE-45	7.3 ± 0.1	7.2 ± 0.1	6.5 ± 0.2	7.4 ± 0.4	7.1 ± 0.8
SE-46	8.8 ± 0.1	8.0 ± 0.3	9.0 ± 0.5	8.9 ± 2.8	8.7 ± 0.9
SSE-47	8.0 ± 0.1	6.4 ± 0.3	7.1 ± 0.6	6.1 ± 0.5	6.9 ± 1.7
SSE-48	6.3 ± 0.3	4.9 ± 0.1	5.2 ± 0.2	5.5 ± 0.4	5.5 ± 1.2
S-49	9.4 ± 0.2	7.4 ± 0.2	7.6 ± 0.7	7.1 ± 0.3	7.9 ± 2.1
S-50	5.1 ± 0.1	3.8 ± 0.3	4.1 ± 0.3	3.5 ± 0.4	4.1 ± 1.4
SSW-51	9.2 ± 0.4	8.8 ± 0.4	9.3 ± 0.4	9.7 ± 0.7	9.3 ± 0.7

TABLE B-16: DIRECT RADIATION MEASUREMENTS -- SECTOR QUARTERLY TLD RESULTS

North Anna Power Station, Louisa County, Virginia - 1991

mR/Std. Month (30.4 days) ± 2 Sigma January 1 to December 31, 1991

Station Number	First Qtr 12/27-03/27 (a)	Second Qtr 03/28-06/27	Third Qtr 06/27-09/27	Fourth qtr 09/27-12/28	Average ± 2 S.d.
SSW-52	4.8 ± 0.5	3.9 ± 0.1	4.5 ± 0.2	3.6 ± 0.2	4.2 ± 1.1
SW-53	9.8 ± 0.5	8.6 ± 0.4	10.6 ± 0.3	7.9 ± 0.4	9.2 ± 2.4
SW-54	7.1 ± 0.6	6.3 ± 0.4	6.2 ± 0.6	5.5 ± 0.2	6.3 ± 1.3
WSW-55	5.6 ± 0.1	4.9 ± 0.1	5.5 ± 0.2	4.5 ± 0.3	5.1 ± 1.0
WSW-56	6.0 ± 0.2	6.0 ± 0.2	5.7 ± 0.3	4.6 ± 0.2	5.6 ± 1.3
W-57	8.3 ± 1.1	7.1 ± 0.2	7.9 ± 0.6	6.5 ± 0.9	7.5 ± 1.6
W-58	5.8 ± 0.2 (c)	5.9 ± 0.5	5.9 ± 1.6	4.6 ± 0.2	5.6 ± 1.3
WNW-59	5.1 ± 0.3	5.4 ± 0.2	5.6 ± 0.2	4.3 ± 0.1	5.2 ± 1.2
WNW-60	5.6 ± 0.5	5.1 ± 0.3	6.2 ± 0.1	4.8 ± 0.4	5.4 ± 1.2
NW-61	8.3 ± 0.6	8.3 ± 0.8	8.8 ± 1.1	8.1 ± 0.3	8.4 ± 0.6
NW-62	5.5 ± 0.1	4.5 ± 0.2	4.9 ± 0.7	4.9 ± 0.4	5.0 ± 0.8
NNW-63	7.3 ± 0.3	5.3 ± 0.3	5.4 ± 0.4	4.9 ± 0.4	5.7 ± 2.1
NNW-64	5.8 ± 0.4	5.4 ± 0.4	6.4 ± 0.2	5.6 ± 0.2	5.8 ± 0.9
C-1	5.6 ± 0.1	5.7 ± 0.7	5.4 ± 0.2	5.4 ± 0.5	5.5 ± 0.3
C-2	6.0 ± 0.8	5.5 ± 0.4	5.6 ± 0.7	4.9 ± 0.3	5.5 ± 0.9
C-3	5.4 ± 0.8	4.5 ± 0.6	4.2 ± 0.2	3.4 ± 0.2	4.4 ± 1.7
C-4	4.9 ± 0.2	4.1 ± 0.4	4.5 ± 0.3	3.5 ± 0.2	4.3 ± 1.2
C-5	4.3 ± 0.1	4.6 ± 0.3	5.1 ± 1.1	3.9 ± 0.2	4.5 ± 1.0
C-6	5.2 ± 0.1	4.5 ± 0.3	4.9 ± 0.2	3.9 ± 0.4	4.6 ± 1.1
C-7	6.6 ± 0.2	5.9 ± 0.8	5.8 ± 0.4	5.8 ± 0.4	6.0 ± 0.8
C-8	7.4 ± 0.7	5.9 ± 0.3	5.5 ± 0.6	5.8 ± 0.7	6.2 ± 1.7
Average ± 2 s.d.	**6.7 ± 2.7**	**5.9 ± 2.7**	**6.1 ± 2.9**	**5.6 ± 3.0**	**6.1 ± 2.9**

(a) Several stations had collection dates of 12/27/90 to 03/28/91.
(b) TLD not found.
(c) TLD found on ground with damaged casing.

LAND USE CENSUS[1]

North Anna Power Station, Louisa County, Virginia

KM = Kilometer | January 1 to December 31, 1991 |

Sector	Direction	Nearest Resident KM (Mile)	Nearest Site Boundary KM (Mile)	Nearest Meat Animal[1] KM (Mile)	Nearest Veg Garden 500 ft.[2] KM (Mile)
A	N	2.17 (1.35)	1.40 (0.87)	3.23 (2.01)	3.07 (1.91)
B	NNE	2.17 (1.35)	1.36 (0.85)	4.22 (2.62)	2.17 (1.35)
C	NE	1.90 (1.18)	1.32 (0.82)	2.51 (1.56)	2.51 (1.56)
D	ENE	3.17 (1.97)	1.31 (0.81)	4.12 (2.56)	3.17 (1.97)
E	E	2.03 (1.26)	1.33 (0.83)	NONE	2.53 (1.57)
F	ESE	2.60 (1.62)	1.37 (0.85)	7.74 (4.81)	5.63 (3.50)
G	SE	2.20 ()1.37	1.41 (0.88)	2.20 (1.37)	2.20 (1.37)
H	SSE	1.47 (0.91)	1.47 (0.91)	8.83 (2.38)	1.47 (0.91)
J	S	1.67 (1.04)	1.52 (0.94)	2.32 (1.44)	1.67 (1.04)
K	SSW	2.30 (1.43)	1.62 (1.01)	5.92 (3.68)	2.30 (1.43)
L	SW	4.83 (3.00)	1.70 (1.06)	NONE	4.83 (3.00)
M	WSW	2.86 (1.78)	1.75 (1.09)	2.86 (1.78)	2.86 (1.78)
N	W	2.46 (1.53)	1.71 (1.06)	NONE	6.58 (4.09)
P	WNW	2.20 (1.37)	1.64 (1.02)	7.13 (4.43)	4.09 (2.54)
Q	NW	1.63 (1.01)	1.56 (0.97)	NONE	1.77 (1.10)
R	NNW	1.72 (1.07)	1.45 (0.90)	3.57 (2.22)	1.91 (1.19)

1 No milk cows or goats within a five mile radius of North Anna Power Station

COMPARISON OF THE 1991 TO 1990 LAND USE CENSUS

I. Changes in nearest resident as compared to previous year.
   a. NW Sector: 1.90 Km (1990) to 1.63 Km (1991)
   b. NNW Sector: 1.91 Km (1990) to 1.72 Km (1991)

II. No changes were observed in the nearest site boundaries distances.

III. No changes were observed in the nearest milk cow status.

IV. Changes in nearest ;vegetable garden as compared to previous year.
   a. ENE Sector: 4.04 Km (1990) to 3.17 Km (1991)
   b. ESE Sector: 6.93 Km (1990) to 5.63 Km (1991)
   c. S Sector: 1.96 Km (1990) to 1.67 Km (1991)
   d. W Sector: 3.91 Km (1990) to 6.58 Km (1991)
   e. WNW Sector: 4.92 Km (1990) to 4.09 (1991)
   f. NW Sector: 1.90 Km (1990) to 1.77 Km (1991)

V. No changes were observed in the nearest milk goat status.

VI. Changes in nearest meat animal as compared to previous year.
   a. SSector: 3.20 Km (1990) to 2.32 Km (1991)
   b. WSW Sector: NONE (1990) to 2.86 Km (1991)
   c. W Sector: 7.13 Km (1990) to NONE (1991)

Land Use Census Data Shown on Maps, Section 3, Pages 33-37

ANALYTICAL PROCEDURES SYNOPSIS

ANALYTICAL PROCEDURES SYNOPSIS

Appendix D is a synopsis of the analytical procedures performed on samples collected for the North Anna Power Station's Radiological Environmental Monitoring Program. All analyses have been mutually agreed upon by VEPCO and Teledyne Isotopes and include those recommended by the USNRC Branch Technical Position, Rev. 1, November 1979.

DETERMINATION OF GROSS BETA ACTIVITY IN WATER SAMPLES

Introduction

The procedures described in this section are used to measure the overall radioactivity of water samples without identifying the radioactive species present. No chemical separation techniques are involved.

One liter of the sample is evaporated on a hot plate. A smaller volume may be used if the sample has a significant salt content as measured by a conductivity meter. If requested by the customer, the sample is filtered through No. 54 filter paper before evaporation, removing particles greater than 30 microns in size.

After evaporating to a small volume in a beaker, the sample is rinsed into a 2-inch diameter stainless steel planchette which is stamped with a concentric ring pattern to distribute residue evenly. Final evaporation to dryness takes place under heat lamps.

Residue mass is determined by weighing the planchette before and after mounting the sample. The planchette is counted for beta activity on an automatic proportional counter. Results are calculated using empirical self-absorption curves which allow for the change in effective counting efficiency caused by the residue mass.

Detection Capability

Detection capability depends upon the sample volume actually represented on the planchette, the background and the efficiency of the counting instrument, and upon self-absorption of beta particles by the mounted sample. Because the radioactive species are not identified, no decay corrections are made and the reported activity refers to the counting time.

The minimum detectable level (MDL) for water samples is nominally 1.6 picoCuries per liter for gross beta at the 4.66 sigma level (1.0 pCi/l at the 2.83 sigma level), assuming that 1 liter of sample is used and that $\frac{1}{2}$ gram of sample residue is mounted on the planchette. These figures are based upon a counting time of 50 minutes and upon representative values of counting efficiency and background of 0.2 and 1.2 cpm, respectively.

The MDL becomes significantly lower as the mount weight decreases because of reduced self-absorption. At a zero mount weight, the 4.66 sigma MDL for gross beta is 0.9 picoCuries per liter. These values reflect a beta counting efficiency of 0.38.

GROSS BETA ANALYSIS OF SAMPLES

Air Particulates

After a delay of five or more days, allowing for the radon-222 and radon-220 (thoron) daughter products to decay, the filters are counted in a gas-flow proportional counter. An unused air particulate filter, supplied by the customer, is counted as the blank.

Calculations of the results, the two sigma error and the lower limit of detection (LLD):

RESULT (pCi/m^3) = $((S/T) - (B/t))/(2.22\ V\ E)$

TWO SIGMA ERROR (pCi/m^3) = $2((S/T^2) + (B/t^2))^{1/2}/(2.22\ V\ E)$

LLD (pCi/m^3) = $4.66\ (B^{1/2})/(2.22\ V\ E\ t)$

where:

S = Gross counts of sample including blank
B = Counts of blank
E = Counting efficiency
T = Number of minutes sample was counted
t = Number of minutes blank was counted
V = Sample aliquot size (cubic meters)

ANALYSIS OF SAMPLES FOR TRITIUM

Water

Approximately 2 ml of water are converted to hydrogen by passing the water, heated to its vapor state, over a granular zinc conversion column heated to 400° C. The hydrogen is loaded into a one liter proportional detector and the volume is determined by recording the pressure.

The proportional detector is passively shielded by lead and steel and an electronic, anticoincidence system provides additional shielding from cosmic rays.

Calculation of the results, the two sigma error and the lower limit detection (LLD) in pCi/l:

$$\text{RESULT} = 2(3.234)\, T_N\, V_N(C_G - B)/(C_N V_S)$$

$$\text{TWO SIGMA ERROR} = 2(3.234)\, T_N\, V_N(E)^{1/2}/(C_N V_S)$$

$$\text{LLD} = 3.3\,(3.234) T_N\, V_N(E)^{1/2}/(C_N V_S)$$

where:

T_N	=	tritium units of the standard
3.234	=	conversion factor changing tritium units to pCi/l
V_N	=	volume of the standard used to calibrate the efficiency of the detector in psia
V_S	=	volume of the sample loaded into the detector in psia
C_N	=	the net cpm of the standard of volume V_N
C_G	=	the gross cpm of the sample of volume V_S
B	=	the background of the detector in cpm
Δt	=	counting time for the sample
E	=	$S/T^2 + B/t^2$

ANALYSIS OF SAMPLES FOR STRONTIUM-89 AND -90

Water

Stable strontium carrier is added to 1 liter of sample and the volume is reduced by evaporation. Strontium is precipitated as $Sr(NO_3)_2$ using nitric acid. A barium scavenge and an iron (ferric hydroxide) scavenge are performed followed by addition of stable yttrium carrier and a minimum of 5 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrCO_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Milk

Stable strontium carrier is added to 1 liter of sample and the sample is first evaporated, then ashed in a muffle furnace. The ash is dissolved and strontium is precipitated as phosphate, then is dissolved and precipitated as $SrN0_3$ using fuming (90%) nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Soil and Sediment

The sample is first dried under heat lamps and an aliquot is taken. Stable strontium carrier is added and the sample is leached in hydrachloric acid. The mixture is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(N0_3)_2$ using fuming (90& nitric acid. A barium chromate scavenge and an iron (ferric hydroxide) scavenge are then performed. Stable yttrium carrier is added and the sample is allowed to stand for a minimum of 5 days for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer Sr-90 activity. Strontium-89 activity is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with an 80 mg/cm2 aluminum absorber for low level beta counting.

Organic Solids

A wet portion of the sample is dried and then ashed in a muffle furnace. Stable strontium carrier is added and the ash is leached in hydrochloric acid. The sample is filtered and strontium is precipitated from the liquid portion as phosphate. Strontium is precipitated as $Sr(N0_3)$ using fuming (90%) nitric acid. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a minimum of 5 days period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta

counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is co ered with an 80 mg/cm^2 aluminum absorber for low level beta counting.

Air Particulates

Stable strontium carrier is added to the sample and it is leached in nitric acid to bring deposits into solution. The mixture is then filtered and the filtrate is reduced in volume by evaporation. Strontium is precipitated as $Sr(N0_3)_2$ using fuming (90%) nitric acid. A barium scavenge is used to remove some interfering species. An iron (ferric hydroxide) scavenge is performed, followed by addition of stable yttrium carrier and a 7 to 10 day period for yttrium ingrowth. Yttrium is then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate is mounted on a nylon planchette and is counted in a low level beta counter to infer strontium-90 activity. Strontium-89 activity is determined by precipitating $SrC0_3$ from the sample after yttrium separation. This precipitate is mounted on a nylon planchette and is covered with 80 mg/cm^2 aluminum absorber for low level beta counting.

Calculations of the results, two sigma errors and lower limits of detection (LLD) are expressed in activity of pCi/volume or pCi/mass:

RESULT Sr-89 = $(N/Dt-B_C-B_A)/(2.22\ V\ Y_S\ DF_{SR-89}\ E_{SR-89})$

TWO SIGMA ERROR Sr-89 = $2((N/Dt+B_C+B_A)/\Delta t)^{1/2}/(2.22\ V\ Y_S\ DF_{SR-89}\ E_{SR-89})$

LLD Sr-89 = $4.66((B_C+B_A)/\Delta t)^{1/2}/(2.22\ V\ YS\ DF_{SR-89}\ E_{SR-89})$

RESULT Sr-90 = $(N/\Delta t - B)/(2.22\ V\ Y_1\ Y_2\ DF\ IF\ E)$

TWO SIGMA ERROR Sr-90 = $2((N/\Delta t+B)/\Delta t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ DF\ E\ IF))$

LLD Sr-90 = $4.66(B/\Delta t)^{1/2}/(2.22\ V\ Y_1\ Y_2\ IF\ DF\ E)$

WHERE:

N	=	total counts from sample (counts)
Δt	=	counting time for sample (min)
B_C	=	background rate of counter (cpm) using absorber configuration
2.22	=	dpm/pCi
V	=	volume or weight of sample analyzed
B_A	=	background addition from Sr-90 and ingrowth of Y-90
B_A	=	0.016 (K) + (K) $E_{Y/abs}$) (IG_{Y-90})
Y_S	=	chemical yield of strontium
DF_{SR-89}	=	decay factor from the mid collection date to the counting date for SR-89
E_{SR-89}	=	efficiency of the counter for SR-89 with the 80 mg/cm.sq. aluminum absorber
K	=	$(N\Delta t - B_C)_{Y-90}/(E_{Y-90}\ IF_{Y-90}\ DF_{Y-90}Y_1)$
DF_{Y-90})	=	the decay factor for Y-90 from the "milk" time to the mid count time
E_{Y-90}	=	efficiency of the counter for Y-90

$IF_{Y\text{-}90}$	=	ingrowth factor for Y-90 from scavenge time to milking time
$IG_{Y\text{-}90}$	=	the ingrowth factor for Y-90 into the strontium mount from the "milk" time to the mid count time
0.016	=	the efficiency of measuring ^{89}R-90 through a No. 6 absorber
$EY_{/abs}$	=	the efficiency of counting Y-90 through a No. 6 absorber
B	=	background rate of counter (cpm)
Y_1	=	chemical yield of yttrium
Y_2	=	chemical yield of strontium
DF	=	decay factor of yttrium from the radiochemical milking time to the mid count time
E	=	efficiency of the counter for Y-90
IF	=	ingrowth factor for Y-90 from scavenge time to the radiochemical milking time

ANALYSIS OF SAMPLES FOR IODINE-131

Milk or Water

Two liters of sample are first equilibrated with stable iodide carrier. A batch treatment with anion exchange resin is used to remove iodine from the sample. The iodine is then stripped from the resin with sodium hypochlorite solution, is reduced with hydroxylamine hydrochloride and is extracted into carbon tetrachloride as free iodine. It is then back-extracted as iodide into sodium bisulfite solution and is precipitated as palladium iodide. The sodium bisulfite solution and is precipitated as palladium iodide. The precipitate is weighed for chemical yield and is mounted on a nylon planchette for low level beta counting. The chemical yield is corrected by measuring the stable iodide content of the milk or the water with a specific ion electrode.

Calculations of results, two sigma error and the lower limit of detection (LLD) in pCi/l:

RESULT		=	$(N/\Delta t\text{-}B)/(2.22\ E\ V\ Y\ DF)$
TWO SIGMA ERROR		=	$2((N/\Delta t+B)/\Delta t)^{1/2}/(2.22\ E\ V\ Y\ DF)$
LLD		=	$= 4.66(B/\Delta t)^{1/2}/(2.22\ E\ V\ Y\ DF)$
where:	N	=	total counts from sample (counts)
	Δt	=	counting time for sample (min)
	B	=	background rate of counter (cpm)
	2.22	=	dpm/pCi
	V	=	volume or weight of sample analyzed
	Y	=	chemical yield of the mount or sample counted
	DF	=	decay factor from the collection to the counting date
	E	=	efficiency of the counter for I-131, corrected for self absorption effects by the formula
	E	=	$E_s(\exp\text{-}0.0061M)/(\exp\text{-}0.0061M_s)$
	E_s	=	efficiency of the counter determined from an I-131 standard mount
	Ms	=	mass of PdI_2 on the standard mount, mg
	M	=	mass of PDI_2 on the sample mount, mg

GAMMA SPECTROMETRY OF SAMPLES

Milk and Water

A 1.0 liter Marinelli beaker is filled with a representative aliquot of the sample. The sample is then counted for approximately 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Dried Solids Other Than Soils and Sediments

A large quantity of the sample is dried at a low temperature, less than 100°C. As much as possible (up to the total sample) is loaded into a tared 1-liter Marinelli and weighed. The sample is then counted for approximately 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Fish

As much as possible (up to the total sample) of the edible portion of the sample is loaded into a tared Marinelli and weighed. The sample is then counted for approximately 1000 minutes with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

Soils and Sediments

Soils and sediments are dried at a low temperature, less than 100°C. The soil or sediment is loaded fully into a tared, standard 300 cc container and weighed. The sample is then counted for approximately six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height and analysis.

Charcoal Cartridges (Air Iodine)

Charcoal cartridges are counted up to five at a time, with one positioned on the face of a Ge(Li) detector and up to four on the side of the Ge(Li) detector. Each Ge(Li) detector is calibrated for both positions. The detection limit for I-131 of each charcoal cartridge can be determined (assuming no positive I-131) uniquely from the volume of air which passed through it. In the event I-131 is observed in the initial counting of a set, each charcoal cartridge is then counted separately, positioned on the face of the detector.

Air Particulate

The thirteen airborne particulate filters for a quarterly composite for each field station are aligned one in front of another and then counted for at least six hours with a shielded Ge(Li) detector coupled to a mini-computer-based data acquisition system which performs pulse height analysis.

A mini-computer software program defines peaks by certain changes in the slope of the spectrum. The program also compares the energy of each peak with a library of peaks for isotope identification and then performs the radioactivity calculation using the appropriate fractional gamma ray abundance, half life, detector efficiency, and net counts in the peak region. The calculation of results, two sigma error and the lower limit of detection (LLD) in pCi/volume of pCi/mass:

$$\text{RESULT} = (S-B)/(2.22\ t\ E\ V\ F\ DF)$$

$$\text{TWO SIGMA ERROR} = 2(S+B)^{1/2}/(2.22\ t\ E\ V\ F\ DF)$$

LLD = $4.66(B)^{1/2}/(2.22\ t\ E\ V\ F\ DF)$

where:

S = Area, in counts, of sample peak and background (region of spectrum of interest)

B = Background area, in counts under sample peak, determined by a linear interpolation of the representative backgrounds on either side of the peak

t = length of time in minutes the sample was counted

2.22 = dpm/pCi

E = detector efficiency for energy of interest and geometry of sample

V = sample aliquot size (liters, cubic meters, kilograms, or grams)

F = fractional gamma abundance (specific for each emitted gamma)

DF = decay factor from the mid-collection date to the counting date

ENVIRONMENTAL DOSIMETRY

Teledyne Isotopes uses a $CaSO_4$:Dy thermoluminescent dosimeter (TLD) which the company manufactures. This material has a high light output, negligible thermally induced signal loss (fading), and negligible self dosing. The energy response curve (as well as all other features) satisfies NRC Reg. Guide 4.13. Transit doses are accounted for by use of separate TLDs.

Following the field exposure period the TLDs are placed in a Teledyne Isotopes Model 8300. One fourth of the rectangular TLD is heated at a time and the measured light emission (luminescence) is recorded. The TLD is then annealed and exposed to a known Cs-137 dose; each area is then read again. This provides a calibration of each area of each TLD after every field use. The transit controls are read in the same manner.

Calculations of results and the two sigma error in net milliRoentgen (mR):

$$\text{RESULT} = D = (D_1+D_2+D_3+D_4)/4$$

$$\text{TWO SIGMA ERROR} = 2((D_1-D)^2+(D_2-D)^2+(D_3-D)^2+(D_4-D)^2)/3)^{1/2}$$

WHERE: D_1 = the net mR of area 1 of the TLD, and similarly for D_2, D_3, and D_4

$D_1 = I_1 K/R_1 - A$

I_1 = the instrument reading of the field dose in area 1

K = the known exposure by the Cs-137 source

R_1 = the instrument reading due to the Cs-137 dose on area 1

A = average dose in mR, calculated in similar manner as above, of the transit control TLDs

D = the average net mR of all 4 areas of the TLD.

EPA Interlaboratory Comparison Program

Teledyne Isotopes participates in the US EPA Interlaboratory Comparison Program to the fullest extent possible. That is, we participate in the program for all radioactive isotopes prepared and at the maximum frequency of availability. In this section trending graphs (since 1981) and the 1991 data summary tables are presented for isotopes in the various sample media applicable to the Surry Power Station's Radiological Environmental Monitoring Program. The footnotes of the table discuss investigations of problems encountered in a few cases and the steps taken to prevent reoccurrence.

VEPCO – NORTH ANNA POWER STATION

US EPA INTERLABORATORY COMPARISON PROGRAM 1991

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EPA Preparation	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	**Warning ***Action
01/11/91	03/07/91	04/15/91	Water	Sr-89	5.0 ± 5.0	5.00 ± 0.00	0.00	
				Sr-90	5.0 ± 5.0	5.00 ± 0.00	0.00	
01/25/91	02/21/91	03/18/91	Water	Gross Alpha	5.0 ± 5.0	9.00 ± 1.00	1.39	
				Gross Beta	5.0 ± 5.0	7.00 ± 0.00	0.69	
02/08/91	03/22/91	04/19/91	Water	Co-60	40.0 ± 5.0	39.33 ± 3.06	-0.23	
				Zn-65	149.0 ± 15.0	147.00 ± 1.00	-0.23	
				Ru-106	186.0 ± 19.0	176.67 ± 17.56	-0.85	
				Cs-134	8.0 ± 5.0	7.33 ± 0.58	-0.23	
				Cs-137	8.0 ± 5.0	7.67 ± 3.21	-0.12	
				Ba-133	75.0 ± 8.0	75.67 ± 5.51	0.14	
02/15/91	03/18/91	05/03/91	Water	I-131	75.0 ± 8.0	80.00 ± 5.29	1.08	
02/22/91	03/22/91	04/15/91	Water	H-3	4418.0 ± 442.0	4500 ± 173.21	0.32	
03/08/91	05/06/91	05/31/91	Water	Ra-226	31.8 ± 4.8	28.33 ± 4.73	-1.25	
				Ra-228	21.1 ± 5.3	16.67 ± 2.08	-1.45	
03/29/91	06/06/91	07/02/91	Air Filter	Gross Alpha	25.0 ± 6.0	42.67 ± 0.58	5.10	***(c)
				Gross Beta	124.0 ± 6.0	126.67 ± 5.77	0.77	
				Sr-90	40.0 ± 5.0	37.00 ± 1.00	-1.04	
				Cs-137	40.0 ± 5.0	43.00 ± 5.29	1.04	
04/16/91	07/25/91		Water	Gross Alpha	54.0 ± 14.0	59.67 ± 4.04	0.70	
				Gross Beta	115.0 ± 17.0	110.00 ± 0.00	-0.51	
				Sr-89	28.0 ± 5.0	31.00 ± 1.00	1.04	
				Sr-90	26.0 ± 5.0	21.00 ± 0.00	-1.73	
				Cs-134	24.0 ± 5.0	25.00 ± 1.00	0.35	
				Cs-137	25.0 ± 5.0	24.00 ± 1.73	-0.35	
04/26/91	06/28/91	07/31/91	Milk	Sr-89	32.0 ± 5.0	24.00 ± 3.00	-2.77	** (d)
				Sr-90	32.0 ± 5.0	26.33 ± 2.08	-1.96	
				I-131	60.0 ± 6.0	53.33 ± 2.31	-1.92	
				Cs-137	49.0 ± 5.0	52.67 ± 1.53	1.27	
				K	1650.0 ± 83.0	1590.00 ± 81.85	-1.25	

VEPCO -- NORTH ANNA POWER STATION

US EPA INTERLABORATORY COMPARISON PROGRAM 1991

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EPA Preparation	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Results(b)	Norm Dev. (Known)	**Warning ***Action
05/10/911	05/06/91	05/10/91	Water	Sr-89	39.0 ± 5.0	38.67 ± 4.51	-0.12	
				Sr-90	24.0 ± 5.0	22.00 ± 1.73	-0.69	
05/17/91	06/13/91	07/08/91	Water	Gross Alpha	24.0 ± 6.0	24.33 ± 2.52	0.10	
				Gross Beta	46.0 ± 5.0	50.33 ± 1.53	1.50	
06/07/91	07/18/91	08/12/91	Water	Co-60	10.0 ± 5.0	10.33 ± 0.58	0.12	
				Zn-65	108.0 ± 11.0	106.0 ± 2.65	-0.31	
				Ru-106	149.0 ± 15.0	136.67 ± 3.79	-1.42	
				Cs-134	15.0 ± 5.0	13.67 ± 1.53	-0.46	
				Cs-137	14.0 ± 5.0	13.67 ± 1.53	-0.30	
				Ba-133	62.0 ± 6.0	56.33 ± 1.53	-1.64	
06/21/91	07/18/91	08/12/91	Water	H-3	12480 ± 1248.0	12833.33 ± 115.50	0.49	
07/12/91	10/08/91	09/06/91	Water	Ra-226	15.9 ± 2.4	15.0 ± 1.00	-0.65	
				Ra-228	16.7 ± 4.2	14.33 ± 2.31	-0.96	
08/09/91	10/08/91	09/04/91	Water	I-131	20.0 ± 6.0	19.33 ± 0.58	-0.19	
08/30/91	10/25/91	12/04/91	Air Filter	Gr-Alpha	25.0 ± 6.0	27.00 ± 2.00	0.58	
				Gr-Beta	92.0 ± 10.0	100.00 ± 0.00	1.39	
				Sr-90	30.0 ± 5.0	27.67 ± 2.89	-0.81	
				Cs-137	30.0 ± 5.0	33.33 ± 3.21	1.15	
09/13/91	10/25/91	12/12/91	Water	Sr-89	49.0 ± 5.0	50.67 ± 2.89	0.58	
				Sr-90	25.0 ± 5.0	26.00 ± 1.00	0.35	
09/20/91	10/17/91	11/04/91	Water	Gr-Alpha	10.0 ± 5.0	11.67 ± 0.58	0.58	
				Gr-Beta	20.0 ± 5.0	21.00 ± 0.00	0.35	
09/27 /91	12/06/91	12/23/91	Milk	Sr-89	25.0 ± 5.0	21.00 ± 2.65	-1.39	
				Sr-90	25.0 ± 5.0	19.00 ± 0.00	-2.08	**(d)
				I-131	108.0 ± 11.0	113.33 ± 5.77	0.84	
				Cs-137	30.0 ± 5.0	29.00 ± 3.61	-0.35	
				K	1740.0 ± 87.0	1503.33 ± 75.06	-4.71	***(e)

VEPCO – NORTH ANNA POWER STATION

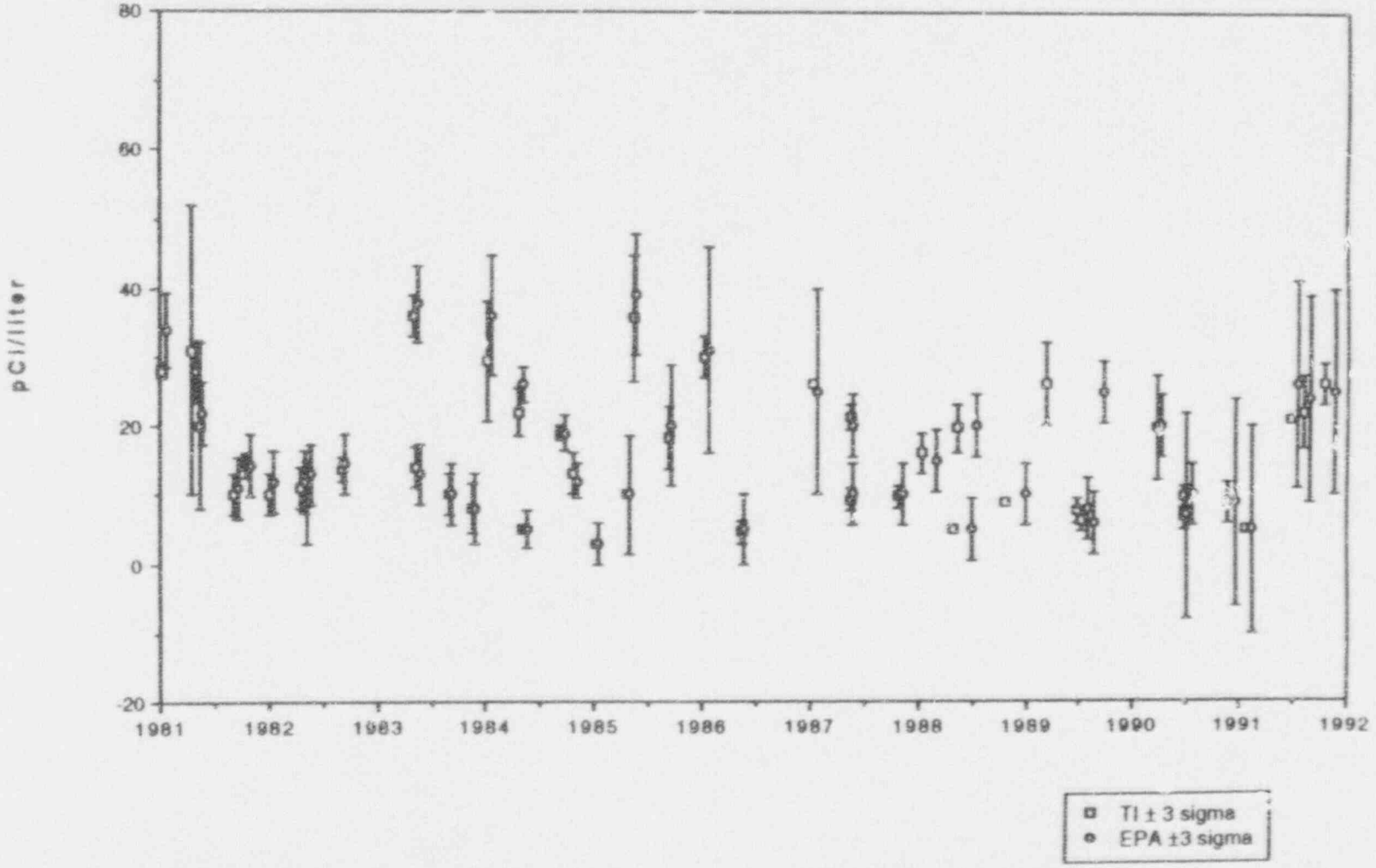
US EPA INTERLABORATORY COMPARISON PROGRAM 1991

EPA Preparation	Date TI Mailed Results	Date EPA Issued Results	Media	Nuclide	EPA Results(a)	TI Result(b)	Norm Dev. (Known)	**Warning ***Action
10/04/91	11/15/91	12/12/91	Water	Co-60	29.0 ± 5.0	30.33 ± 2.08	0.46	
				Zn-65	73.0 ± 7.0	72.67 ± 7.09	-0.08	
				Ru-106	199.0 ± 20.0	197.67 ± 7.51	-0.12	
				Cs-134	10.0 ± 5.0	10.33 ± 0.58	0.12	
				Cs-137	10.0 ± 5.0	11.33 ± 0.58	0.46	
				Ba-133	98.0 ± 10.0	97.00 ± 8.72	-0.17	
10/18/91	11/15/91	12/04/91	Water	H-3	2454.0 ± 353.0	2333.33 ± 57.74	-0.59	
10/22/91	01/02/92	01/21/92	Water	Gross Alpha	82.0 ± 21.0	55.00 ± 4.36	-2.23	***(f)
				Ra-226	22.0 ± 3.3	21.00 ± 2.65	-0.52	
				Ra-228	22.2 ± 5.0	18.00 ± 1.00	-1.30	
				Gross Beta	65.0 ± 10.0	56.00 ± 1.00	-1.56	
				Sr-89	10.0 ± 5.0	10.67 ± 2.08	0.23	
				Sr-90	10.0 ± 5.0	9.33 ± 0.58	-0.23	
				Co-60	20.0 ± 5.0	19.67 ± 0.58	-0.12	
				Cs-134	10.0 ± 5.0	10.33 ± 2.08	0.12	
				Cs-137	11.0 ± 5.0	13.67 ± 0.58	0.92	
11/08/91	01/02/92	01/21/92	Water	Ra-226	6.5 ± 1.0	5.37 ± 0.32	-1.96	
				Ra-228	8.1 ± 2.0	7.90 ± 1.20	-0.17	

(a) Average ± experimental sigma.
(b) Expected laboratory precision (1 sigma, 1 determination).
(c) The sample presents a different counting geometry. The EPA deposits activity in a 3/4 inch diameter circle, on a plastic disk approximately 3/32 inch thick. A special calibration for EPA filters will be performed. The laboratory has obtained blank filters from the Las Vegas facility, and will simulate their deposits.
(d) The cause for the deviation is believed to be erroneously high strontium yields, probably caused by incomplete separation of calcium. The laboratory has investigated carrier concentrations and pipeting techniques, and have found them to be correct. Further aspects of analysts' techniques are being tested. The laboratory has received a new strontium extraction material developed at Argonne National Laboratory. Experiments with this method to achieve better separation of calcium were completed and procedure PRO-032-105 was implemented on 2/1/92.
(e) There is no apparent cause for the low K-40 results. Two other isotopes spiked in the sample were in good agreement with EPA values. Unit conversions were reviewed and found to be correctly applied. Possible background errors in geometry were investigated and found to have an insignificant effect.
(f) Probable failure to transfer all sample residue to the counting planchet. Analysts are being tested using in-house and other EPA spikes.

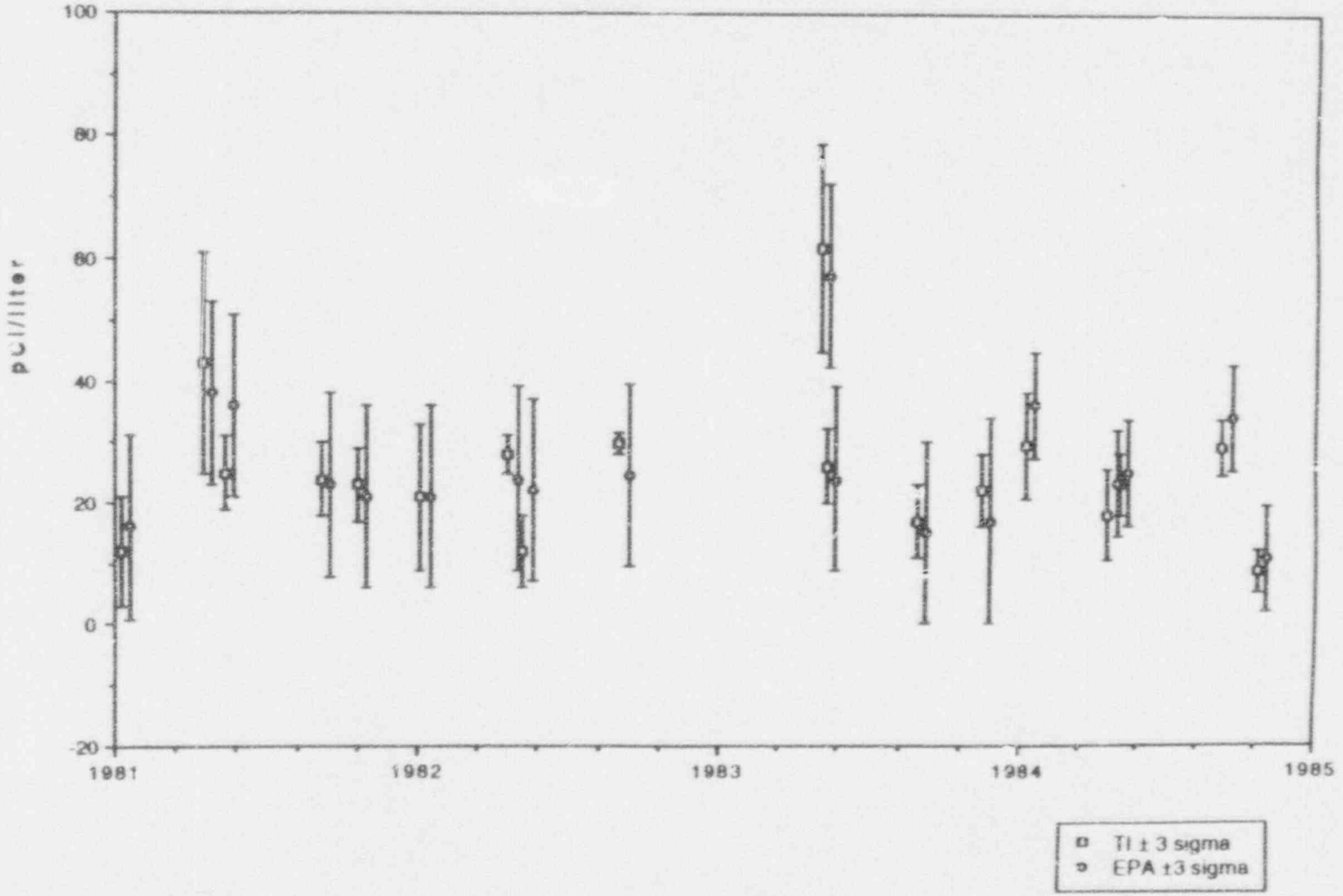
US EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN WATER



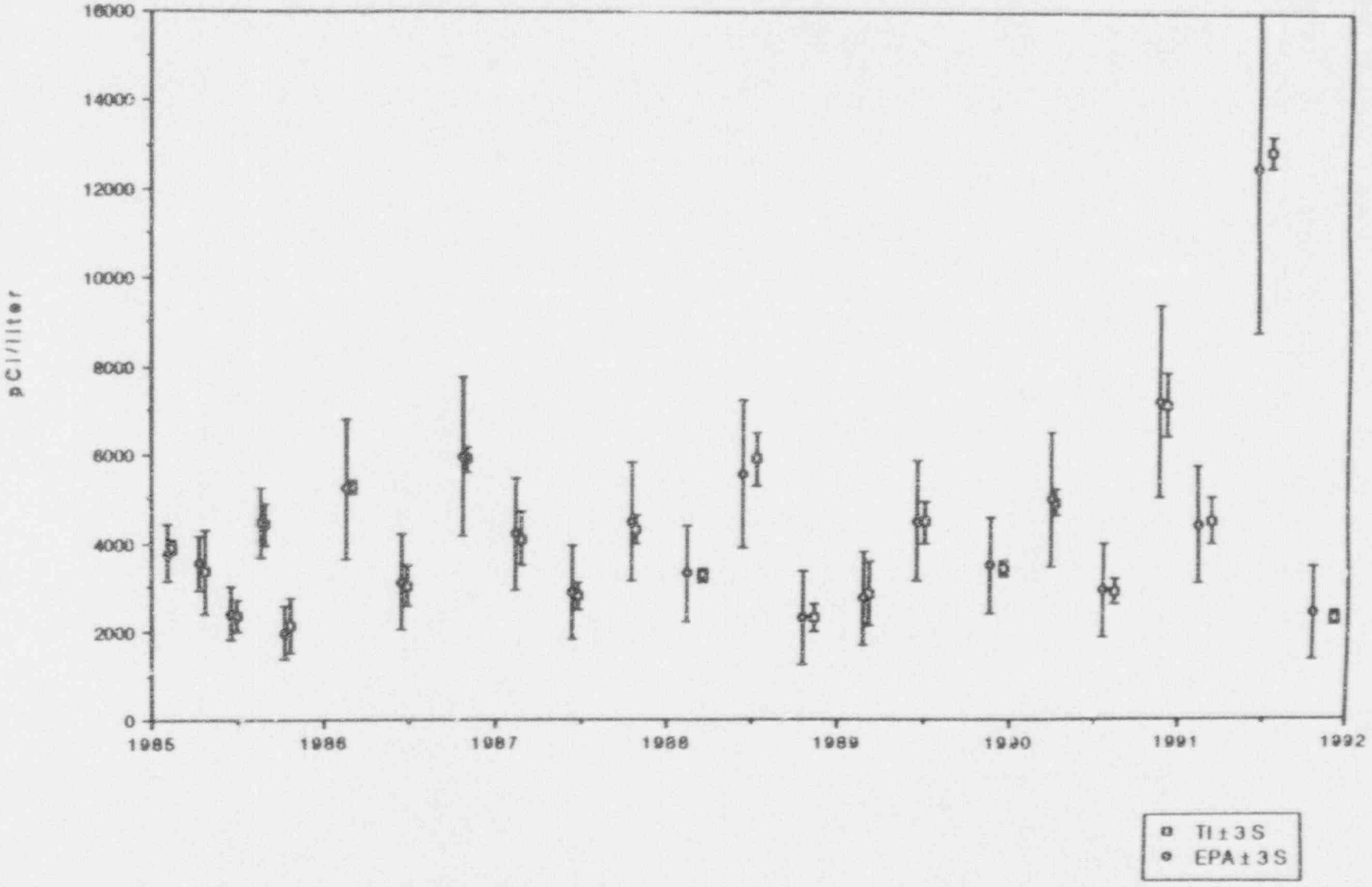
US EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN WATER



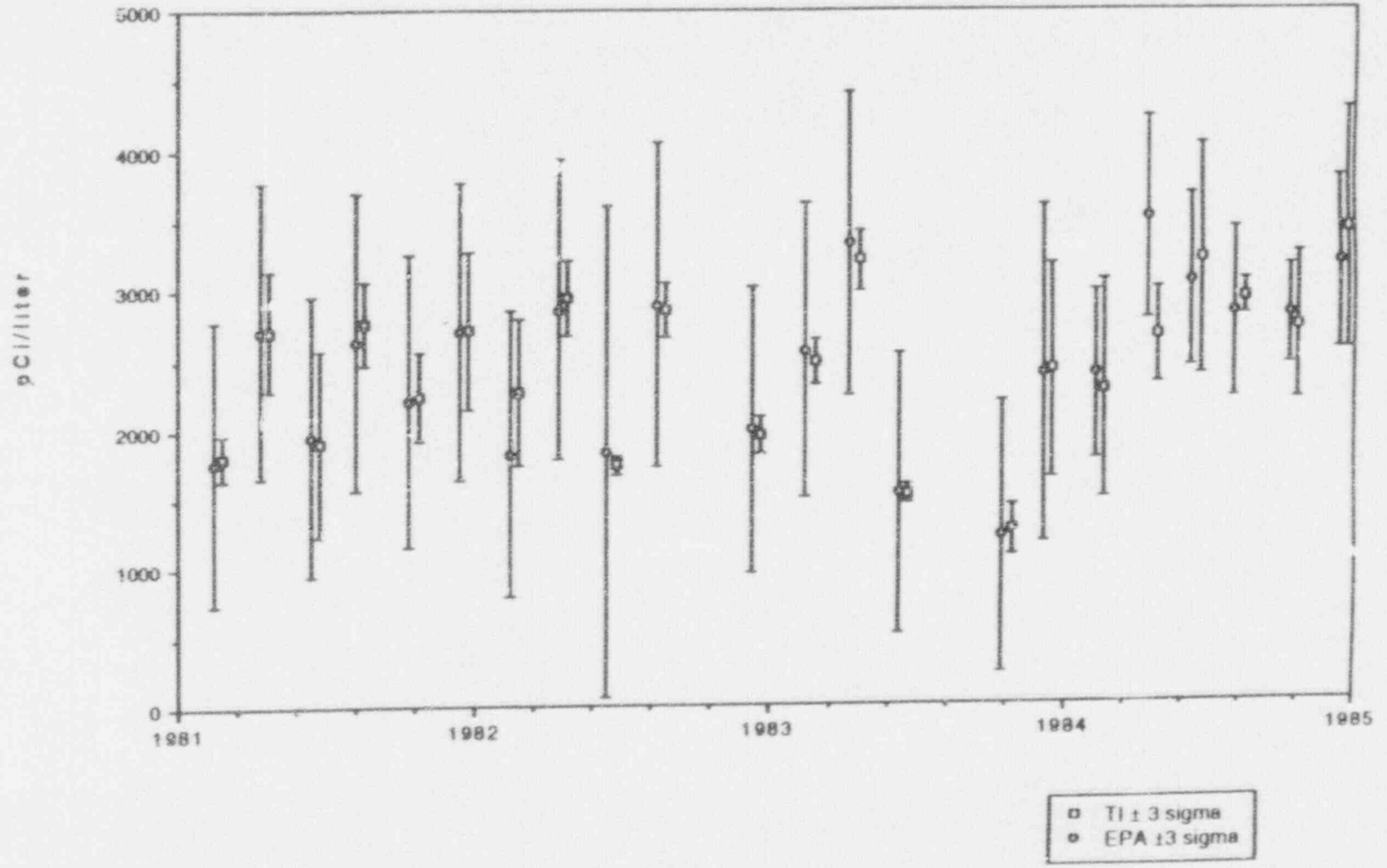
US EPA CROSS CHECK PROGRAM

TRITIUM IN WATER (Cont.)



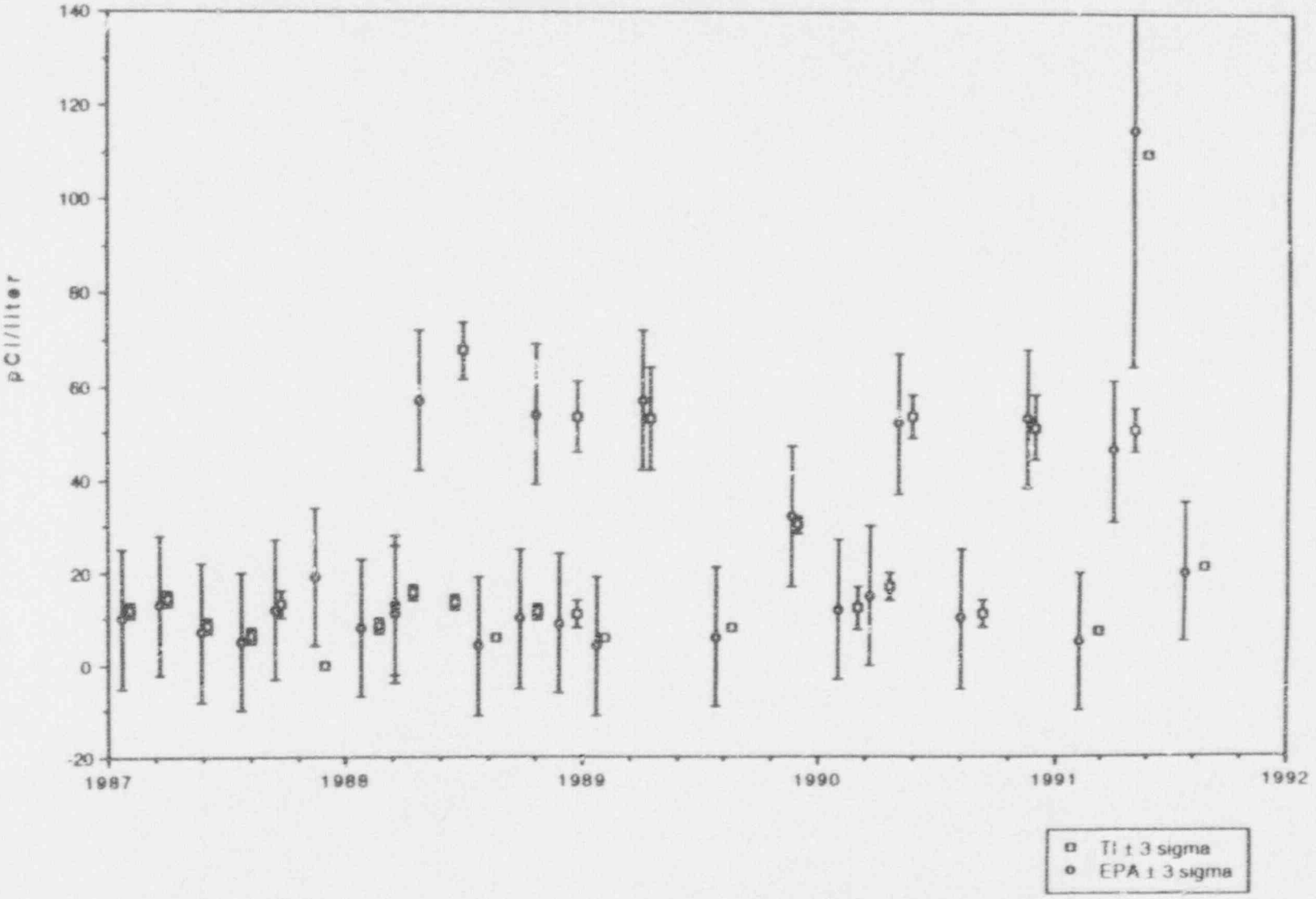
US EPA CROSS CHECK PROGRAM

TRITIUM IN WATER



US EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER (Cont.)



US EPA CROSS CHECK PROGRAM

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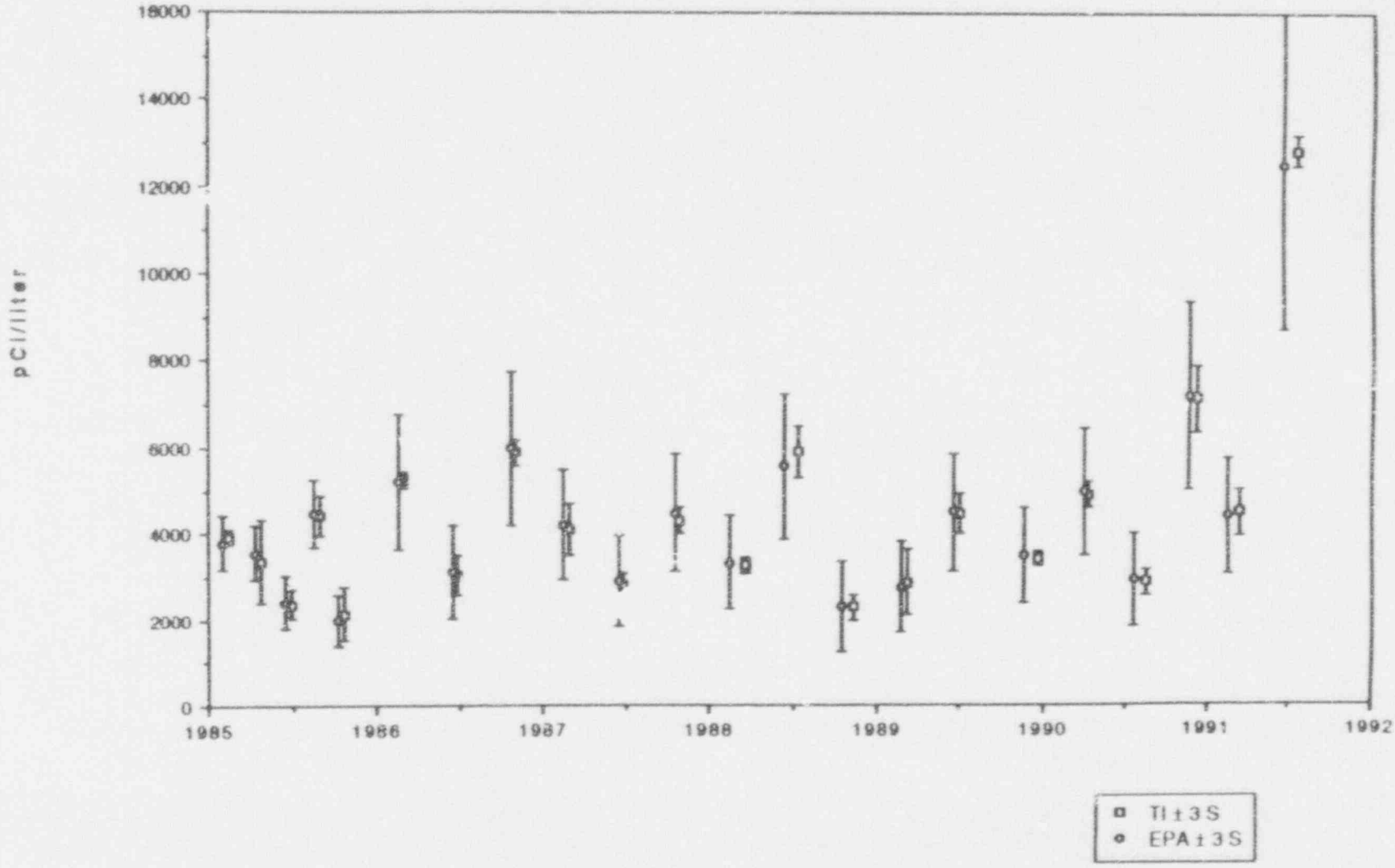
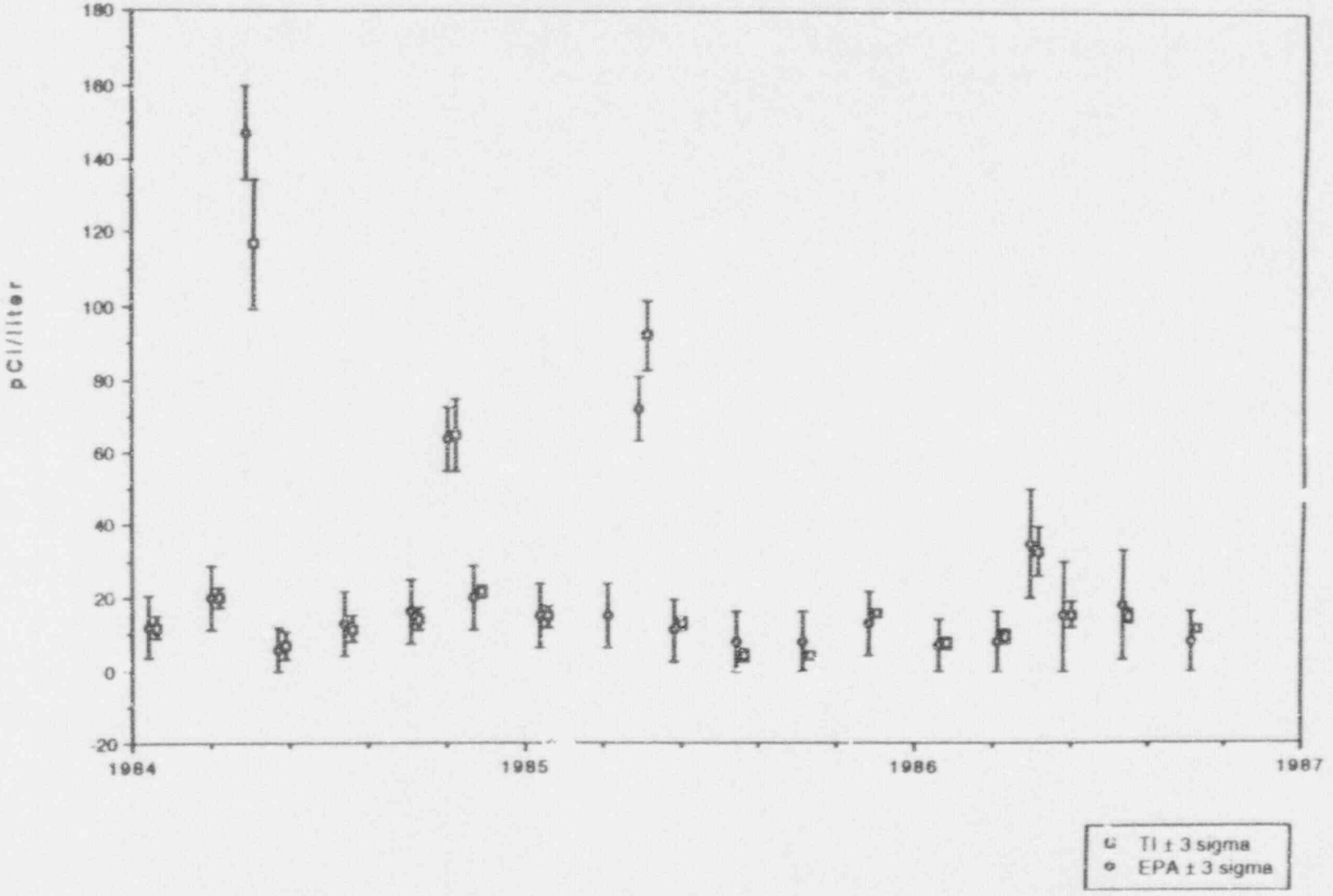


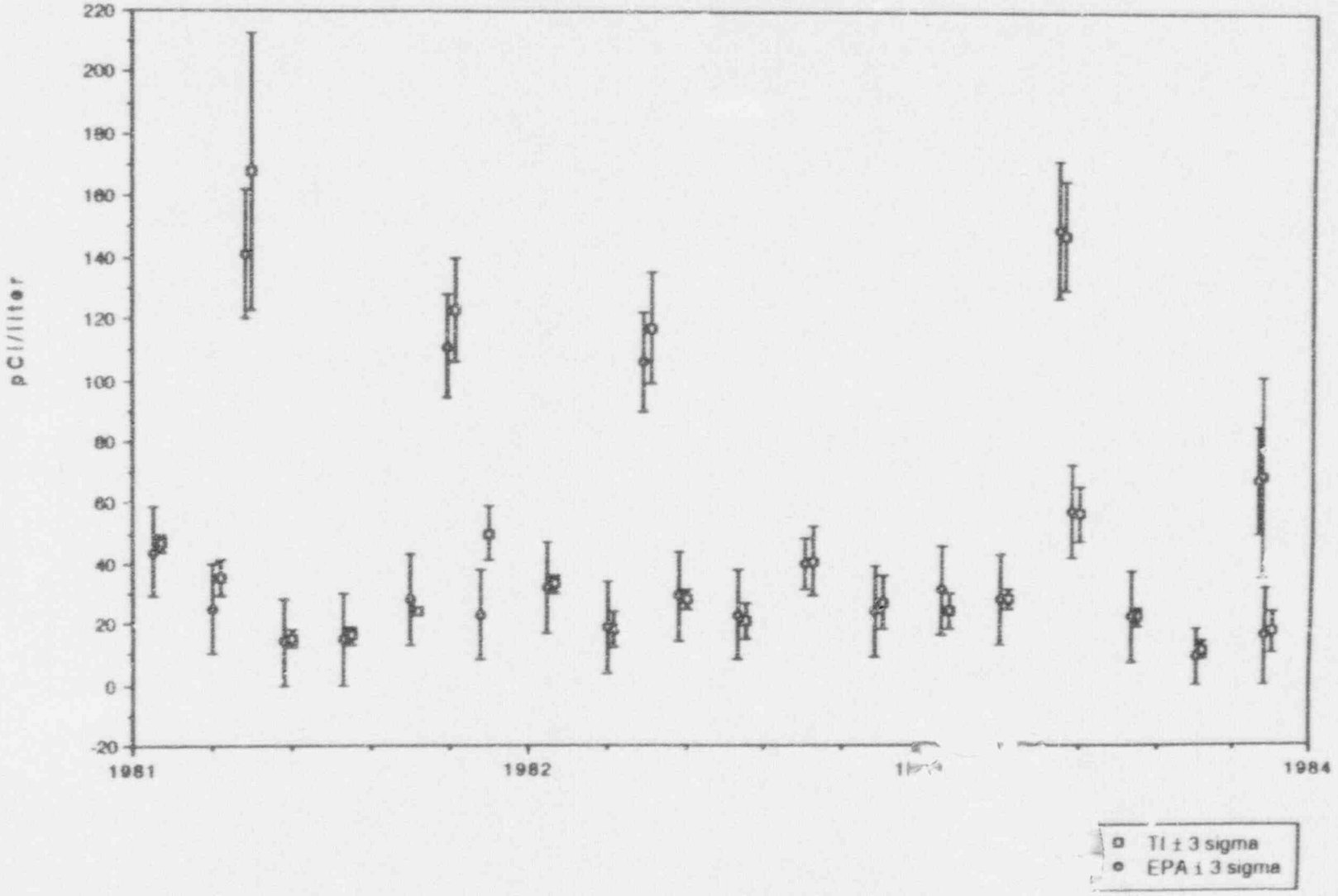
US EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER



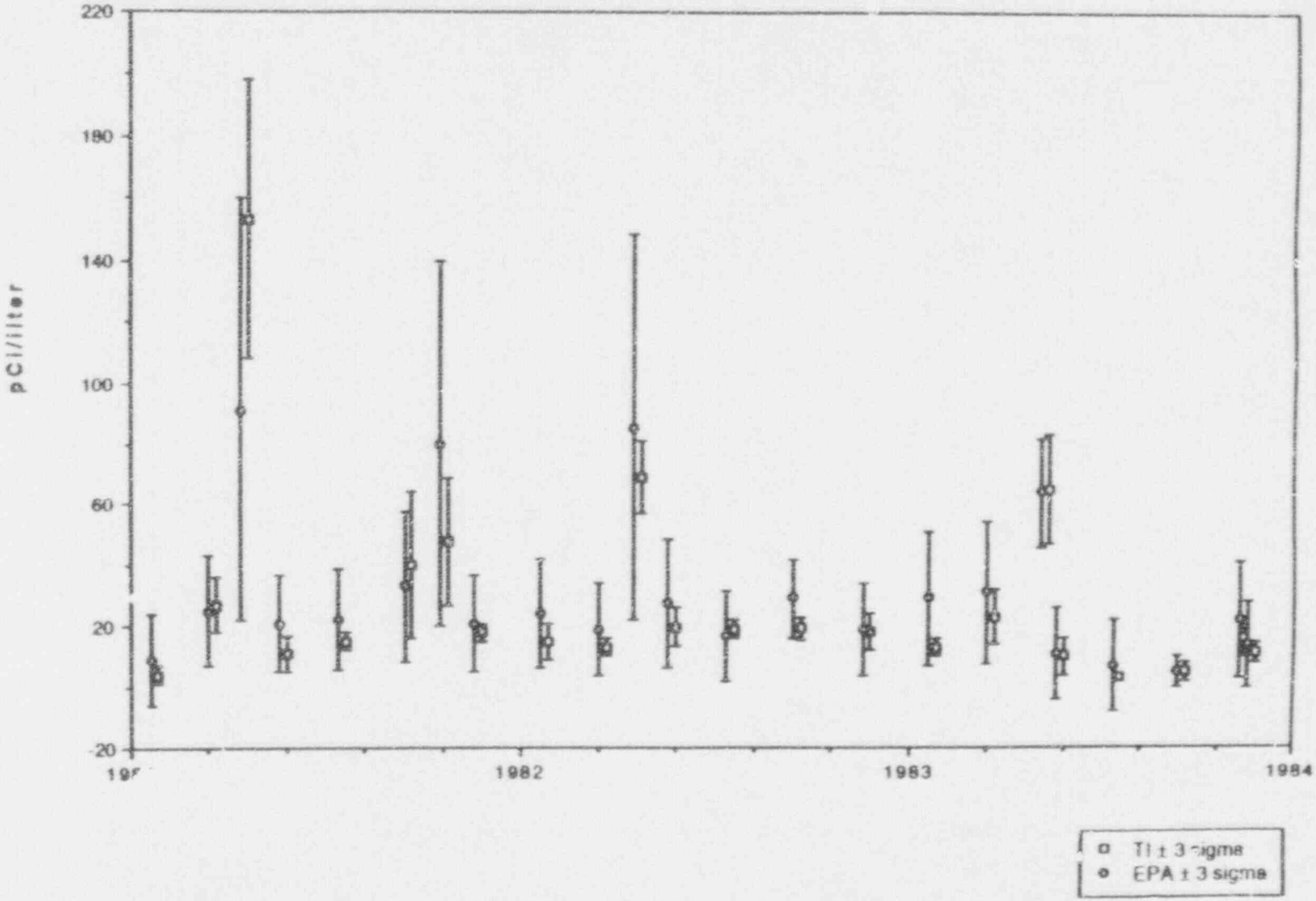
US EPA CROSS CHECK PROGRAM

GROSS BETA IN WATER



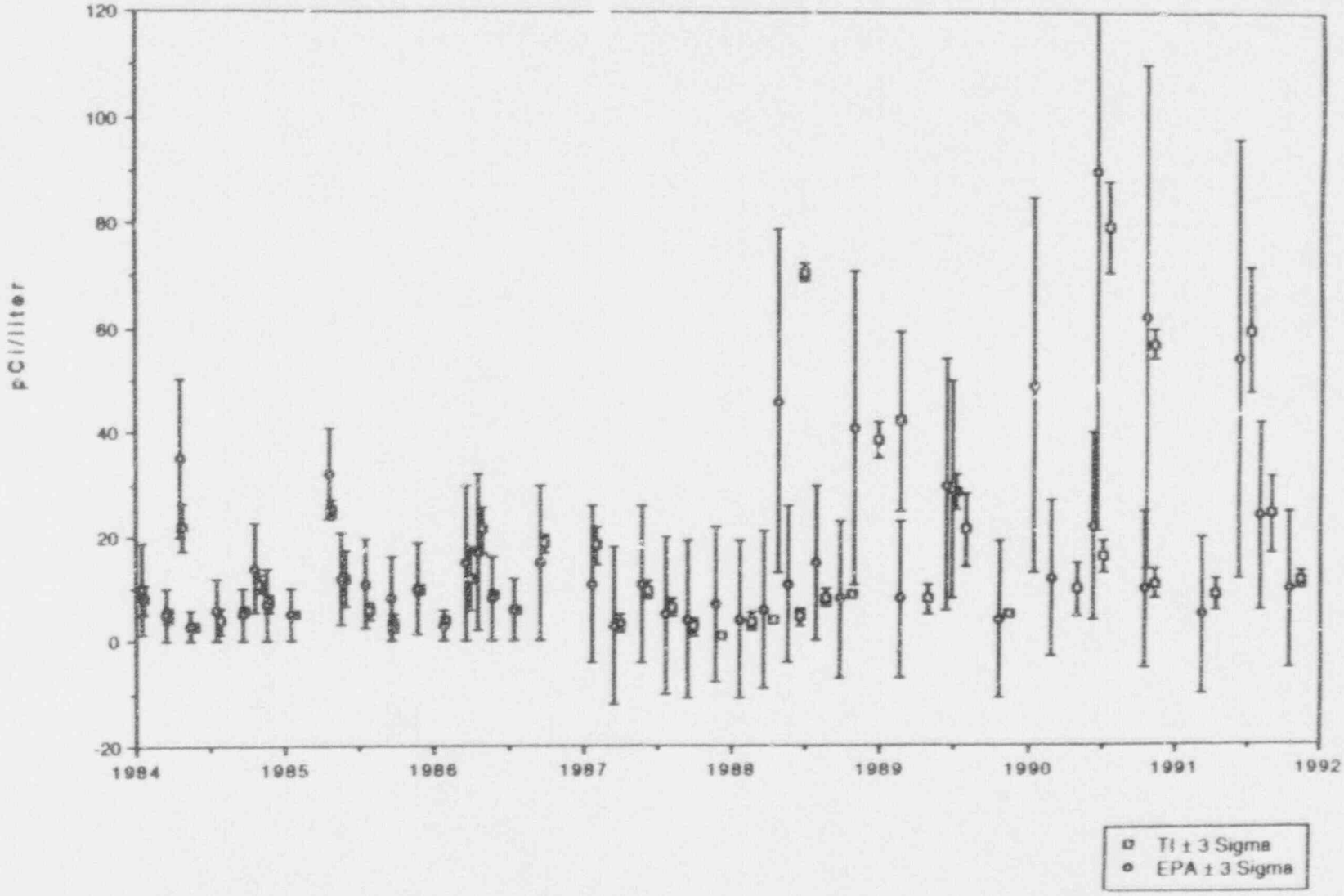
US EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER



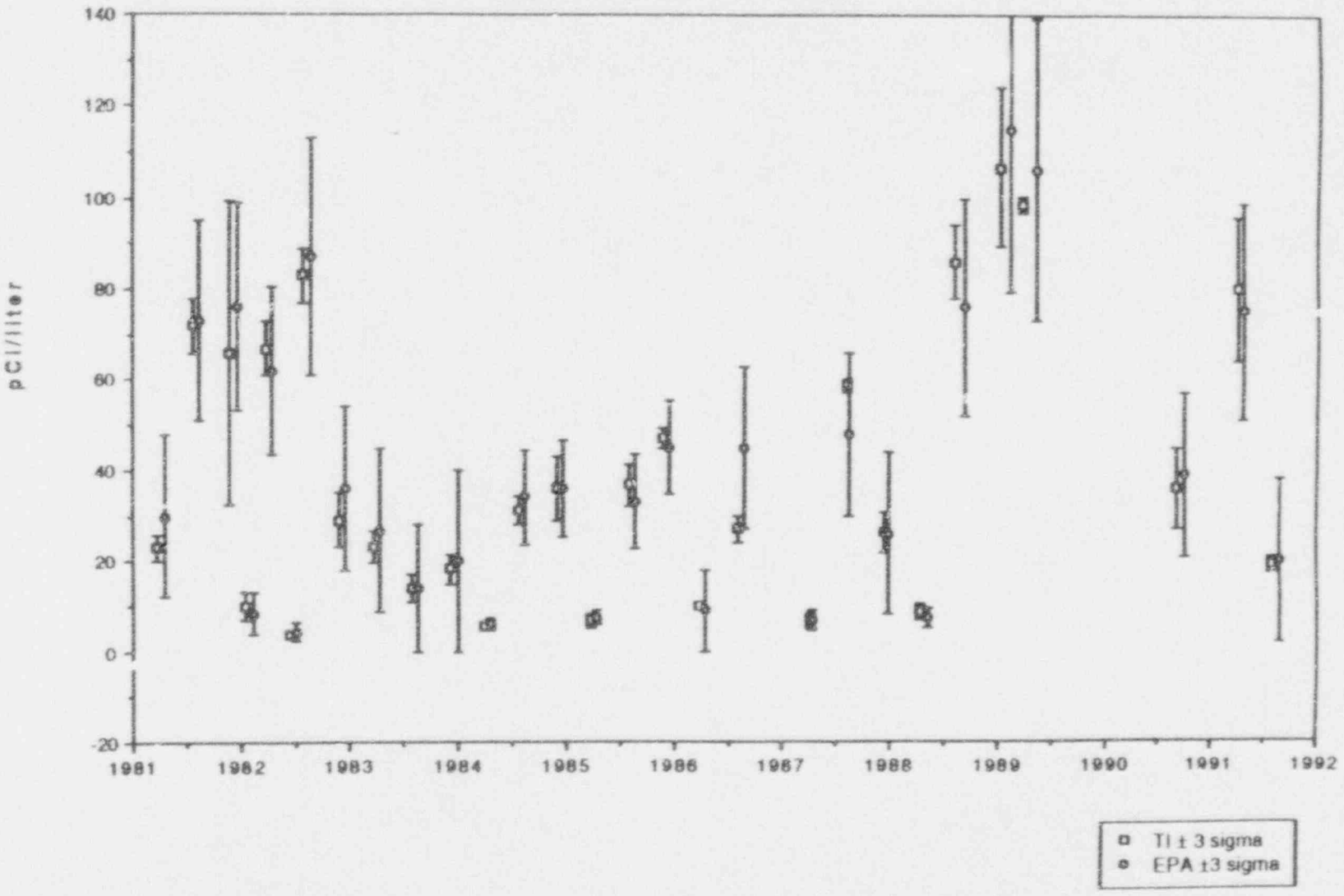
US EPA CROSS CHECK PROGRAM

GROSS ALPHA IN WATER



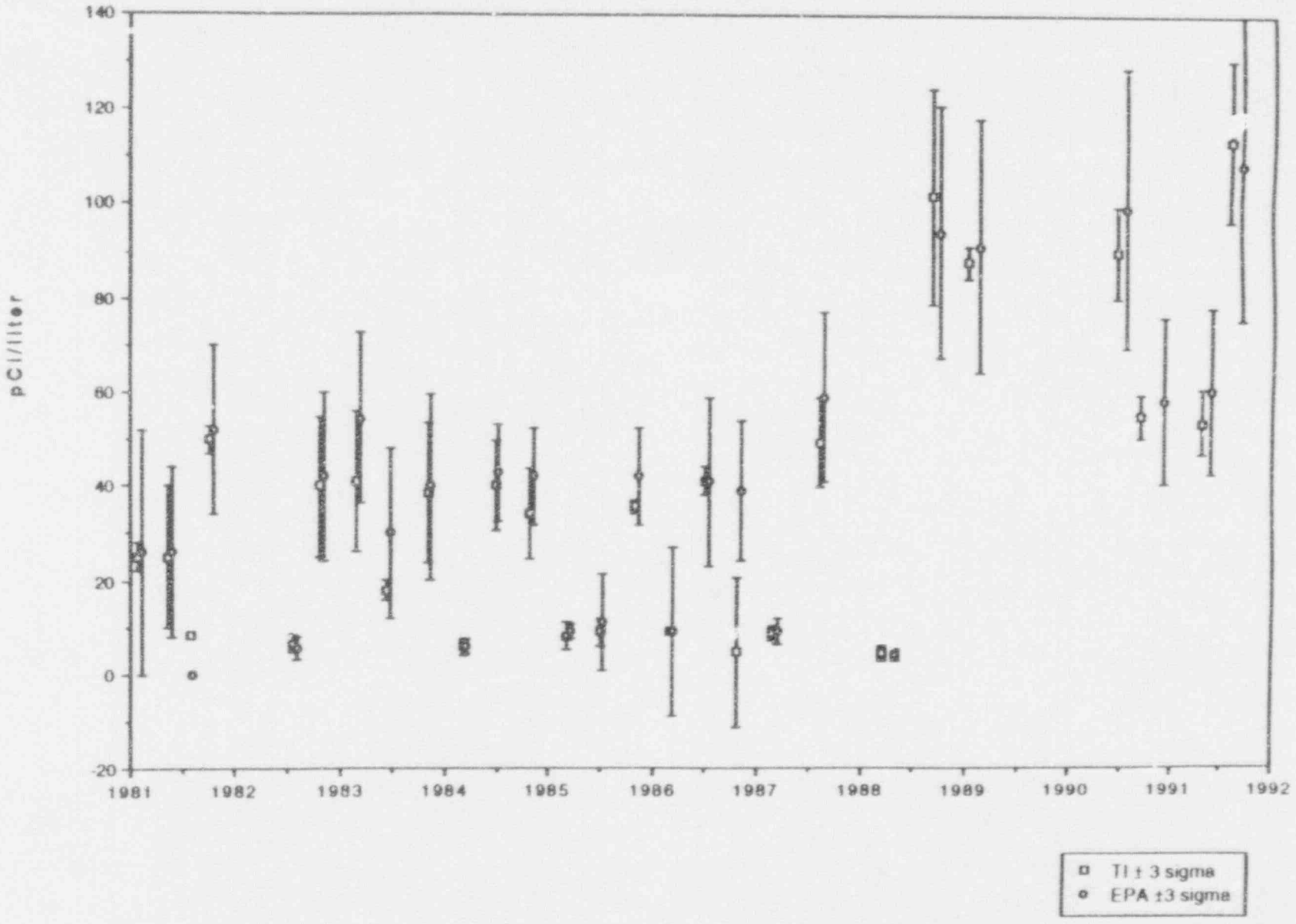
US EPA CROSS CHECK PROGRAM

IODINE-131 IN WATER



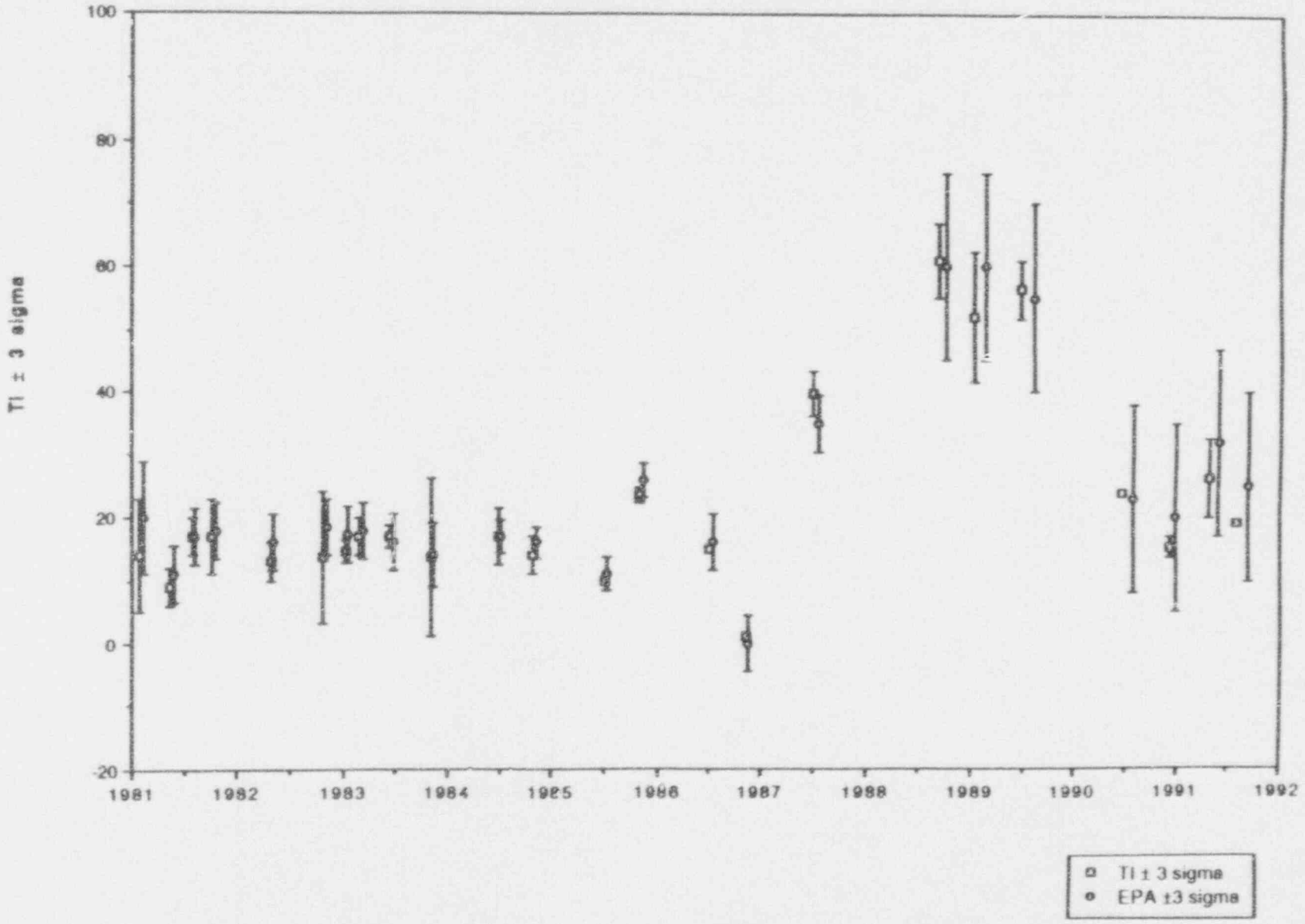
US EPA CROSS CHECK PROGRAM

IODINE-131 IN MILK



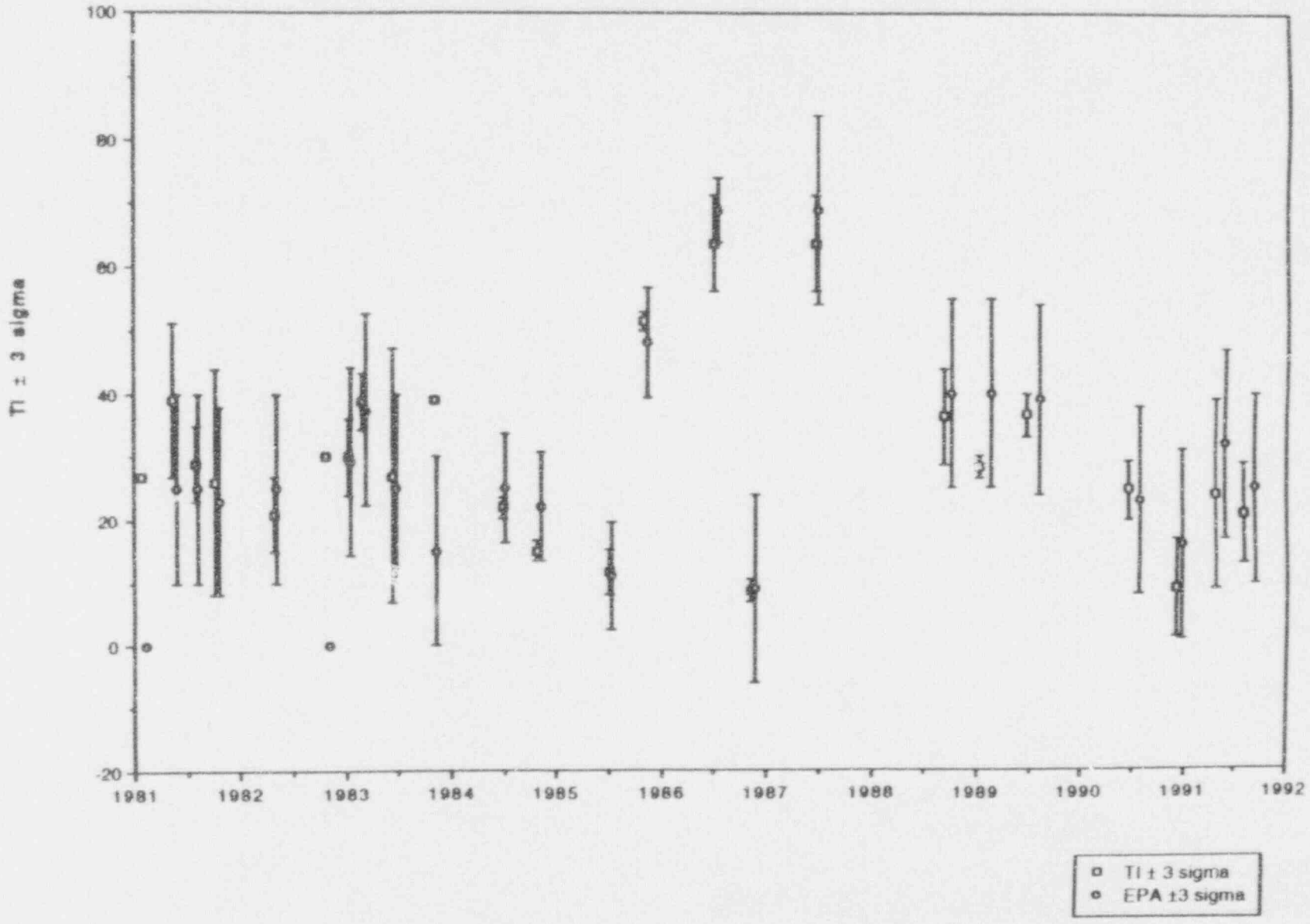
US EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN MILK



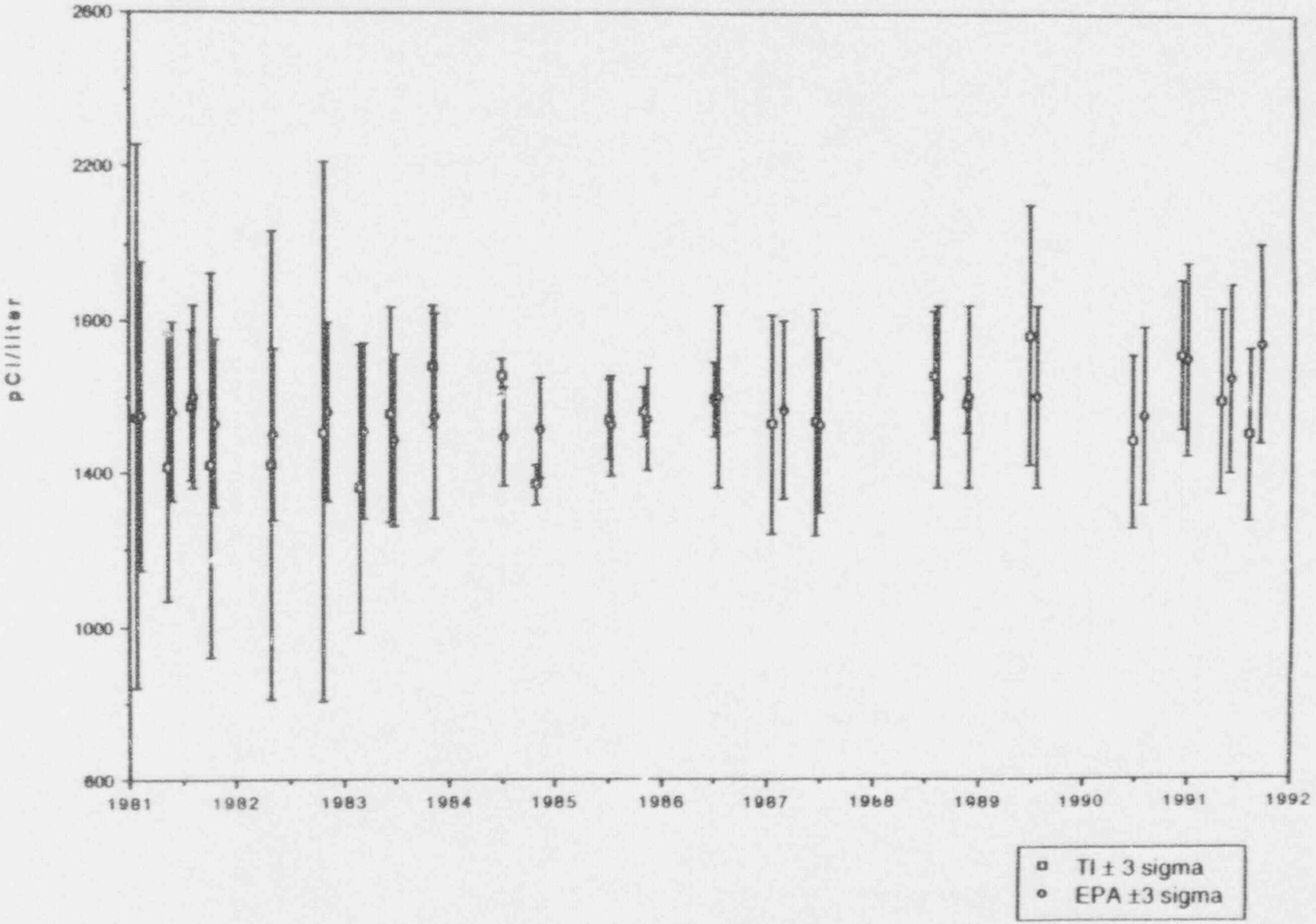
US EPA CROSS CHECK PROGRAM

STRONTIUM-89 IN MILK



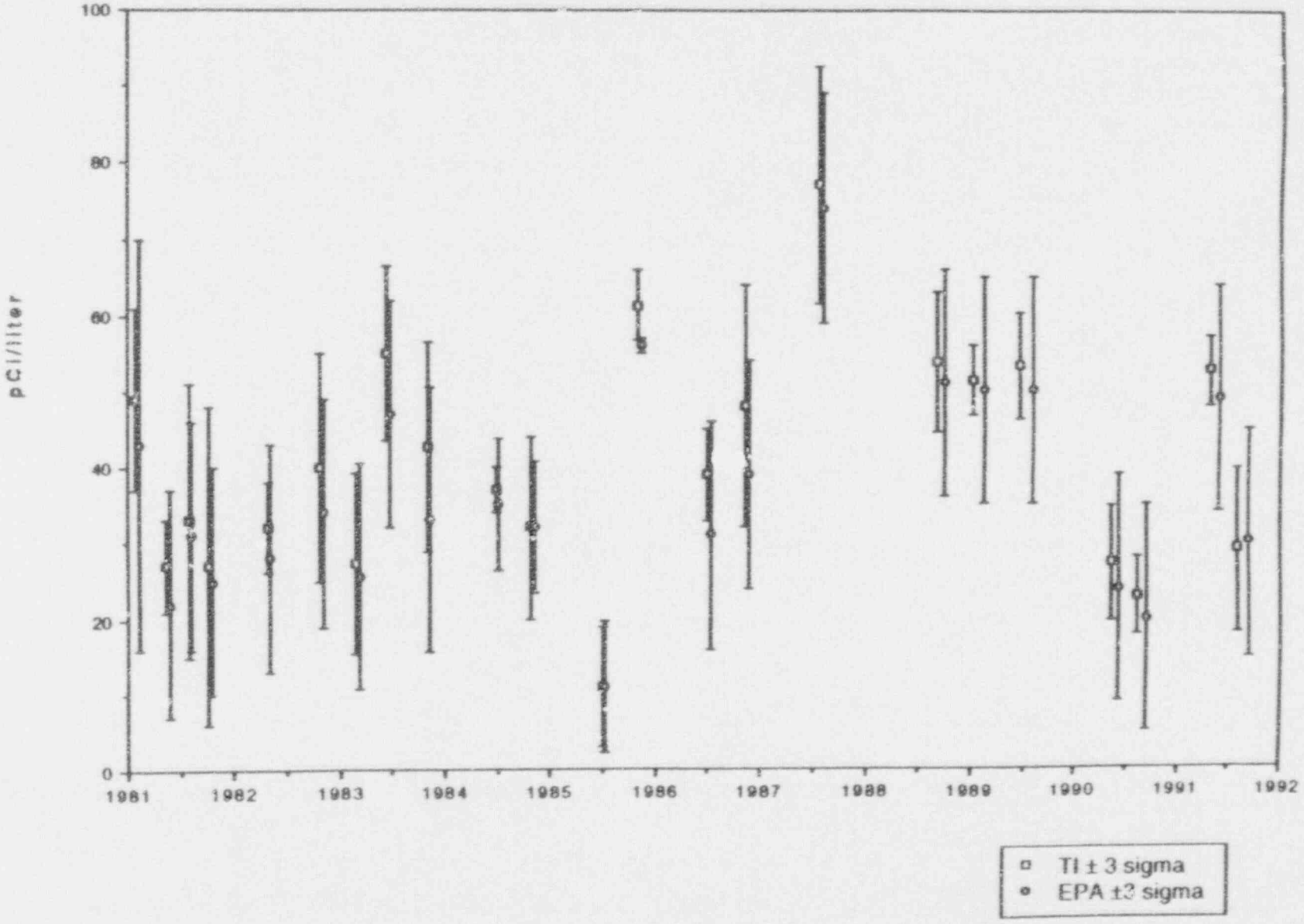
US EPA CROSS CHECK PROGRA.

POTASSIUM-40 IN MILK



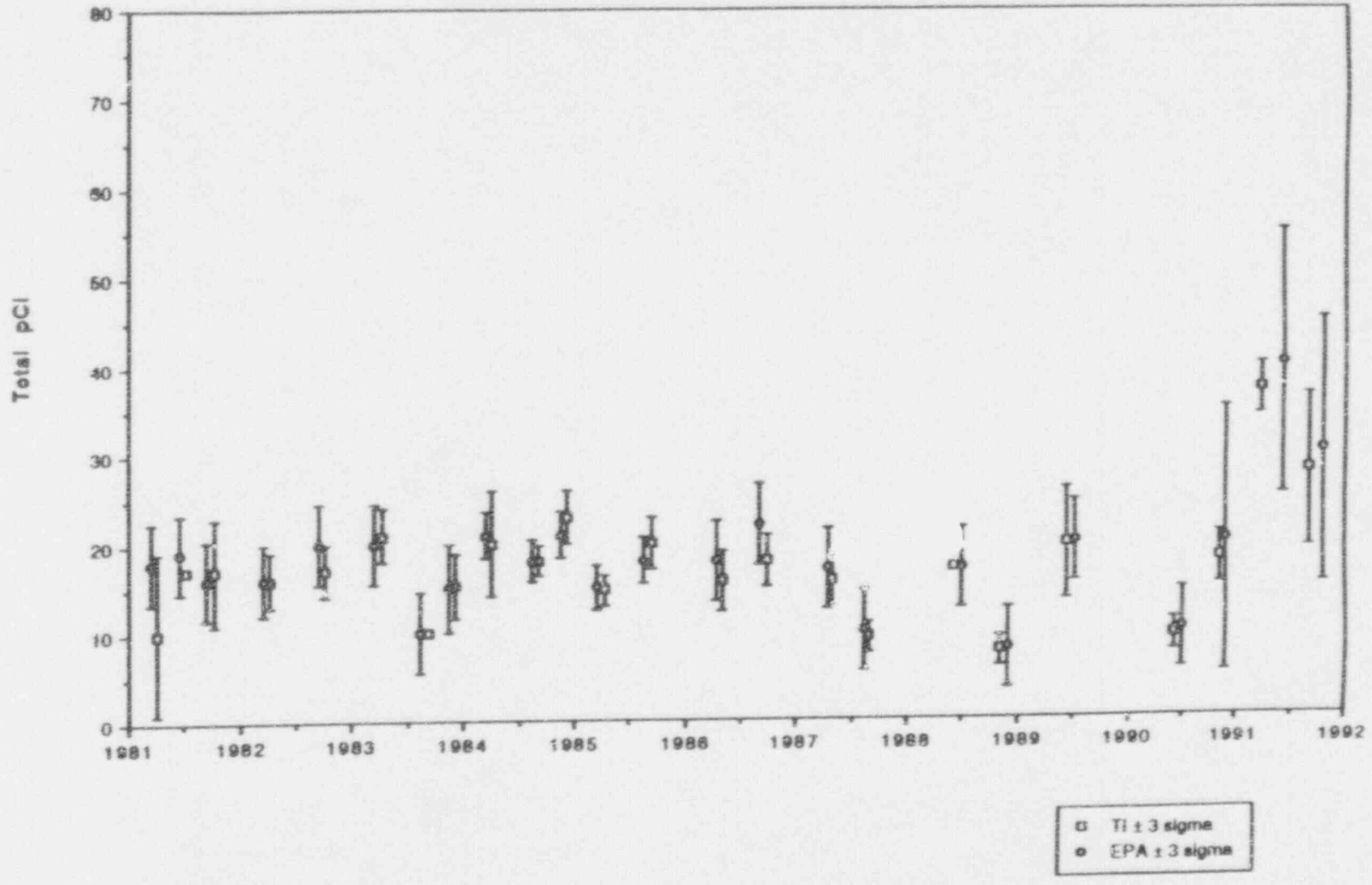
US EPA CROSS CHECK PROGRAM

CESIUM-137 IN MILK



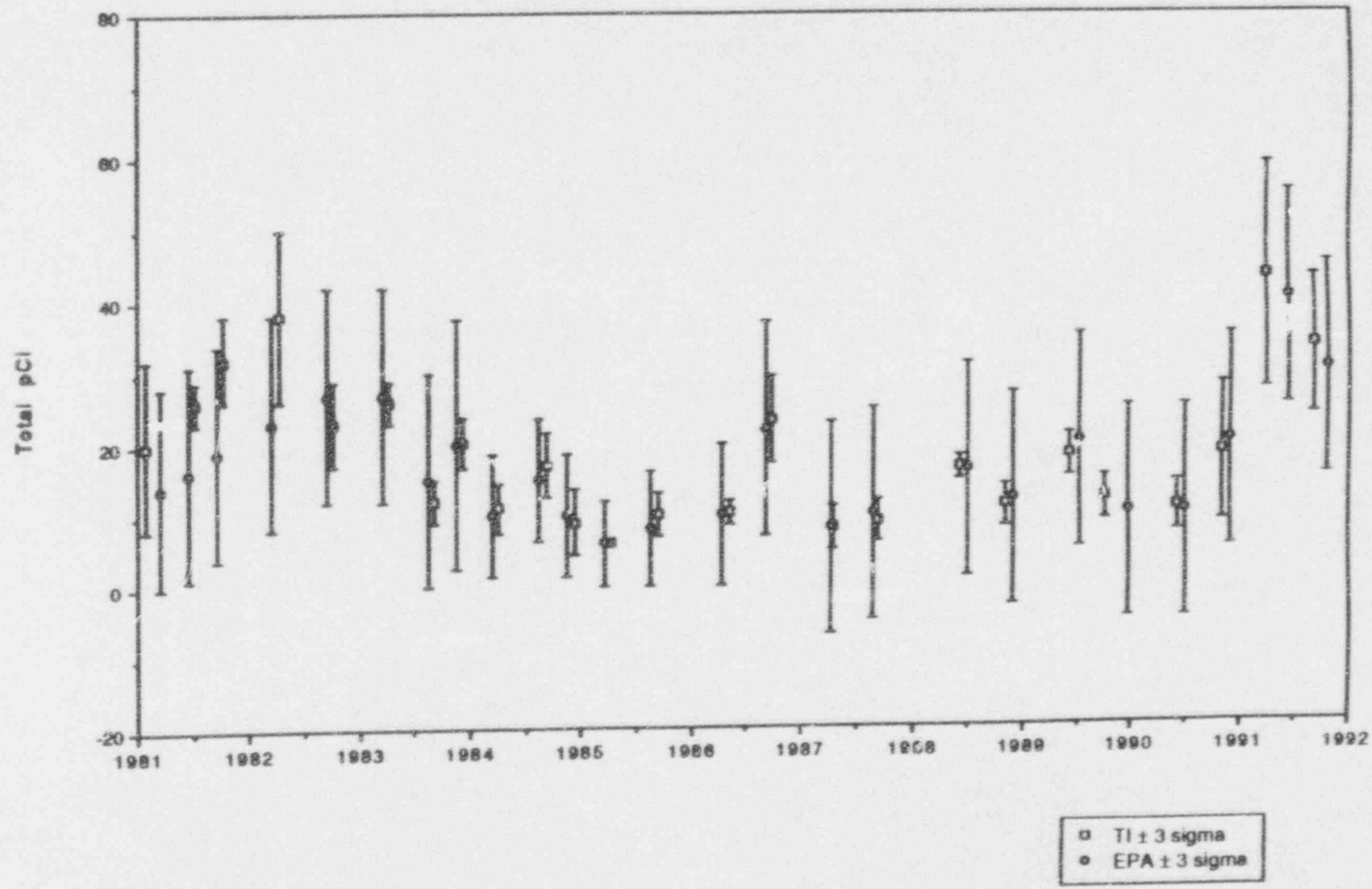
US EPA CROSS CHECK PROGRAM

STRONTIUM-90 IN AIR PARTICULATES



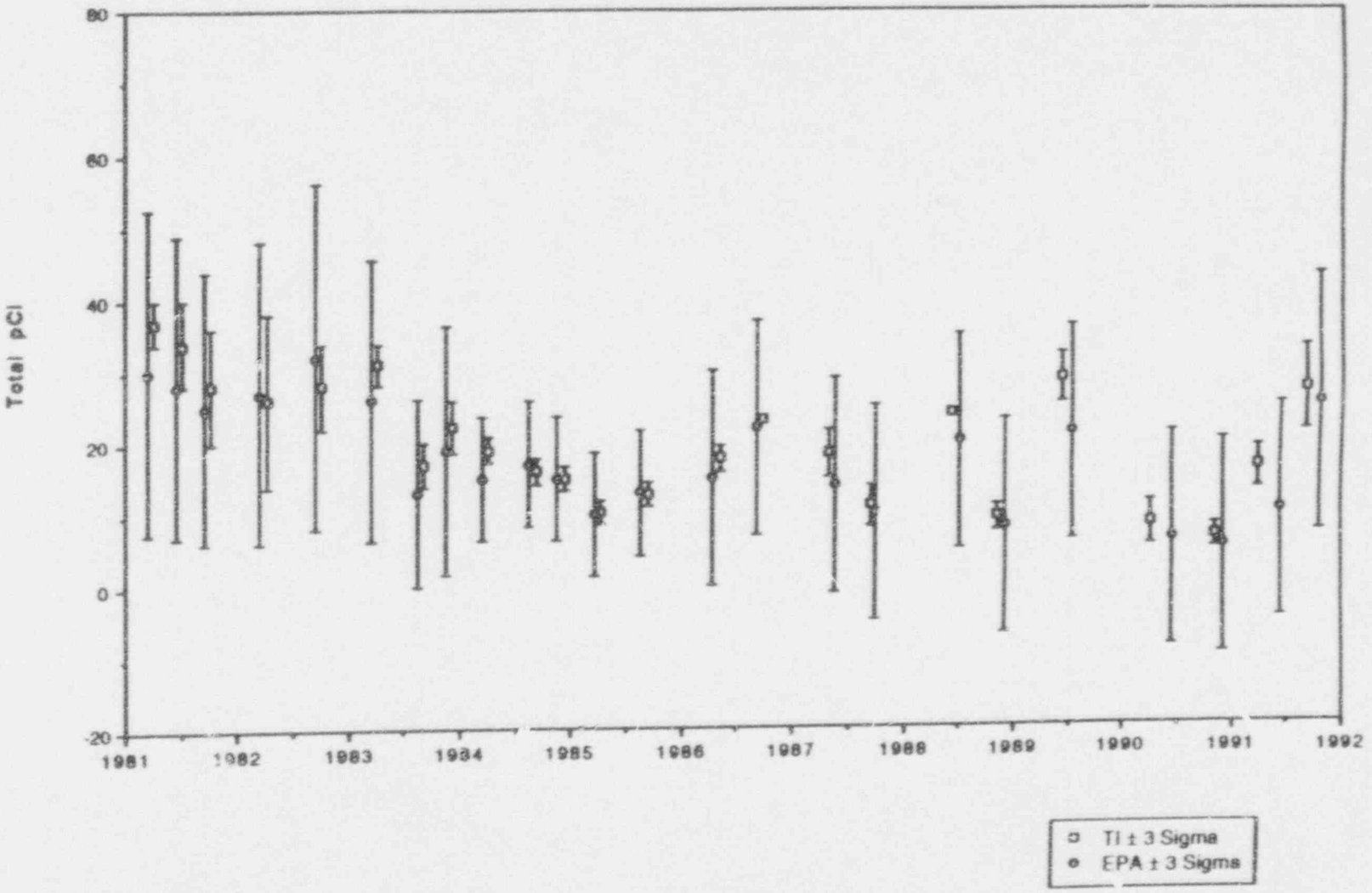
US EPA CROSS CHECK PROGRAM

CESIUM-137 IN AIR PARTICULATES



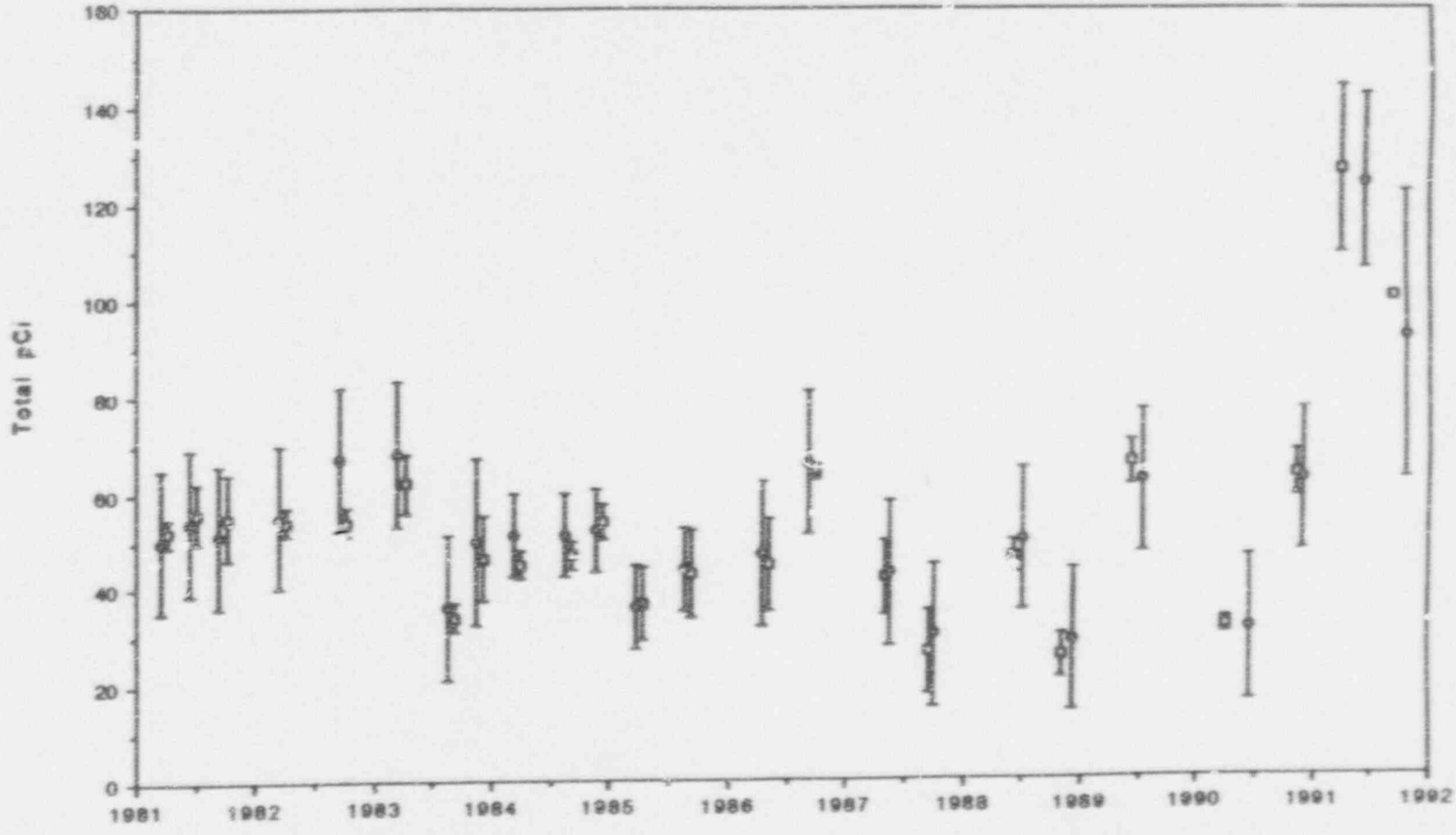
US EPA CROSS CHECK PROGRAM

GROSS ALPHA IN AIR PARTICULATES



US EPA CROSS CHECK PROGRAM

GROSS BETA IN AIR PARTICULATES



* 06/25/89 EPA test invalid.